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Centrality Computation in Weighted Networks Based On Edge-Splitting Procedure

Ivan Belik, Norwegian School of Economics, Norway
Kurt Jörnsten, Norwegian School of Economics, Norway

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Abstract
The analysis of social network's centralities has a high-level significance for many real-world applications. The variety of game and graph theoretical approaches has a paramount purpose to formalize a relative importance of nodes in social networks. In this paper we represent an algorithm for the centrality calculation in the domain of weighted networks. The given algorithm calculates network centralities for weighted graphs based on the proposed procedure of edges' splitting. The approach is tested and illustrated based on different types of network topologies.

Keywords: network centrality, weighted graphs, edge splitting

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Introduction
The variety of approaches for the analysis of network centralities has a purpose to understand and formalize a relative importance of nodes on graphs (i.e., networks). The classical approaches are based on the structural measurements that come from graph theory. Centralities based on degree (Freeman, 1979), closeness (Beauchamp, 1965; Sabidussi, 1966), betweenness (Anthonisse, 1971; Freeman, 1977), and information (Wasserman, 1994) are the most common measures. Also there exist centrality measures for the analysis of node's importance in complex networks: percolation centrality (Piraveenan, Prokopenko, & Hossain, 2013), cross-clique centrality (Faghani & Nguyen, 2013), etc. Details about each of these network centralities can be found in the corresponding literature. However, it is important to notice that the majority of the mentioned topological measures are based on two main concepts: (a) the analysis of different types of flows transferred across a network (Borgatti, 2005), and (b) the analysis of cohesiveness of a network (Borgatti & Everett, 2006).

There is a family of measures that are constructed based on the combination of graph and game theoretic concepts (Gómez, González-Arangüena, Manuel, Owen, del Pozo, & Tejada, 2003; Suri & Narahari, 2008). Specifically, Shapley Value (Shapley, 1952; Littlechild & Owen, 1973; Gul, 1989), which is considered as one of the most important concepts in coalition games, was employed by Aadithya, Ravindran, Michalak, & Jennings (2010) to measure an importance (i.e., centrality) of nodes in networks. According to Aadithya et al. (2010) the equation of Shapley value (SV) for player i in the coalition game with n players is the following:

$$SV_i(v) = \sum_{S \subseteq N \setminus \{i\}} \frac{|S|!(n-|S|-1)!}{n!} \left(v(S \cup \{i\}) - v(S) \right), \qquad (1)$$

where:
N is the set of n players;
v is the characteristic function: $2^N \rightarrow \mathbb{R}$; $v(\emptyset) = 0$.

Aadithya et al., 2010 introduced the idea of SV application "in the domain of networks, where it is used to measure the importance of individual nodes, which is known as game theoretic network centrality".
Consider graph $G(V,E)$ and $v_i \in V$. Then $N_G(v_i)$ denotes the set of all neighboring nodes that are reachable from v_i in at most one hop within $G(V,E)$.
The degree of node v_i is defined by $deg_G(v_i)$. According to Aadithya et al. (2010) The SV interpretation for node v_i in $G(V,E)$ is the following:

$$SV(v_i) = \sum_{v_j \in \{v_i\} \cup N_G(v_i)} \frac{1}{1 + deg_G(v_j)}, \qquad (2)$$

The formulation represented in equation (2) "is an exact closed-form expression for computing the SV of each node on the network" (Aadithya et al., 2010).

Centrality Measure In Weighted Networks
Since weights play an important role in networks it is necessary to consider them as one of the key factors when measuring centralities. We assume that nodes in graphs with the same structure, but with different weights should have different centralities depending on the given weights. Inspired by ideas represented in Aadithya et al. (2010) we developed the algorithm to measure the importance of nodes in weighted graphs.

The core idea of the algorithm is to split edges into sub-edges based on their weights. Specifically, we split an edge with weight w into w-number sub-edges, where the weight of each sub-edge is equal to "1".

Consider the weighted graph G(V,E) where for each node (u, v) the specific weight w is assigned. The algorithm of edges' split into single-weighted (i.e., w=1) sub-edges is the following:

Weight-Split G(V,E)
1   **FOR** each edge $(u, v) \in$ G.E **do**:
2   Split edge (u, v) into w-number of sub-edges $\{(u, v)'_1, \ldots, (u, v)'_w\}$;
3   **FOR** i=1 to w **do**:
4                $w'(u, v)'_i = 1$;
5   **end**
6   **end**
7   return WEIGHT-SPLITTED-GRAPH $G'(V', E')$

Note: $\forall (u, v) \in$ G.E: $\sum_{i=1}^{w} w'(u, v)'_i = w(u, v)$; i={1,…, w };

According to lines 2-4 of WEIGHT-SPLIT G(V,E) each edge of graph G(V,E) has to be split into w sub-edges, where each sub-edge has a weight of "1".

The trivial example of how WEIGHT-SPLIT G(V,E) works is represented in Figure 1.
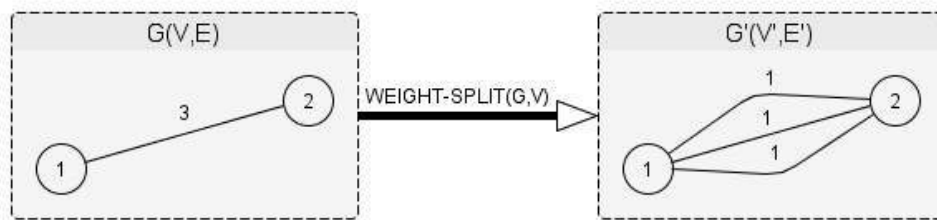
Figure 1. Edge-splitting procedure

According to Figure 1 there is a graph G(V,E) that consists of two nodes and the edge between them with the weight of "3". Applying WEIGHT-SPLIT G(V,E) we get a new graph $G'(V', E')$ with three sub-edges, where each sub-edge has a weight equal to 1.

The WEIGHT-SPLIT G(V,E) procedure is the initial stage of the algorithm that calculates centrality measures for each node of a graph.

We consider the centrality measure of a node as its individual level of importance on the network. Specifically, we introduce the algorithm for the centrality measurement in weighted networks. Since the given algorithm is based on the idea of splitting weighted edges into sub-edges, we call the proposed centrality measure as Split-based Centrality (SC). The algorithm for SC-calculation is the following:

Centrality-Computing G(V,E)
1   WEIGHT-SPLIT G(V,E)
2   Total=0;
3   **FOR** each vertex u ∈ G.V **do**:
4   V[u]=0;
5   **FOR** each edge $(u, v) \in$ G.E **do**:
6   **FOR** each sub-edge $(u, v)' \in$ G′.E′ **do**:
7   V[u]+=$\frac{1}{1+\text{Neig}(u)} + \frac{1}{1+\text{Neig}(v)}$;
8   **end**
9   **end**
10   Total=Total + V[u];
11   **end**
12   **FOR** each vertex u ∈ G.V **do**:
13   SC[u]= $\frac{V[u]*|G.V|}{\text{Total}}$;
14   **end**
15   return all SCs

Notation:
V(node) is an intermediate non-normalized value   for Split-based Centrality calculation;
Neig(node) is the number of neighboring vertices directly connected to the current node;
SC(node) is the Split-based Centrality measure;
|G.V| is the cardinality of the set of vertices G.V

To show how the algorithm works we consider a trivial example represented in Figure 2.
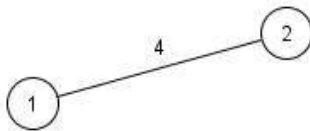
Figure 2. Illustrative example

We apply CENTRALITY-COMPUTING G(V,E) to calculate SCs in the graph represented in Figure 2. According to line 1 of the algorithm, we split the only edge (1,2) with *w*= 4 into four sub-edges. The weight of "1" is assigned to each sub-edge based on the WEIGHT-SPLIT algorithm (see Figure 3).
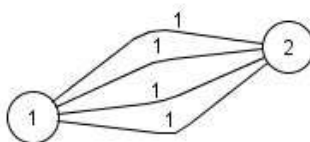
Figure 3. Illustrative example with split weight

Next, following lines 2-15 we calculate SCs for all vertices in the graph. Line 3 initiates the cycle to go through the list of all nodes in G(V,E). In line 4 we assign zero-value to V of the current vertex. Every time, when the algorithm starts to calculate V for the next vertex of the graph, line 4 resets V to zero-value. Line 5

initiates the process of going through the list of all edges of the current vertex. Line 6 extracts all sub-edges $(u, v)' \in G'. E'$ that are encapsulated in the currently processed edge $(u, v) \in G. E$. Line 7 accumulates all V sub-values going through all edges and sub-edges of the currently analysed vertex $u \in G.V$. It is important to notice that the idea of V-calculation (as the main component of SC) is interrelated with the formalization of SV represented in equations (1)-(2). Next, we tot up Vs of all vertices $u \in G.V$ getting Total-value in line 10. In lines 12-14 we normalize the results calculating SCs for each vertex $u \in G.V$. Finally, in line 15 we get SCs of all vertices in G(V,E).

For our trivial example represented in Figures 2-3 we get SC[1]=SC[2]=1.
In section 3 we represent SC-calculation results applying the algorithm in different network topologies.

Application In Different Network Topologies
3.1 "Point-to-point" or "Line" topology

The initial structure of the weighted "point-to-point" graph is represented in Figure 4. It is characterized by two nodes with the following weights: $w(1,2)=4$ and $w(2,3)=5$. Applying the CENTRALITY-COMPUTING algorithm we get the graph with split weights represented in Figure 5. The results of SC calculations are represented in Table 1. Since node 1 has the only neighbor node 2 (i.e., Neig(1)=1) and $w(1,2)=4$ we get four sub-edges connecting node 1 and node 2. Similarly, node 3 has the only neighbor node 2, but $w(2,3)=5$. In this case we get five sub-edges connecting node 3 and node 2. Based on the CENTRALITY-COMPUTING algorithm we have SC(1)=0.667 and SC(3)=0.833. Both nodes are connected to node 2 only, but the weights of initial links (i.e., edges) are different. As the result SC(1)<SC(3). Node 2 connected to both mentioned nodes, and it has nine sub-edges in total. Playing the role of a hub it gets the highest SC=1.5.

Table 1. SCs calculation for the "point-to- point" topology

#	node	Neig	SC
1	1	1	
2	1	1	0.667
3	1	1	
4	1	1	
5	2	2	
6	2	2	
7	2	2	
8	2	2	
9	2	2	1.500
10	2	2	
11	2	2	
12	2	2	
13	2	2	
14	3	1	
15	3	1	
16	3	1	0.833
17	3	1	
18	3	1	
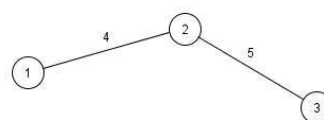
Figure 4. Weighted "Point-to-point" graph
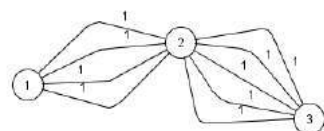
Figure 5. "Point-to-point" graph with split weights

3.2 "Star" topology

"Star" topology is characterized by the existence of a centric node, which is connected to all other nodes on the network. All nodes, excluding the centric one, form an independent set (Robson, 1986; Boppana & Halldórsson, 1992; Merris, 2003). The "star" graph with established weights is represented in Figure 6. It is characterized by three links with the following weights: $w(1,2)=3$, $w(1,3)=2$, $w(1,4)=4$. Applying CENTRALITY-COMPUTING to the given graph we get the graph with split weights (see Figure 7) and SCs computational results (see Table 2). Based on the corresponding weights, edge (1,2) is split into three sub-edges, edge (1,3) – into two and edge (1-4) – into four. Nodes 2, 3 and 4 are connected to node 1 only, but weights of their initial links are different. The computational results are the following: SC(2) = 0.667; SC(3)=0.444; SC(4)=0.889. Node 1 is connected to all others, and it is characterized by 18 sub-edges in total. Playing the role of a hub it gets the highest SC=2.0.

Table 2. SCs calculation for the "star" topology

#	node	Neig	SC
1	1	3	
2	1	3	
3	1	3	
4	1	3	
5	1	3	2.000
6	1	3	
7	1	3	
8	1	3	
9	1	3	
10	2	1	
11	2	1	0.667
12	2	1	
13	3	1	0.444
14	3	1	
15	4	1	
16	4	1	0.889
17	4	1	
18	4	1	
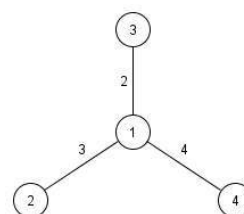
Figure 6. Weighted "star" graph
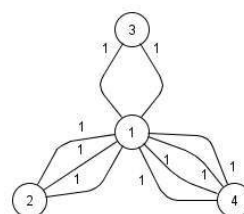
Figure 7. "Star" graph with split weights

3.3 "Ring" topology

"Ring" topology is characterized by sequential connection of each node to exactly two other nodes forming a cycle. There is no leading node in a "ring"-based structure, and the deletion of at least one edge may cause the destructive effect of the overall network. We consider two types of "ring" topologies: (a) graph with even number of nodes (b) graph with odd number of nodes.

3.3.1 "Ring" topology with even number of nodes

The graph with assigned weights is represented in Figure 8. It consists of four nodes connected by edges with the following weights: $w(1,2)=2$, $w(2,3)=3$, $w(3,4)=4$, $w(4,1)=5$. Applying the CENTRALITY-COMPUTING algorithm we get a modified graph based on weights' split (see Figure 9). The resulting SCs are represented in Table 3. Node 2 gets the smallest SC=0.714 based on five sub-edges created within

two links: (1,2) and (2,3). Node 4 has the highest SC=1.286. It is characterized by two "heaviest" links (i.e., $w(3,4)=4$ and $w(4,1)=5$) that split into nine sub-edges.
Table 3. SCs calculation for the "ring"
topology with even number of nodes

#	node	Neig	SC
1	1	2	
2	1	2	
3	1	2	
4	1	2	1.000
5	1	2	
6	1	2	
7	1	2	
8	2	2	
9	2	2	
10	2	2	0.714
11	2	2	
12	2	2	
13	3	2	
14	3	2	
15	3	2	
16	3	2	1.000
17	3	2	
18	3	2	
19	3	2	
20	4	2	
21	4	2	
22	4	2	
23	4	2	
24	4	2	1.286
25	4	2	
26	4	2	
27	4	2	
28	4	2	

Figure 8. Weighted "ring" graph with even number of nodes
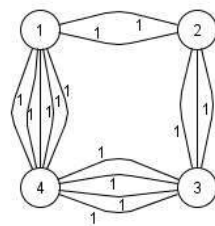
Figure 9. "Ring" graph (even number of nodes)

with split weights

3.3.2 "Ring" topology with odd number of nodes

We calculate SCs for the "ring" graph with odd number of nodes. The initial graph structure is represented in Figure 10. It consists of five nodes connected by five edges with the following weights: $w(1,2)=2$, $w(2,3)=3$, $w(3,4)=4$, $w(4,5)=5$ and $w(5,1)=1$. Applying the CENTRALITY-COMPUTING algorithm we get the graph with split weights (see Figure 11) and the resulting SCs (see Table 4).

Table 4. SC calculations for the "ring" topology with odd number of nodes

#	node	Neig	SC
1	1	2	
2	1	2	0.500
3	1	2	
4	2	2	
5	2	2	
6	2	2	0.833
7	2	2	
8	2	2	
9	3	2	
10	3	2	
11	3	2	
12	3	2	1.167
13	3	2	
14	3	2	
15	3	2	
16	4	2	
17	4	2	
18	4	2	
19	4	2	
20	4	2	1.500
21	4	2	
22	4	2	
23	4	2	
24	4	2	
25	5	2	
26	5	2	
27	5	2	1.000
28	5	2	
29	5	2	
30	5	2	

Figure 10. Weighted "ring" graph with odd number of nodes
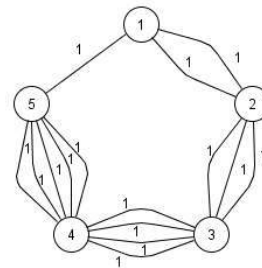
Figure 11. "Ring" graph (odd number of nodes)

with split weights

3.4 Mixed topology

We consider a graph as a mixed structured if it is represented by different combinations of trivial topologies, such as "point-to-point", "ring" and "star". The initial graph structure is represented in Figure12. It includes seven nodes connected by the following links with assigned weights:

$w(1,2)=5$; $w(4,5)=4$;
$w(1,3)=2$; $w(5,6)=4$;
$w(2,3)=3$; $w(5,7)=2$;
$w(3,4)=2$; $w(6,7)=3$.

Based on the CENTRALITY-COMPUTING algorithm we get the graph with split weights (see Figure 13). SC computational results are represented in Table 5. Node 5 has got the highest SC=1.339 based on three links split into ten sub-edges. Node 7 is the node with the minimum SC-value: SC(7)=0.727. It is based on the split of two links ($w(5,7)=2$ and $w(6,7)=3$) into 5 sub-edges in total.

Table 5. SCs calculation for the mixed topology

#	node	Neig	SC
1	1	2	
2	1	2	
3	1	2	
4	1	2	1.033
5	1	2	
6	1	2	
7	1	2	
8	2	2	
9	2	2	
10	2	2	
11	2	2	
12	2	2	1.167
13	2	2	
14	2	2	
15	2	2	
16	3	3	
17	3	3	
18	3	3	
19	3	3	0.937
20	3	3	
21	3	3	
22	3	3	
23	4	2	
24	4	2	
25	4	2	
26	4	2	0.803
27	4	2	
28	4	2	
29	5	3	
30	5	3	
31	5	3	
32	5	3	
33	5	3	
34	5	3	1.339
35	5	3	
36	5	3	
37	5	3	
38	5	3	
39	6	2	
40	6	2	
41	6	2	
42	6	2	0.995
43	6	2	
44	6	2	
45	6	2	
46	7	2	
47	7	2	
48	7	2	0.727
49	7	2	
50	7	2	
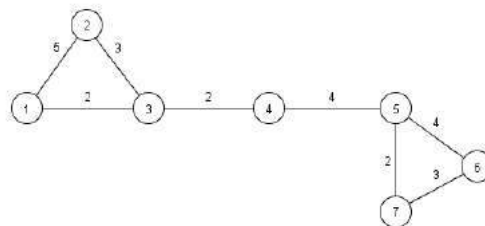
Figure 12. Weighted mixed graph
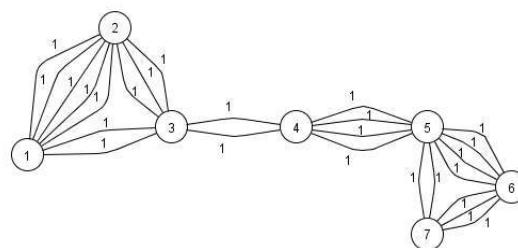
Figure 13. Mixed graph with split weights

Conclusion

In the given paper we represented an algorithm for centrality calculation in weighted networks. The algorithm consists of two sub-components. The first component (i.e., WEIGHT-SPLIT) processes edges' weights. Specifically, it splits network links into sub-links (i.e., sub-edges) based on the corresponding weights. This procedure is polynomially executable in terms of running time. As the result of the first component execution, we get a modified graph to be processed for the Split-based Centrality calculation. The second subcomponent of the CENTRALITY-COMPUTING algorithm is based on the weight-splitting concept. Going through all edges and through the corresponding sub-edges of each node in the network, we accumulatively calculate SC-values. Therefore, the procedure has an iterative nature running in polynomial time to calculate SC-values for every node on the network. Next, we apply the CENTRALITY-COMPUTING algorithm to different types of network topologies, such as "point-to-point", "star", "ring", and "mixed". The results are represented in tabular and graphical formats. Analyzing network centralities it is necessary to consider edges' weights as an important factor as well as the structural factor. In this paper we maintain a statement that the importance of network nodes depends on the corresponding weights of links. The represented algorithm is based on this statement.

References

Aadithya, K. V., Ravindran, B., Michalak, T. P., & Jennings, N. R. (2010). Efficient Computation of the Shapley Value for Centrality in Networks. In *Internet and Network Economics* (pp. 1-13). Springer Berlin Heidelberg.

Anthonisse, J. M. (1971). *The Rush in a Directed Graph.* Tech. Rep. BN 9/71, Stichting Mathematisch Centrum, 2e Boerhaavestraat 49 Amsterdam.

Beauchamp, M. A. (1965). An Improved Index of Centrality. *Behavioral Science, 10*, 161–163.

Borgatti, S. P. (2005). Centrality and network flow. *Social networks*, *27*(1), 55-71.

Borgatti, S. P., & Everett, M. G. (2006). A graph-theoretic perspective on centrality. *Social networks*, *28*(4), 466-484.

Boppana, R., & Halldórsson, M. M. (1992). Approximating maximum independent sets by excluding subgraphs. *BIT Numerical Mathematics*, *32*(2), 180-196.

Faghani, M.R.; Uyen Trang Nguyen, "A Study of XSS Worm Propagation and Detection Mechanisms in Online Social Networks," *Information Forensics and Security, IEEE Transactions on* , vol.8, no.11, pp.1815,1826, Nov. 2013

Freeman, L. C. (1977). A Set Of Measures of Centrality Based upon Betweenness. *Sociometr*y, *40*, 35–41.

Freeman, L. C. (1979). Centrality in Social Networks: Conceptual Clarification. *Social Networks, 1*, 241–256.

Gómez, D., González-Arangüena, E., Manuel, C., Owen, G., del Pozo, M., & Tejada, J. (2003). Centrality and power in social networks: a game theoretic approach. *Mathematical Social Sciences*, *46*(1), 27-54.

Gul, F. (1989). Bargaining foundations of Shapley value. *Econometrica: Journal of the Econometric Society*, 81-95.

Littlechild, S. C., & Owen, G. (1973). A simple expression for the Shapley value in a special case. *Management Science*, *20*(3), 370-372.

Merris, R. (2003). Split graphs. *European Journal of Combinatorics*, *24*(4), 413-430.

Piraveenan, M., Prokopenko, M., & Hossain, L. (2013). Percolation centrality: Quantifying graph-theoretic impact of nodes during percolation in networks. *PloS one*, *8*(1), e53095.

Robson, J. M. (1986). Algorithms for maximum independent sets. *Journal of Algorithms*, *7*(3), 425-440

Sabidussi, G. (1966). The Centrality Index of a Graph. *Psychometrika, 31*, 581–603.

Shapley, L. S. (1952). *A value for n-person games* (No. RAND-P-295). RAND CORP SANTA MONICA CA.

Suri, N. R., & Narahari, Y. (2008, May). Determining the top-k nodes in social networks using the shapley value. In *Proceedings of the 7th international joint conference on Autonomous agents and multiagent systems-Volume 3* (pp. 1509-1512). International Foundation for Autonomous Agents and Multiagent Systems.

Wasserman, S. (1994). *Social Network Analysis: Methods and Applications*(Vol. 8). Cambridge University Press.

Inspecting the Bad Society? Bentham's Panopticon Revisited

Alistair S. Duff, Edinburgh Napier University, Scotland

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Abstract

In Panopticon; or, The Inspection-House, the utilitarian philosopher Jeremy Bentham outlined what he perceived to be a model prison, based on the 'inspection-principle'. It was centrally about power, the control of miscreants by subjecting them to total visibility. Even more worryingly, he claimed that his model applied equally to schools, hospitals, and other innocent institutions. In a postscript, he added chapels to his list, but one could argue that he had already usurped God. Michel Foucault's influential treatment of Panopticism developed Bentham-inspired themes which resonate increasingly loudly in the information age, such as surveillance systems, automatic power, permanent registration, etc. The paper pursues this discussion in light of the normative crisis facing post-industrial, informatised societies. 'What would you say, if by the gradual adoption and diversified application of this single principle, you should see a new scene of things spread itself over the face of civilized society?—morals reformed, health preserved, industry invigorated, instruction diffused...all by a simple idea in architecture?', Bentham asked. What indeed! Mr Snowden will help us with the answer.

Keywords: power abuses, information society, inspection-principle, Bentham, surveillance studies, normativity

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Introduction

Jeremy Bentham's Panopticon, the perfect prison where inmates are subjected to total inspection, is becoming as well-known as Orwell's Big Brother. People say when they are caught by a police camera or when their employer introduces another Nosey-Parker system, 'it is the Panopticon'. The central idea of the Panopticon, that we feel we are being watched but we are not sure by whom and exactly at what moment, seems to sum up modern experience. So you would think that Bentham and Michel Foucault, the late thinker who dug Bentham's prison idea out of obscurity and turned what he called panopticism into a damning critique of modernity/postmodernity, would be heroic figures. But in fact among the cognoscenti, the experts of the field of surveillance studies, they are now considered old hat. Other terms have been invented, such as the Superpanopticon, the NeoconOpticon and the Banopticon, and even the generic term surveillance has been replaced by sousveillance and dataveillance. Books and articles have started appearing with titles along the lines of 'Beyond Bentham', 'Post-Panopticism' and 'After Foucault'. Apparently, Bentham's Panopticon does not model the realities of contemporary or emerging surveillance, and Foucault's interpretation is at best an anachronism and at worst a distortion.

It is this debate that I should like to enter here. I do so with trepidation because, with a surfeit of fine scholarship already available, it is not easy to achieve an original contribution. However, the attempt must be be made. Broadly speaking, I want to argue for the continuing relevance of panopticism as a way of understanding the world we live in. I proceed as follows. First, I try to kindle a keener appreciation of what Bentham actually said, based on my own archival research. Many commentators do not seem to have read much Bentham, and I suspect that some have only read what Foucault or others have said he said. This will throw up some surprises. Secondly, I shall offer a definite reaffirmation of the value of the Panopticon as a model of contemporary and emergent surveillance, as against those who speak of post-panopticism. I will acknowledge that there has been a complexification of surveillance but argue that nevertheless panopticism is still the best way to understand key aspects of surveillance. Thirdly, I want to suggest that we need to understand that the inspection principle, Bentham's term and one of which he approved, is predicated on the assumption that we are all bad, on the bad society. Fourthly and finally, I offer some thoughts on what form resistance might take, and will defend the supposedly dull ideal of privacy as the flag under which we need increasingly to rally.

Back to Bentham: Primary Sources

The Panopticon was a new type of prison which Bentham tried to persuade the British government to build, initially in what is now central London. He advocated it tirelessly and claimed that he got the verbal backing of prime minister William Pitt, no less. It got as far as a government bill in the House of Commons, as is evident from: 'General Panopticon Penitentiary Act or an Act for the punishment and restoration of Felons, by means of a Penitentiary House of new invention, to be stiled the General Panoptic

Penitentiary House' (Panopticon Bill, box 150b folder 11). Bentham was furious that repeated administrations failed to follow through. However, in my view, it was providential that the prison was never built in Britain, because it is founded on unworkable and unethical principles.

It is fascinating to see the evolution in the archive at the Bentham Project at UCL from handwritten drawings, little more than doodles really, to quite detailed architect overviews of this supposedly perfect prison. It is basically a circular structure, with cells on the circumference for the prisoners, an inspector's lodge in the centre, galleries right next to the inspector's lodge for sub-inspectors, a brick wall between cells to prevent communication between prisoners, steel bars on the front of the cells so that nothing the prisoner does escapes notice, blinds on the windows of the inspection lodge and galleries so that inmates cannot see what is going on in the interior and have no means of knowing if they are not being watched, plus patrols to ensure the same security at night as in the day. The key point is inspection. The Panopticon is based on the 'inspection principle' (1802, box 116a folder 2), or sometimes 'the central inspection principle' (1802 Letter 3 to Lord Pelham, box 116b folder 11) or 'central-inspection principle' (Box 150 folder 10 folio 10). Bentham pointedly called his slim published book on the topic, *Panopticon; or The Inspection House* (1786 and 1790-91).

Now I would like to give some of the lowdown, and this might be a bit offensive if you are a Bentham admirer, but I cannot see how to avoid it. I approached the Bentham Papers with an open mind and I was surrounded by pro-Bentham scholars, but the evidence I saw only confirmed for me that the common negative view of the Panopticon is correct, indeed that it is unduly lenient! I have a whole catalogue of problems. I basically believe that Bentham, far from being the genius he thought he was and some today think he is, was something between a lunatic and a charlatan, and that the concept of a panoptic penitentiary was one of the worst things ever to have been foisted on an unsuspecting public.

First, there is its shoddy, ad hoc origin. One would have thought that this, Bentham's life project, would have been grounded deeply in his utilitarian philosophy, the system of thought that he argued had superseded religion, morality, politics and everything else that had gone before. You would be wrong. I could not find anything remotely approximating a rationale for the Panopticon. There are a few assertions in his Panoptic writings, but all of them unsubstantiated and often pure hyperbole, the patter of a snake-oil salesman. Admittedly, there are scraps in *Panopticon versus New South Wales* (1812), and his *Rationale of Punishment* was a substantial work, but it contains little rationale for the panopticon and it only appeared in 1830, 44 years after the *Letters*. Bentham was morally obliged, given that people's welfare and the public purse were at stake, to articulate it in sufficient detail in the original plans, to show exactly how it would lead to the greatest happiness of the greatest number, and, unless I have bungled my archival work, he did not.

Few too know that the idea was not even Bentham's own. It was his brother Samuel's, who was testing the design on the workers on a Russian aristocrat's estate. Bentham

admits he was not the author, to be fair, for example: 'for the invention of which he [JB] was principally indebted to his brother Brigadier General Bentham, the inspector general of His Majesty's naval works' (Box 150 folder 10 folio 10) and indeed at the start of *Panopticon; or The Inspection House* (1786 and 1790-91). And Bentham did usefully christen 'Panopticon' what his brother was calling 'The Inspection House' or, ironically in light of our digital fascinations, the 'Elaboratory'. There is of course nothing intrinsically wrong with borrowing someone else's idea and blowing it up into a major affair, but this ad hoc, second-hand origin should be more widely known and the aforementioned absence of a philosophical anchoring is thus even more unacceptable.

The main point is that Bentham was a big fan of the Panopticon; here the relation is quite different from that of Big Brother/Orwell. That is well-known but I would like to ask: should he have been? The whole system is classically draconian: 'absence of drunkenness and gaming total. religious exercise constant...in case of a second offence Panopticon for life would incapacitate for any third' (Cover table of contents, 1802, box 116a folder 2). He claims that other prisons to some extent resembling his model were not successful because of 'the want of compleatness in the plan of separation' (1802 Letter 3 to Lord Pelham, box 116b folder 11) and because they failed to add to total separation 'occupation, profitable or at least innocent, to fill up the mind with useful ideas or at least innocent ones, and by that repletion to exclude mischievous ones' (Letter 3 to Lord Pelham, box 116b folder 11). Worst of all, the cells had only one inmate in them. He justified this on what one might call anecdotal-consequentialist grounds: 'it has more than once happened to myself to be in the same room for a considerable time together, and I cannot say I ever found any bad consequence from it' (quoted in Semple, 1993, p. 123). However, he eventually (*Postscript*), after negative feedback from the great Christian prison-reformer John Howard, who had criticised solitary confinement as being inhumane as well as expensive, changed it to up to 6 per cell—thereby, one would have thought, nullifying much of what passed for the rationale of the whole scheme.

There is so much that could be said against this design (see also Steadman, 2011). Indeed, if there was ever nonsense on stilts it was this idea of the Panopticon penitentiary. At a practical level, it was a nonstarter. It was architecturally absurd, with no natural light going to the centre, nowhere for the warden to live, the prisoners had better views of cells than the warders, they could tell if someone was in, there was no escape for wardens in the event of a riot (he had to put in an expensive secret tunnel), it was psychologically absurd because it was based on solitary confinement and deception, it was ethically wrong because it involved exploitation and cruelty, it was politically stupid because it was so expensive to build circular building and tunnels—for this reason he quietly changed the design to a 24-sided polygon in the *Postscripts*—and as I have said, it was philosophically absurd because it was based not even on the thin theory of the good that is utilitarianism.

The Panopticon and Contemporary Surveillance Studies

Not surprisingly, in light of the foregoing evidence, the Panopticon has achieved a kind of reverse iconic status, as how *not* to run an institution. However, there is actually lots of talk among specialists now of its being no longer useful as either a model or a metaphor (e.g. Green, 1999; Lyon, 2006; Brunon-Ernst, 2012). No-one denies that it has been useful in the past, but the feeling is that it is now past its sell-by date. In particular, Foucault's interpretation of the Panopticon has been subjected to criticism. This is important, because Foucault was the great modern disseminator of Bentham's concept. It is hardly an exaggeration to say that without his chapter 'Panopticism' in *Discipline and Punish* (Foucault, 1977) most people would never have heard of the Panopticon, or of Bentham for that matter. It was an extraordinarily thought-provoking retrieval and bears the quoting of a few passages.

Bentham, Foucault writes, 'is more important for the understanding of our society than Kant or Hegel' (p. 217). But Foucault does not think this is a good thing; his view echoes that of Karl Marx, that Bentham was the 'arch-philistine' (quoted in Crimmins, 2015). 'We are much less Greeks than we believe', Foucault writes. 'We are neither in the amphitheatre, nor on the stage, but in the panoptic machine, invested by its effects of power, which we bring to ourselves since we are part of its mechanism' (p. 217). Foucault grasps that Bentham's ideas were centred on the inspection principle; indeed, Foucault's book ought to have been translated, Supervise (surveiller) and Punish (punir). The Panopticon prison was about 'permanent visibility'; but while it replaces the dungeon, it is still a 'cruel, ingenious cage' (p. 219). It is also a 'laboratory of power' (p. 219). The Panopticon encases a new, insidious, polymorphic, automatic sort of power, one which helps the authorities to deal with marginal, 'floating populations', to fix them, a change from the 'old [expensive, spectacular] economy of power' (p. 219). Its mode is the deployment of 'anonymous instruments of power, such as hierarchical surveillance, continuous registration, perpetual assessment and classification' (p. 220). It works through 'normalisation', inducing inmates to internalise the rules and thereby control themselves (p. 220).

However, it is far more than a meso-story. Bentham had in mind a terrifyingly wide range of institutions where he envisaged as sites for his principle, namely, lunatic asylums, hospitals, poor-houses and schools (not to mention libraries: see Alistair Black, 2001). But Foucault realised that panopticism could and inevitably would be applied to society as a whole. The Panopticon is a 'diagram of a mechanism of power reduced to its ideal form; its functioning, abstracted from any obstacle, resistance or friction, must be represented as a pure architectural and optical system: it is in fact a political technology that may and must be detached from any specific use' (p. 221). It tells us about macrolevel political reality, 'the society of surveillance', a 'disciplinary society' (p. 222)—it is, in short, a dystopia. 'The Panopticon is', indeed, Foucault would write later in *The Birth of Biopolitics* (quoted in Laval, 2012, p. 55), 'the very formula of a liberal government'. That is to say, liberal society, never mind baser forms of government, is designed to run automatically through the internalisation of behavioural norms and the

harmonising of interests; in that way, one might say, panopticism can also be sold as an expression of utopianism.

I believe that Foucault's insights are still wholly intact. But many fine scholars have argued that we need to refuse Foucault's interpretation and to drop his understanding of power. New terms abound; I mentioned already the superpanopticon and the banopticon. There is also the synopticon (the surveillance of the few by the many), the panspectrum: Braman's (2006) term for a state 'in which information is gathered about everything, all the time, and particular subjects become visible only in response to the asking of a question' (p. 315), the omnicon, pedagopticon, etc. You might think that the very use of these cognate terms shows that the metaphor is still relevant, but the critics have much of a substantive nature to say against what I will for sake of referential ease call Bentham-Foucault.

Kevin Haggerty (2006), a leading light in surveillance studies, registers that 'the Panopticon has stood for sinister manifestations of power/knowledge', but he thinks that its dominance as a 'scholarly model' has become 'oppressive'; 'the sheer number of works that invoke the Panopticon is overwhelming' (p. 23). More problematically, the panoptic model has become reified, directing scholarly attention to a select subset of attributes of surveillance and thereby 'neglected a host of other key qualities and processes of surveillance' (p. 23). Bentham-Foucault has been the 'paradigm', in the Kuhnian 'normal science' sense (p. 24). He, Haggerty, wants to see this paradigm overthrown. Similarly, Anne Brunon-Ernst's recent edited collection *Beyond Foucault* (2012), the work mainly of French scholars associated with the Centre Bentham in Paris, a mirror-image of the illustrious and impressively prolific Bentham Project in London, is devoted to saving Bentham from the supposed distortions of his position by Foucault—to showing, as she puts, it 'ways in which Bentham's Panopticon can be construed as post-panoptical' (p. 12). It is a fine scholarly apology, one which forces into consideration other relevant works by both Bentham and Foucault, but for me it smacks of special pleading. It is difficult, in light of the primary sources, at least those I saw, and of the main text Bentham himself published on the subject, i.e. *Panopticon; or The Inspection House*, to deny that Bentham was a panopticist, a believer in panopticism, absolutely in Foucault's negative sense.

Whether or not they are also attempting a rearguard action on Bentham's behalf, the consensus of the critics is that panopticism is not an inadequate explanatory principle, because it does not capture what is most in need of registering in emergent surveillance. What are these qualities, then? That is an important question not about history, or interpretations or reputations, but about the real world. First, and foremost, neither Bentham, understandably, nor Foucault, chronologically more culpably, grasped the role of information technology. The whole laboured, monumental, impossible design of the central lodge, the visible cells, etc, is of course solved at a stroke by CCTV and the like: Bentham's dream come true; Foucault's nightmare. But if this were the only issue, one would have to say that the Panopticon has not only not been superseded, but that it has been perfectly realised, not just in any prisons where cameras operate but in society as a whole. So what then is the problem with the Panopticon?

The answer is that it supposedly does not capture the multifaceted nature of modern surveillance. For example, its model of the captive surveilled by the central captor does not pick up increasingly common situations where people *want* to be surveilled. For example, Hille Koskela (2006) says in her article on 'the other side of surveillance' that unlike surveillance cameras, webcams are not at all after the Bentham pattern; they involve 'deliberate exposure of the self' and they are not about 'normalization', quite the opposite, so they change the power-visibility relation as Foucault depicted it completely (p. 176). Ergo, she concludes that 'we are certainly "beyond" the Panopticon' (p. 177). Leo Bogard (2006) also talks about post-panopticism; the Panopticon was about a delimited, static space of a prison, but modern surveillance is deterritorialised, it is about networked systems of surveillance, and he also thinks it is less split into subject-object (pp. 97, 102).

We should never neglect Japanese voices in information society debates, because the Japanese coined the very terms 'information society' and 'informatistion' and can lay claim to having engineered the first actual information society (Duff, 2000). Toshimaru Ogura (2006) argues that we should refer to 'surveillance-oriented society', by which he means that present society must be seen as the outcome of an accumulation over time of many layers of surveillance, from workplace in the Taylor era to surveillance of public spaces, mind control, and now also the surveillance of segmented and individuated, demassified populations by capitalists and the state. Many modern values and achievements are thus under threat. Finally, Bart Simon (2015) makes the extremely interesting point that surveillance is no longer at the level of visual and other perceptual sense data, that the threat of surveillance really lies, in Lockean language, not in 'secondary properties' but in deeper 'primary qualities' like time and space. In sum, major complexification is required; Bentham-Foucault is obsolete; we need 'theory recall' (p. 14).

Resurgent Panopticism: The Continuing Relevance of Bentham-Foucault

Now I do not at all wish to deny the analytical advances that have undoubtedly been achieved. But I think it is highly misleading to talk of post-panopticism. I also think that there is a real danger in surveillance studies that we are diverting attention away from the main issues. The Bentham-Foucault Panopticon applies more than ever. Bentham's position was empirical and normative: the Panopticon did not exist, but should; Foucault's and my position is the precise opposite: that it does exist, but should not. There is no doubt in my mind that the model fits perfectly in the most important domain, namely, political society. Surveillance studies has erred in depoliticising surveillance.

As regards state surveillance, we are in a Bentham-Foucault era, for sure. After Snowden, it is not possible to say that the main problem is not the state. And although Bentham's case study was the static enclosure of a prison, Foucault was right that his principle of panopticism applies to the nomadic, decentred reality of the whole social field: that the Panopticon was, in Foucualt's words, a political technology. This is obvious to those of us watching the situation in Britain. Heather Brooke was a member of a British

committee set up by the deputy prime minister to review Britain's secret state in light of the Snowden revelations, one of many such sudden exercises in official soul-searching (Wood & Wright, 2015). She writes in a *Guardian* article (2015): 'In bulk collection the potential exists for anyone to be watched at any time. One of the red herrings put our way was that GCHQ does not conduct mass surveillance because it does not read everyone's email. What was not mentioned is that GCHQ might intercept and store large quantities of it, as the Amnesty case demonstrates.' And she cites, well, you can guess, Bentham:

> The point of Jeremy Bentham's Panopticon wasn't that everyone was actually watched at all times, it was that they could all potentially be watched. It is the possibility of omnipotent surveillance that acts as a chilling effect on any behaviour that potentially offends the state or the powers that be. For those who commit acts of journalism or legal advocacy that directly challenge state power, the risks in such a society are great.

So in the real world, where people are actually fighting unwarranted surveillance, the Panopticon is still a vital reference. It is absolutely correct for today, first in that we discipline ourselves, automatically behaving, because we know that we might be being watched by an unseen observer, when we drive, when we go into the town centre, when we go online, when at work, when we vote and act as 'free' citizens; it is the soul-training Bentham had in mind.

A crucial new development since 9/11 is the presumption of guilt. This is the true significance of Edward Snowden's revelations: everyone is suspect, everyone is being watched, the authorities in the United States regard the United States as a society full of bad people, and Britain and many other governments take the same dim view of us. In Foucauldian terms, panopticism has moved from the margins of society to the mainstream; from the small number of actual or potential deviants to the great number of the citizenry as a whole; paranoia is the norm. This is a huge shift, the default going from good society to bad society, from presumption of innocence to presumption of guilt. Put another way, we are now in a *culture* of surveillance and this is fundamentally new. And it is also fundamentally wrong. It is not normal, it is an abnormal state of affairs, especially in the absence of a real war.

Against the Panopticians: Openly Resisting the Threat

In this final section, I want to look at the existential question of what we today should be doing to stop this process of 'transforming the "information society" into the "surveillance society"' (Raab, 1996, p. 295); more particularly, at resisting the Panopticon. Here again opinion divides, both in academia and beyond. For many activists, direct action is the only answer. At one extreme, there is survivalism, 'getting off the grid'. This is increasingly less of a practical solution, of course. There is nowhere to run. However, I would point out that there are small acts of refusal to comply, such as not filling in personal data where you think you can get away with it, or putting in false information. I confess I have done this, for example where systems do not allow you to proceed without giving a mobile phone number. (I jealously guard my mobile number: if

you have it, you are probably my girlfriend!) Sousveillance, the surveilling of the surveillors, is another method, and there is a lot to be said for this, for filming police brutality, for example. At the extreme are positive acts of sabotage in the tradition of machine-breaker Ned Ludd of my hometown, Nottingham. That is not the answer.

In fact, none of these individualistic methods is the answer. No, we must instead hold up our heads and openly call the foe out. I have argued that it is a political problem, so it needs a political, collective response. The only way to deal with the resurgent threat of a twisted 'open society' of panopticism, is via a politics of information and its operationalisation in public debate, promoting ethical information policy, smart norms and good practice and, where necessary, moving the heavy hands of regulation and law.

The first step in such a politics, obviously, is to be clear about what we want to preserve. Framing our response in terms of the defence of privacy rather than some other ideal is the right first step. Actually, the sophisticated surveillance studies scholars have given up on that notion too. For example, David Lyon, arguably the dean of surveillance studies, writes that 'the concept of privacy is inadequate to cover what is at stake in the debate over contemporary surveillance' (1994, p. 196; see also Gandy, 2006, p. 319). I disagree. The value of privacy is important, intelligible and robust enough to be the cause around which we should rally. It is precisely because we have not majored on it in law and ethics, preferring instead other important values like liberty or autonomy, that it has often been lost, slipping between stools. We need to focus the debate and frame it properly. We need to define privacy, justify it, demonstrate its value, plot its coordinates, and patrol its boundaries.

We need to be clear about precisely when privacy must bow to openness or surveillance or the right to know and be honest about what is going on in such situations, i.e. that the value is being sacrificed for another value. We need to work much harder on the concept, on a post-industrial privacy, not consign it to history. And we need to define a core, what, borrowing a phrase from the metaphysician Peter Strawson, I would call a 'massive central core' of privacy that cannot under any circumstances be given away. Only a principle will suffice to counter the principle of panopticism and the growing army of 'zealous Panoptician[s]', a term Bentham used (cited in Semple, 1993, p. 237). I also recommend Anita Allen's argument for privacy paternalism, i.e. that the state should step in to enforce even some privacies people do not want (2011). We cannot accept that people do not care, but even if they do not, a politics of privacy should override privacy's abandonment, just as a politics of liberty non-negotiably refuses the right to consent to being a slave.

I would suggest, finally, that the politics of privacy should be rooted in what Walter Lippmann (1989 [1955]) called a 'public philosophy', and specifically in a theory of the good information society. I have tried to make a start on this in my normative theory of the information society (Duff, 2012), where I argued for two principles, the first a principle of political information justice, including both the right to privacy and the right to information. This principle is a principle of liberal-democracy and should I believe be honoured by all democrats. The second principle, about economic justice, is left-wing,

but the first and more important principle transcends left and right. In the battle for privacy, we need all the allies we can find. Just as understanding the threat of surveillance is an interdisciplinary problem—roping in sociology, philosophy, law, political science, information science, and even, according to Lyon (2013, p. 146), theology—so resistance will involve a left-right alliance. This comes across very well in Colin Bennett's *The Privacy Advocates* (2008). Only with a broad, open alliance of impassioned advocates, anchored in a shared theory of the political good, will we be able to defeat the fans of the Panopticon.

References

Allen, A. L. (2011). *Unpopular privacy: What we must hide*. New York: Oxford University Press.

Bauman, Z., & Lyon, D. (2013). *Liquid surveillance: A conversation*. Cambridge: Polity Press.

Ball, K. (2006). Organization, surveillance and the body: Towards a politics of resistance. In D. Lyon (Ed.), *Theorizing surveillance: The Panopticon and beyond* (pp. 296-317). Cullompton: Willan Publishing.

Bennett, C. J. (2008). *The privacy advocates: Resisting the spread of surveillance*. Cambridge: Cambridge University Press.

Bentham, J. (1786 and 1790-91). *Panopticon; or the inspection house*. Various editions.

Black, A. (2001). The Victorian information society: surveillance, bureaucracy, and public librarianship in 19th century Britain. *The Information Society, 17*, 63-80.

Bogard, L. (2006). Surveillance assemblages and lines of flight. In D. Lyon (Ed.), *Theorizing surveillance: The Panopticon and beyond* (pp. 97-122). Cullompton: Willan Publishing.

Braman, S. (2006). *Change of state: Information, policy, and power*. Cambridge, MA: The MIT Press.

Brooke, H. (2015, July 14). The Independent Surveillance Review Panel. *The Guardian*. Available at http://heatherbrooke.org/2015/article-the-independent-surveillance-review-panel/

Brunon-Ernst, A. (Ed.) (2012). *Beyond Foucault: New perspectives on Bentham's Panopticon*. Farnham: Ashgate.

Brunon-Ernst, A. (2012). Deconstructing panopticism into the plural Panopticons. In A. Brunon-Ernst (Ed.), *Beyond Foucault: New perspectives on Bentham's Panopticon* (pp. 17-41). Farnham: Ashgate.

Crimmins, J. E. (2015). Jeremy Bentham. *The Stanford encyclopedia of philosophy* (Spring 2015 edition). Available at http://plato.stanford.edu/archives/spr2015/entries/bentham/

Duff, A. S. (2000). *Information society Studies*. London: Routledge.

Duff, A. S. (2012). *A normative theory of the information society*. London: Routledge.

Elmer, G. (2003). A diagram of panoptic surveillance. *New Media and Society*, *5*(2), 231-247.

Foucault, M. (1977). *Discipline and punish: The birth of the prison*. London: Penguin Books.

Gandy, O. (2006). Quixotics unite! Engaging the pragmatists on rational discrimination. In D. Lyon (Ed.), *Theorizing surveillance: The Panopticon and beyond* (pp. 318-336). Cullompton: Willan Publishing.

Green, S. (1999). A plague on the Panopticon: surveillance and power in the global information economy. *Information, Communication and Societ*y, *2*(1), 26-44.

Haggerty, K. D. (2006). Tear down the walls: On demolishing the Panopticon. In D. Lyon (Ed.), *Theorizing surveillance: The Panopticon and beyond* (pp. 23-45). Cullompton: Willan Publishing.

Koskela, H. (2006). The other side of surveillance: Webcams, power and agency. In D. Lyon (Ed.), *Theorizing surveillance: The Panopticon and beyond* (pp. 163-181). Cullompton: Willan Publishing.

Laval, C. 2012. From Discipline and Punish to The Birth of Biopolitics. In A. Brunon-Ernst (Ed.), *Beyond Foucault: New perspectives on Bentham's Panopticon* (pp. 43-60). Farnham: Ashgate.

Lippmann, W. (1989 [1955]). *The public philosophy*. New Brunswick, NY: Transaction Publishers.

Los, M. (2006). Looking into the future: surveillance, globalization and the totalitarian potential. In D. Lyon (Ed.), *Theorizing surveillance: The Panopticon and beyond* (pp. 69-94). Cullompton: Willan Publishing.

Lyon, D. (Ed.) (2006). *Theorizing surveillance: The Panopticon and beyond*. Cullompton: Willan Publishing.

Lyon, D. (1994). *The electronic eye: The rise of surveillance society*. Cambridge: Polity Press.

Lyon, D. (2007). *Surveillance studies: An overview*. Cambridge: Polity Press.

Ogura, T. (2006). Electronic government and surveillance-oriented society. In D. Lyon (Ed.), *Theorizing surveillance: The Panopticon and beyond* (pp. 270-295). Cullompton: Willan Publishing.

Raab, C. (1996). The information polity: electronic democracy, privacy and surveillance. In W. Dutton (Ed.), *Information and communication technologies: Visions and realities* (pp. 283-299). Oxford: Blackwell.

Semple, J. (1993). *Bentham's prison: A study of the Panopticon penitentiary*. Oxford: Clarendon Press.

Simon, B. (2005). The return of panopticism: supervision, subjection and the new surveillance. *Surveillance and Society*, *3*(1), 1-20

Steadman, P. (2007). The contradictions of Jeremy Bentham's Panopticon penitentiary. *Journal of Bentham Studies*, *9*, 1-31.

Wood, D. M., & Wright, S. (2015). Editorial: before and after Snowden. *Surveillance and Society*, *3*(2), 128-132.

Power to the Population? The Population Census under Review

Lynn Killick, Edinburgh Napier University, Scotland
Alistair S. Duff, Edinburgh Napier University, Scotland
Mark Deakin, Edinburgh Napier University, Scotland
Hazel Hall, Edinburgh Napier University, Scotland

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Abstract
Many regard the population census as the backbone of national statistics. It is also regarded as a national institution; a data source held in high regard by the academic, policymaker, historian and genealogist alike. However, technological advances, pressure on resources and the availability of alternative information about the demography of the population have led to a recent review of the census.
The results of this review have led the UK to develop a population census that in future will be conducted online and augmented by data derived from other government sources, for example, health and social care records, without the need for explicit consent of the population. It is, therefore, an opportune time to build upon previous studies relating to privacy and the census and examine the impact that these confirmed changes to the population census in the UK will have on public perceptions of the confidential nature of the census, with a particular focus on information security, privacy and ethics.
This paper will discuss the results of a study examining public attitudes to an online census, information sharing between government agencies without explicit consent, and attitudes to private companies processing census data. The census office have made changes to the census have with limited input from the public and lead us to question where ultimate power lies? Is it with those making the changes, or those providing information, to the census?

Keywords: Privacy, confidentiality, population census, information sharing, information society

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Introduction

History tells us that those in power from Babylonian times to the present day have understood the importance of knowing their population (Grajalez, Magnello, Woods, & Champkin, 2013) (Missakoulis 2010).   It is, however, the case that the rationale for the count, its method and the subjects of the count, have changed dramatically from the early counts conducted in Babylonian times. The question is, as the nature and purpose of the count have changed over time, has the power shifted from the state to the population?

In an attempt to answer this question I would like to share with you the preliminary results of some work that I have undertaken to assess the perception of the public and policy-makers to upcoming changes to the population census in Scotland. However, I think it is important first to look at the origins of the census and, in particular, the position of power in the population census.

The census and the state

In early history, the censuses were predominantly taken to assess the wealth of a nation, or perhaps more specifically a nation's ruler, by establishing the assets at their disposal. For example, the count of the population enabled the Egyptians to establish the workforce available to them to construct the pyramids. The Romans are also well documented for their use of the census to ascertain taxes due and the availability of conscripts for the Army. Literature examining historical censuses suggest that in the main, censuses were predominantly undertaken to count men available to till the land, fight in wars and importantly pay taxes based on land and livestock owned (Coleman, 2013, Grajalez et al., 2013). The 17th & 18th centuries, however, brought a change in focus for the census. Governments came to understand that information about the population of their nation could be used as evidence to inform policy decisions, with specific regard to policy decisions that could improve health and social outcomes for the population (White, 2011).

To obtain this information the state enters into a contract with the population. The population are compelled to complete the census within a set timeframe, and the state provides a commitment to hold census information securely and importantly to ensure published census results do not identify individuals or households. (In the UK census records must be kept confidential for 100 years)

However, despite a commitment to security and confidentiality past studies have identified an abuse of power on the part of the state. For example, US Census information was accessed to locate people living in some US states and identifying as Japanese for internment (Anderson & Seltzer, 2009). Perhaps more notably, the Nazi party abused the confidentiality and purpose of the census to use census information to locate individuals who could help or hinder its vision for an Arian society (Aly & Roth, 2004).   So history tells us that the census is indeed a powerful tool for the government of the day, a tool that has the potential to be used or abused.

There are of course no reported instances of data abuses in the UK, nor is there any evidence that confidential information originating from the census is shared between government agencies.   However, the public may be justified in having misgivings regarding the security of personal information collected by the census. The most recent privacy impact assessment for the census highlights the confidential nature of the census and the robust data control measures in place. It also suggests, by

reference to the Statistics and Registration Service Act 2007, that the census data could be used for alternative purposes as Section 39 (4)(g) provides an exception, allowing information to be released, if it is in the interests of national security, to an intelligence agency.

The census in Scotland has at its core a commitment, and legal obligation, to ensure the right to confidentiality of those who participate in the census. There is, of course, a risk that any endeavour that seeks to capture and publish detailed information obtained from individuals could lead to data breaches.

The census and the population

Research by Heeney (2012) explains that the potential for data breaches is one factor that may affect public participation in the census; another is the intended use of the data provided in the census. Furthermore, research by Cullen (2008) highlights concerns regarding data handling, particularly by private organisations, are a factor that has the potential to affect the trust of the public in the census adversely.

In the UK, there are powerful examples of the public withdrawing from the census to great effect. The withdrawal from the census by suffragettes in the 1911 census is well documented (White, 2011); in this instance a very public protest to raise awareness of the campaign to grant all women a vote. More recently swathes of people avoided the count in 1991 in rebellion against the poll tax (Simson and Dorling 2004), in this instance, a quieter, although sizeable, avoidance of the count driven by concerns that census data would be shared without restriction to other government departments. The impact of the 'missing millions' (Simpson et al. 2004) was not fully appreciated until after the count at the point of distribution of funds from central to local government, and it is only by comparing the 2011 census with the 1991 census that statisticians were able to identify that the majority of the missing millions in the 1991 were young adult males. More recently across the UK we see significant numbers allegedly misrepresenting themselves through their declaration of religious affiliation with the Church of the Jedi Knight.

Brunton & Nissenbaum (2011) provide a political theory of obfuscation, they define obfuscation in the context of data gather as 'producing misleading, false, or ambiguous data to make data gathering less reliable and, therefore, less valuable.' In the context of the census, perhaps with the exception of the suffragette protest, it is not clear that the provision of false or ambiguous data is to make the census less valuable. Rather recent studies (See Heeney 2012 & Cullen 2008) suggests a decision not to participate in the census is more likely in an attempt protect privacy due to a lack of trust regarding data confidentiality. My work seeks to explore the potential for obfuscation in more detail. To understand the motivations of individuals and the risks to the census it is necessary to understand more about the planned changes to the Scottish census.

The Future of the Census

Firstly, the process for data collection in the census is set to change. The next census in Scotland will be conducted predominantly online. Online completion was an available option during the 2011 census. The majority of census returns (80%) were returned using the traditional form. The relatively low take up reflects the soft marketing approach employed by the census office. The online response rate of 20% was considered a success by the census office. It produced returns in a manageable

number that the systems were able to cope with. Also, the online returns provided better data quality in comparison with handwritten returns, with fewer errors and increased efficiencies in data processing (Dr J Goodlet-Rowley, Seminar, December 2013).

In addition to a predominantly online the census, the census office has advised that census results will be augmented by information obtained from administrative records. Administrative records contain identifiable information gathered for administrative activities as opposed to statistical endeavours. Such movements of data may be legal. However, ethical issues are present.   The use of administrative records raises issues of informed consent and to an extent the 'right to be forgotten' as highlighted by Ausloos, (2012). For example, information provided to register with a doctor or tax a vehicle is not provided with explicit consent to be retained ad infinitum or shared with external agencies.

The act of the census itself, however, is found to be compliant with Article 8 of the Human Rights Act as the process of obtaining information by compulsion is deemed necessary to support the aims of a democratic society.

The census has been described as a public institution (Anderson 2008, p2). The expectation may then follow that the sensitive process of collecting and publishing census information would be a public endeavour, operated in the public sector. However, recent census exercises, for example across the UK and also New Zealand, have outsourced elements of the census. This outsourcing, or perhaps more specifically, the choice of contractors, has not been without controversy.

To illustrate the importance of securing public trust Cullen (2008) described the careful planning that led to the success of the 2006 New Zealand's first census allowing online responses. Factors such as perceptions of information security were paramount, particularly as a private sector company was being used to collect the data.

The Joseph Rowntree Reform Trust Ltd in a review of government databases, including the English and Welsh census, noted the use of a private sector company, Lockheed Martin, as an information security risk. Public scrutiny relating to the award of Lockheed Martin for the English and Welsh 2011 census and a comparable firm, CACI, for the Scottish 2011 census, resulted in a review of the contract awarded to these firms. The data processing rights were reviewed and these firms, both with links to foreign intelligence agencies, were prevented from storing the census data.

It is likely that the future Scottish 2021 census will involve a considerable procurement exercise to ensure there is appropriate infrastructure in place to support a predominantly online census capable of capturing the information relating to over five million people over a short time frame. It is not clear if procurement legislation will prevent companies with involvement in intelligence operations from bidding for the delivery contract.

Once collected, census data is released in the years following the census in anonymised format and released in its entirety 100 years after the census has taken place. Information generated from the census is open data. It is possible for any individual or organisation to download data tables or access a variety of tools available on the census website. Also, individuals and organisations can make direct requests for particular results from the census.
(http://www.scrol.gov.uk/scrol/help/scrolHelp.jsp)

The open data generated from the Census can be accessed by anyone and linked to any other data source. Palmer (2013) highlights how Australian census information, combined with anonymised customer records of an Australian bank, to create a comparison website, provided the conditions to identify individuals. This suggests that it may be possible to identify individuals if statistical data from the Scottish census is combined with data gleaned from other sources..

This notion that information given in good faith for one purpose could be shared and use for another, divides opinion, illustrated for example by comments regarding the perceived security of census information at http://www.theregister.co.uk/2011/03/25/confidentiality_of_census_data_not_guaranteed/.

Some comments suggest anger and deep distrust in the census due to the possibility of sharing information with intelligence agencies; others remark that the Facebook generation should be accepting that there is no such thing as private information. An online approach to the census may be attractive due to improvements made to the quality of the data obtained, (Baffour et al. 2013, Coleman 2013, Cullen 2008, Deonandan 2013) and the cost-savings generated as a result of reduced data cleansing and more efficient data processing. An online future does, however, present challenges both for data users and the public as well as those responsible for administering the census. Issues of access to technology will hinder many individuals participating easily in the census. Language barriers, availability of hardware, confidence and disabilities can all impact on an individual's ability to participate online. In addition, a connection with the census may be lost if it is reduced from its current historical record featuring ancestors handwritten entries to an online box check survey. This sense of value in the census may be further diminished if individuals cannot see an explicit link between the census and policy decisions to their benefit, or the benefit of wider society. Concerns regarding data privacy, trust in government and the perceived low risk of sanction for non-compliance are other factors that may also result in individuals deciding not to participate in a future census if it transfers to a predominantly online activity.

The studies to date do raise issues of trust and concerns regarding data security. However, the recent studies looking specifically at attitudes to the census, and specifically an online census, have been small in scale, have not specifically sought the views of Scotland's population and, therefore, call for more attention. Also, it is not yet clear from the literature, the extent to which the population in the UK are aware of issues such as data breaches in other censuses and to what extent this may affect their participation in either an online census or if they would be opposed to data sharing across government agencies.

This study

As part of a wider doctoral study, I am investigating the perceptions of the public and policy-makers to the census. In this paper, I discuss findings generated from semi-structured interviews with policy-makers who may work with census information and emerging findings from an online survey created to gather responses from the public. The interviews were conducted in 2015 with 20 policy-makers working in Government (both local and national), Non-departmental Government bodies (such as Health Boards) and with individuals holding policy roles in the third sector and those working in governance roles as either non-executive directors of public bodies or regulators in organisations set up by parliament but independent of government.

The online survey was designed using Novisurvey and was publicised using social networking platforms such as LinkedIn and Twitter. The survey was aimed at people who either work or are resident in Scotland. The results shared in this paper represent complete returns from 124 individuals, all of whom reported a Scottish connection through work or residency.

The information presented here relates specifically to questions regarding perceptions regarding data security and data sharing set against an exploration the respondents' view of the purpose of the census.

The online survey results suggest that the place of the census as a public institution (Anderson 2008) is still relevant as 89% of survey respondents believed that taking part in the population census was an important part of citizenship. Furthermore, 53% reported that the purpose of the census was to develop public policy.

This understanding of the place and purpose of the census is echoed in the semi-structured interviews with policy makers who reported the view that the census was an important societal asset albeit one that could be applied more effectively to the policy-making process (Killick, Hall, Duff & Deakin, in press)

Policy-makers expressed concern about the online move, although issues of data security or concerns regarding procurement are not expressed as priority issues. Rather, issues relating to broadband availability in remote and rural areas coupled with low information literacy skills and limited access to Internet-enabled devices are mentioned. The concerns here relate to under-enumeration as a result of Scotland's patchy digital infrastructure.

Perhaps reflecting the online nature of the survey 76% of respondents indicated that they would prefer to complete their next census online with 55% of all respondents indicated that the thought that completion of the census online offered a secure method. This suggests that the convenience of Internet-completion outweighs concerns regarding data security.

Considering the procurement of the census, echoing the findings of Heeney (2012), the survey respondents were not comfortable with private sector companies handling census data. When asked specifically about UK-based private sector firms 52% stated that they were not comfortable with such firms handling their data, with only 26% confirming they would be comfortable with this situation. When asked regarding their attitudes regarding non-UK based firms handling the data there was a marked shift with only 0.05% (6 people) confirming they would be happy for an overseas firm to handle their data and 81% stating that they would not be comfortable with overseas firms handling their census data. The strength of objection to private sector firms being involved in the handling of data suggests that the census office will need to undertake activity to alleviate concerns, this finding is consistent with the work of Cullen (2008).

When asked about plans to augment census data with information gleaned from administrative records policy-makers working in institutions external to government (third sector and regulatory bodies) voiced concern both about the quality of the information to be input to the census and also expressed caution that such 'augmentation' may be the first step to replacing the census. The specific concern being that while a variety of sources can provide a population count, only the census can provide a reliable dataset that reports on the diversity of the population.

Survey respondents were in the main happy to provide information to the census (62%), albeit noting that legal obligation to complete a return was a driving factor in

their participation (47%). The attitudes, however, were not as positive regarding information sharing, with 45% comfortable with the information they had provided to other government departments being shared with the census and 34% noting an objection.

The survey respondents were also asked for their opinion regarding information being shared from the census to other government departments. First they were asked if they were comfortable with anonymous information from the census being shared, first with government departments such as HMRC (Tax) or Health & Social Care. The vast majority of respondents noted that they were comfortable with such information sharing with only 16% expressing that they were not content. Similarly, the same question regarding anonymous information sharing but in this instance with government security agencies generated a similar response again with 16% of respondents expressing dissatisfaction.   However, when asked regarding their attitudes regarding identifiable information being shared with other government agencies, there is a marked difference with 60% reporting opposition to identifiable information being shared with any government agencies. These results suggest that the confidential nature of the census is important to members of the population. Another factor may be levels of trust, 66% of respondents noted that they trusted the census office to treat their personal information with respect for their privacy, compared to a lower number (58%) reporting a similar level of trust in 'government'.

Conclusion
These initial findings suggest that if the next census is to be successful those responsible for its administration must balance the necessary infrastructure challenges to ensure effective enumeration of those who may be digitally excluded, with activity to ensure the population has confidence in an online census and importantly the confidential nature of the census and its outputs. A failure to do so has the potential to alienate sections of the population and may lead to a repeat of the 1991 census. The initial results of this study suggest that any motivation to obfuscate that may manifest itself is likely to originate from a desire to protect one's privacy rather a deliberate desire to devalue the census. More work would be welcomed in this area particularly as if there is a significant undercount in the 2021 census it could undermine the future of censuses beyond 2021.

References

Aly, G, Roth, K H, (2004) *The Nazi Census:Identification and Control in the Third Reich*. Philidelphia: Temple University Press

Anderson, M (1988) *The American census: A social history*. New Haven: Yale University Press

Anderson, M (2008) The Census, Audiences, and Publics. Social Science History, Volume 32 (1), p1-18

Ausloos, J (2012) The 'Right to be Forgotten' - Worth remembering? (2012) *Computer Law & Security Review*, 28 (2), p143-152

Balarajan, R., & Raleigh, V. S. (1994, 1994/07/30/). Public health and the 1991 census: non-random underenumeration complicates interpretation. *British Medical Journal, 309,* 287+.

Coleman, D. (2013). The Twilight of the Census. *Population and Development Review, 38*, 334-351.

Cullen, R (2008) New Zealand's 2006 Census Online: A Case Study. *Integrated Series in Information Systems*,17, p647-670

Cullen, R (2009) Culture, identity and information privacy in the age of digital governement. *Online Information Review,* 33 (3), p405-421

Grajalez, C. G., Magnello, E., Woods, R., & Champkin, J. (2013). Great moments in statistics. *Significance, 10*(6), 21-28.

Heeney, C. (2012). Breaching the Contract? Privacy and the UK Census.*Information Society, 28*(5), 316-328.

Missiakoulis, S. (2010). Cecrops, King of Athens: the First (?) Recorded Population Census in History. *International Statistical Review, 78*(3), 413-418.

White, I. (2009) The 2011 Census taking shape: methodological and technological developments. Population Trends, 136, p64-72, Palgrave Macmillan
White, I (2010) No vote – no census: an account of some of the events of 1910-1911. Population Trends 142, Office for National Statistics

Simpson, S., & Dorling, D. (1994). Those Missing Millions: Implications for Social Statistics of Non-response to the 1991 Census. *Journal of Social Policy, 23*(04), 543-567

Comparative Analysis of Purchasing Behavior at Physical and Online Bookstores by University Students

Takafumi Suzuki, Toyo University, Japan
Maki Mizukami, Toyo University, Japan

Abstract

This study conducts a comparative experiment on the purchasing behavior of students from mid-tier private universities in Tokyo at both physical and online bookstores. Recently, the spread of the Internet has changed people's lifestyles and their purchasing behavior. Given the presence of large online bookstores, this also applies to book purchasing behavior. In particular, this study uses university students—the so-called neo-digital native generation—to conduct a comparative experiment on purchasing behaviors at physical and online bookstores and to examine the differences in both purchasing behavior and the characteristics of the two types of bookstores. We draw empirical conclusions regarding the purchasing behavior of this generation and aspects of their lifestyle. We also wish to gain some basic insights regarding the future evolution of physical and online bookstores.

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1. Introduction

Recently, the spread of the Internet has greatly changed people's lifestyles and their purchasing behavior. Books are no exception. The advent of large-scale online bookstores has enabled people to shop for and purchase books from their homes at any time.

Online bookstores differ from physical bookstores as they have their own systems. These systems center on recommendations, rankings, and search features, and guide the user's purchasing behavior. Therefore, online purchasing behaviors have different characteristics than purchasing behavior at physical bookstores.

Indeed, purchasing behavior at online bookstores differs, depending on the purchaser's age and his or her proficiency with the systems. Recently, we have seen the emergence of the so-called neo-digital natives, who feel more comfortable with mobile phones than with PCs (Hashimoto et al., 2010). We can assume that this generation has its own characteristics as it relates to online purchasing behavior.

In this study, we conducted an experiment to compare purchasing behavior at physical bookstores with that at online bookstores. Our participants were students at mid-tier private universities in the Tokyo region. The goal was to examine the usage of both physical and online bookstores by neo-digital native generation, to empirically demonstrate one aspect of that generation's lifestyle, and to provide fundamental insights regarding the evolution of physical and online bookstores. This study is organized as follows. Section 2 presents the related research. Section 3 describes the experimental methodology. Section 4 discusses the results. Section 5 presents our conclusions.

2. Related Research

Many studies on marketing theory have examined both online and physical purchasing behavior (e.g., Bucklin and Sismeiro, 2003; Degeratu, Rangaswamy and Wu, 2003). Studies on purchasing in bookstores include Kobayashi et al. (2008), who used a market survey to analyze the behavior of users in physical and online bookstores. Our study provides new insights through an actual experiment and interviews of the neo-digital native cohort.

Moreover, many studies involved experiments on participants and conducted interviews to analyze the information behavior of library users (e.g., Sugie et al., 2010). This study provides insights that contribute to the information behavior analysis in libraries.

3. Experimental Methodology

We performed a subject-based experiment on purchasing behavior in both physical and online bookstores, and subsequently conducted interviews. The test participants included nine students of both genders, ranging in age from 18 to 22, from mid-tier private universities in the Tokyo region. We asked them to shop on the same day in both physical and online bookstores. The bookstores were visited in a fixed order, the physical bookstore first and the online bookstore second, with one to two hours between visits.

For the physical bookstore, we used a large bookstore in Tokyo. We imposed no time limit. The participants shopped as freely as they normally would in a bookstore. The participants were accompanied by a researcher who recorded their path, the books

they looked at, the things they said, and the time they spent browsing.

For the online bookstore, we used Amazon. We imposed no time limit, and we had the participants shop as freely as they normally would on the Internet. The experiment was conducted in the university lab on PCs. The operating system was Windows 7, the browser was Firefox, and no login was required. We recorded the session and documented the path of participants, the books they clicked on, they things they said, and the time they spent browsing.

After these experiments, we interviewed the participants. The questions were as follows:
   (1) Please state your gender and your year in university.
   (2) How often do you usually read books?
   (3) How often do you visit physical bookstores and make purchases there?
   (4) How often do you visit online bookstores and make purchases there?
   (5) Was there a particular book you wanted to buy before this experiment?
   (6) What books did you want to (or actually) buy?
   (7) For each book you looked at or thought you wanted to buy, what were the reasons?
   (8) What thought process led you to those books?
   (9) Have you ever seen a book in a physical bookstore, and then purchased it online, or vice versa?
   (10) Is there any difference in how or why you use physical bookstores and online bookstores?
   (11) Did you find it easier to purchase or find items in the physical bookstore or the online bookstore?
   These questions enabled us to learn regarding the experiment participants' personal attributes, typical frequency of using bookstores, and purchasing frequency, as well as to explore their thought processes when they were using physical or online bookstores.

4. Results and Findings

Table 1 shows the basic data for the participants, based on the interview results, including year at university, gender, typical book-reading frequency, typical frequency of visiting both physical and online bookstores, and typical frequency of purchases at both physical and online bookstores. Table 2 shows whether the participants had a specific book they wanted to purchase before the experiment, the number of books they picked up to look at (or clicked on) during the experiment, the amount of time spent browsing (physical and online), and the number of books they wanted to purchase (or actually purchased), for both the physical and online bookstore. Table 3 tabulates the books picked up (or clicked on) at the physical and online bookstores, into categories (A) specific books the participants wanted to purchase before the experiment, (B) books the participants found interesting in terms of content or appearance, and (C) books picked up (or clicked on) at random.

Table 1 shows that, for most of the participants, both typical visiting and purchasing frequencies were higher at the physical bookstores than at the online ones. Table 2 shows that a majority of the participants picked up (or clicked on) more books at the physical bookstore than at the online one. A majority of the participants also spent more time browsing at the physical bookstore than at the online one. The foregoing indicate that the number of books picked up (or clicked on) corresponded almost directly with the time spent browsing, and that both of these also had a certain

correspondence with typical frequency of visits.[1] More participants found books they thought they wanted to purchase at the online stores than at the physical ones. For these participants, we can conclude that the information, reviews and rankings, and recommendations at the online store succeeded in making them more inclined to buy a book. On the other hand, no participants actually made a purchase from the online bookstore during the experiment. Based on the opinions we heard from the participants, where they noted that they would purchase the book from a physical bookstore after getting information and reviews about it online, we may conclude that, for the participant cohort in this study, an increase in the inclination to buy does not necessarily lead directly to an online purchase.

Table 3 reveals wide variations among individuals in terms of inclination to make purchases at physical and online bookstores. A quick glance shows no general trend. However, looking at the participants who had no specific book in mind (3, 5, 7, 8, 9), for four of the five, the percentage of books they picked up to look at (or clicked on) was higher in the physical bookstore than in the online bookstore. This group just browsed throughout the bookstores with no clear objective, more often picking up books they somehow noticed at the physical bookstore. In online bookstores, however, it is more common to find books by searching keywords, recommendations, and rankings. This indicates a tendency toward a book being easier to pick up (or click on) if its content or appearance is found to be interesting.

5. Conclusions
In this study, we conducted a comparative experiment of the purchasing behavior of students from mid-tier universities in Tokyo at physical and online bookstores.
The results of the experiment and the interviews showed that while the neo-digital native cohort visits physical bookstores more often than they do online ones, some participants become more inclined to purchase books when they are at online bookstores, but they generally make their actual purchases at physical bookstores. Also, when not looking for a specific book, for some reason they will pick up a book in a physical bookstore more often that they will click on a book in an online bookstore.

This study used a small number of participants and, as such, its findings are still limited. We hope to supplement our findings by conducting additional experiments and follow-up interviews. Our study also suggests that the sequence of the experiment had an effect on the outcome. Here also, we hope to complete additional experiments that will supplement our results.
Acknowledgements

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[1] For this experiment we used a fixed test order: the physical bookstore was visited first, the online bookstore next. We plan to conduct additional tests in the future to determine whether the order has any impact on the test results.

paper presented at the 59th Conference of the Japan Society of Library and Information Science.

References

Bucklin, Randolph E. and Catarina Sismeiro (2003) A model of web site browsing behavior estimated on clickstream data, *Journal of Marketing Research*, 40(3), 249-267.

Degeratu, Alexandru M., Rangaswamy, Arvind and Jianan Wu (2003) Consumer choice behavior in online and traditional supermarkets: the effects of brand name, price, and other search attributes, *International Journal of Research in Marketing*, 17(1), 55-78.

Hashimoto Yoshiaki, Oku Ritsuya, Nagao Yoshihide, and Shono Tooru (2010) *Neo dejitaru neitibu no tanjo: nihon dokuji no shinka o togeru netto sedai* [The Birth of the Neo-Digital Natives: How Japanese Net Users Are Different], Diamond, Tokyo.

Matubayashi Mamiko, Toshimori Atsushi, Chiba Seiko, Ikeuchi Jun, Nagata Haruki (2008) "Intanetto chosa o mochiita shoten riyo kodo no bunseki: onrain shoten to riaru shoten riyo no jittai" [Analysis of Bookstore Usage Behavior Using Internet Surveys: The Status of Online and Physical Bookstore Usage], *Proceedings of the 2008 Spring Workshop of the Japan Society of Library and Information Science*, 83-86.

Sugie Noriko (2010) "Kokyo toshokan ni okeru riyosha no joho kensaku kodo: intabyu kiroku no shitsuteki bunseki ni yoru gainen to riron no seisei" [Information Searching Behaviors of Users of Public Libraries: Creating Concepts and Theory from Qualitative Analysis of Interview Records], *Journal of Japan Society of Library and Information Science*, 57(1), 18-26

Appendix 1

表1．被験者の基礎データ

被験者	学年	性別	本の閲覧頻度	利用頻度			購入頻度		
				リアル	オンライン		リアル	オンライン	
1	3	女	年に数冊	1か月に1回程度	ほとんどなし		半年に1・2冊	ほとんどなし	
2	3	女	月に2冊	週に3回	週に1・2回時間のある時		月に2冊	ほとんどなし	
3	4	男	月に3冊	月に5回	一週間に2回程度		月に2冊	ほとんどなし	
4	2	女	雑誌を月に1冊	行かない	半年に1・2回		買いたい本があった時	半年に1・2回	
5	4	女	月に2冊	月に1・2回	見ない		ほぼなし	買ったことがない	
6	2	男	雑誌を月に1冊	月に1回	必要な時だけ（半年に1回）		ほとんどなし	必要な時だけ（半年に1回）	
7	1	女	雑誌を3冊	月に2回	必要な時だけ（半年に1回）		買わない	必要な時だけ（半年に1回）	
8	1	男	月に1冊か2冊	月に3・4回	週に1回		一か月に1冊	買わない	
9	1	女	月に2.3冊	月に2回	あまり見ない		月に1冊	買わない	

Table 1. Basic Data on Participants

Participants	Year	Gender	Reading frequency	Usage frequency		Purchase frequency	
				Physical	Online	Physical	Online
1	3	F	Several books per year	About 1 time per month	Almost none	1–2 books per six months	Almost never
2	3	F	2 books per month	3 times per week	1–2 times per week when time permits	2 books per month	Almost never
3	4	M	3 books per month	5 times per month	About 2 times per week	2 books per month	Almost never
4	2	F	1 magazine per month	No visits	1–2 times per six months	When there's a book I want to purchase	1-2 times per six months
5	4	F	2 books per month	1–2 times per month	No visits	Almost never	Have never purchased
6	2	M	1 magazine per month	1 time per month	Only when necessary	Almost never	Only when necessary

					(1 time per six months)		(1 time per six months)
7	1	F	2 books per month	2 times per month	Only when necessary (1 time per six months)	Do not purchase	Only when necessary (1 time per six months)
8	1	M	1 or 2 books per month	3–4 times per month	1 time per week	1 book per month	Do not purchase
9	1	F	2–3 books per month	2 times per month	Rarely	1 book per month	Do not purchase

表2. 実験結果1

被験者	目的の本	手に取った冊数		購入冊数		時間(分)	
		リアル	オンライン	リアル	オンライン	リアル	オンライン
1	あり	10	4	2	0	15	10
2	あり	15	6	2 (1)	0	20	6
3	なし	21	9	2	1	30	10
4	あり	15	16	0 (2)	3	30	30
5	なし	21	10	1	0	30	10
6	あり	14	2	1	2	30	9
7	なし	7	3	0	3	15	7
8	なし	8	6	0	0	20	15
9	なし	26	26	0	5	35	37

Table 2. Experimental Results 1

Books considered

Books purchased

Time (minutes)

Participants

Desired book

Physical

Online

Yes	Yes	No	Yes	No	Yes	No	No	No

表 3. 実験結果 2

Table 3. Experimental Results 2

Physical bookstores

Online bookstores

Participants

Number of As

Number of Bs

Number of Cs

Number of As

Number of Bs

Number of Cs

Help is Just a Click Away! - Social Network Sites, Parents of Children with Special Educational Needs, and Parents' Support

I-Jung Lu University of Manchester, UK

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Abstract

This pilot study aims to understand the use of social network sites (SNSs) for parents' support among parents of children with special educational needs (SEN) and to examine the interaction and relationship among parents and the professionals within SNSs. A qualitative research, including six month web-based observation of six SNS pages and 12 interviews, was carried out in this study. The data were examined through the conceptual framework of the concepts of support, including informational support and emotional support. This study highlighted that SNSs played an important role in providing informational, emotional support to this group of parents. It also provided an important platform for voices of the parents being heard. Encouragement from professionals, parents and even other SNS users were found provided through clicking 'Likes', sharing information in personal pages, and commenting on the post. However, real life relationship of both parents to parents and parents to professionals also helped promoting the interaction on SNSs.

Keywords: Social network sites, parents' support, special educational needs.

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Introduction

Support for parents of children with special educational needs (SEN) plays a critical role in the wellbeing of the children and the family (Winton, Sloop, & Rodriguez, 1999 ; Yau & Li-Tsang, 1999; Scharer, 2005). Parents of children with SEN who receive this support shows healthier adaptation to the difficult situation of their children (Al-Kandari, 2014). Moreover, within recent years, social network sites (SNSs) have been suggested as important tools that help provide better support for parents without restrictions of location and time (Nieuwboer, Fukkink, & Hermanns, 2013; Scharer, 2005). More and more professionals, such social workers, teachers and consultant psychiatrist, are now also using SNSs as a platform to provide instant support, such as useful information and encouragement, for this group of parents.

This pilot study probed on popular SNSs to understand their optimal use as a supportive tool and platform for parents of children with SEN. By employing qualitative modes of inquiry, I attempt to explore the role of SNSs in providing and receiving support for Taiwanese parents of children with SEN. I also aim to explore how the usage of SNSs may influence the relationship and interactions between the parents and professionals. Finally, I seek to obtain data which will help address current research gaps of web-based interactions among parents of children with SEN from the Taiwanese context. Based on these research aims, my research questions are:

RQ1. How is the SNS-based support for Taiwanese parents of children with SEN provided?

RQ2. What are the purposes of searching support through SNSs among Taiwanese parents of children with SEN?

RO3. How support provided through SNSs impacts the relationship between parents of children with SEN and the professionals within Taiwanese context?

Literature review –Parents' support and SNSs

The term 'parents' support' or 'parents' social support' implies parenting information and resource which enable the parents of children with SEN to take better care of their children. The support also protects and promotes the wellbeing of the parents; helping them to cope with their stress and frustration when faced with difficult parenting situations (Nieuwboer, Fukkink, & Hermanns, 2013; Plantin & Daneback, 2009). Barlng and MacEwen (1988) suggest that based on the type and source of support, parents' support could be consistently distinguished into four categories, including instrumental, informational, appraisal and emotional support. Instrumental support refers to essential support that based mainly on material or physical help, such as providing money for children's healthcare or babysitting (House, 1981; Barlng & MacEwen, 1988); emotional support implies sympathy, encouragement, and also

includes listening; informational support includes sharing advice on different problems, knowledge of different area relates to parenting and special need; and finally appraisal support consists information that helps individual to make decision or evaluate their decisions or current status as parents (House, 1981; Barlng & MacEwen, 1988).

Traditionally, support for this particular group of parents is suggested to be highly reliant upon certain organisations, parental support groups, development centres and local hospitals; in other words, the support for parents of children with SEN is restricted to physical locations and time (Winton, Sloop, & Rodriguez, 1999). However, with the development of the internet, support for parents of children with SEN is now easier to access and is less restricted to time and space. The internet enables parents of children with SEN to access different resources of support with better flexibility on the location and time (Nieuwboer, Fukkink, & Hermanns, 2013; Scharer, 2005).

SNS is suggest to be one of the most popular and powerful internet platforms for communication, social networking and information exchange (boyd & Ellison, 2007; Cheung, Chiu, & Lee, 2011; Ding, Chen, & Fu, 2013). Several studies on specific parents' groups, for example parents of children with very low birth weight infants, using SNSs suggest that SNSs provides platforms for parents to easily access updated medical information and valuable experience of other parents with similar circumstance (Gabbert et al., 2013; Janvier, Farlow & Wilfond, 2012). Hudson et al., (2008) also argue that based on the given authority of deciding personal visual presence and selection of audiences or 'friends' within SNSs, parents of children with SEN are more willing to share and accept suggestions and information from SNSs. Within cyberspace like SNS platforms, Plantin and Daneback (2009) suggest that support for parents are mainly informational support and some emotional support. According to Plantin and Daneback (2009), 86% of parents-to-be search for information of pregnancy through internet and nearly 70% of parents searched for parenthood and healthcare information on the World Wide Web (WWW). Madge and O'Connor (2006) argued that information from internet is gradually replacing parenting knowledge from their own mothers or other mothers among the new generation. Scharer (2005) also states that parents are increasingly turning to internet for parenting and healthcare information; parents use internet to form their own emotional support network while they been thorough different stage of parenthood in life. Scharer (2005) states that web-based emotional support helps parents cope with difficult situations and surpass stress. Although Scharer (2005) also suggests that,

along with web-based emotional support, other methods, such as consultation, are also needed for patents to surpass stress. Baum (2004) also indicates a significant increase of self esteem after parents participated in the online support group.

Even though SNSs have played a significant role in providing support for parents of children with SEN, research on SNS-based interaction of parents of children with SEN is still scant (Lenhart et al., 2011; Madden et al., 2012; Zickuhr & Smith, 2012). Whilst some research has been carried out on web-based interaction among parents, most of the studies were carried out within the western context, or mostly American context; there have been few studies that were based on the East Asian context. It is possible to suggest that there is a lack of understanding in the web-based interaction among parents from the East Asian culture. There is, therefore, a need to balance the western dominance of literature in this field of research with an East Asian point of view.

Methodology

Conceptual Framework

I adopted the three concepts of support, informational support, emotional support and advocacy support from the literature as helpful concepts in forming my research framework; their definitions are as follows:

- Informational support: updated medical knowledge referring to the children's disabilities; information of the illness situation of the children; options for provisions, such as educational and occupational suggestions; information for treatments; information on parents activities held by the organisation; parenting experience (Plantin & Daneback, 2009; Dichtelmiller et al., 1992).

- Emotional support: including encouragement, emotional disclosure, sense of being accompanied by others and language that expresses comfort (Plantin & Daneback, 2009; Scharer, 2005). Emotional support is also suggested as providing a safe environment for parents of children with SEN to alleviate their stress by sharing their parenting experience of the children with disability and rebuilding the identity of being a parent (Yau & Li-Tsang, 1999).

- Advocacy support: including the deliberate process to directly and indirectly influence decision makers, stakeholders and relevant audiences to support and implement actions that contribute to the fulfilment of the right of children with SEN (UNCEF, 2010:3).

-

I also listed out sub-questions based on the research questions that guide the analysis of the data. These questions include: What are the existing types and forms of SNS-based support for Taiwanese parents of children with SEN?; who provides the

support?; what do they expect to receive?; what are the purposes of searching support?; why is support on SNSs valuable for this group of parents?; how the support impacts the relationship between the parents and professionals?

Based on the two concepts of support from literature, and the questions, a chart is constructed as the analytical framework of this inquiry. Other than the two concepts of support, I added 'Other' as the last category of the support for new emerged concepts of support. The complete chart of the analytical framework is constructed as

Table 1.
Table 1. Chart of the Analytical Framework

Types of support	Emotional Support	Information support	Advocacy Support	Other
What are the existing types and forms of SNS-based support?				
Who provides the support?				
What do they expect to receive?				
What are the purposes of searching support?				
Why is support on SNSs valuable for this group of parents?				
How the support impacts the relationship between the parents and professionals ?				

Research Methods

A two-phased qualitative research was conducted. The first phase was conducted with web-based observations of the three selected public web pages and three public web groups. This web-based observation process collected data which is posted between 1st November 2014 and 31st May 2015. The second phase was conducted with semi-structured interviews of the six administrators of the web pages and groups, and six parents of children with SEN. Throughout the two phases, a research diary which helped me reflect on the data generation process and the data analysis process was kept.

To interpret my research data, I conducted a thematic analysis (Bryman 2012) based on my analytical framework. I compared the differences and similarities of expectation of support among different SNS users, including parents and professionals. The comparison of the expectation for SNS support between parental users and professionals allows me to explore the realignment of control of support as the result

of easily accessed SNS-based information and resource for parents. The notes within the research diary also helped triangulate the data within both phrases.

Sampling

In this research, Facebook is selected to be the main SNS for data collection, as Facebook is one of the biggest SNSs in Taiwan, with fifteen million users, 65% penetration rate of Taiwanese population (ET newletter, 2015). Three web pages of Taiwanese parents of children with SEN on Facebook were identified and three public groups for supporting Taiwanese parents of children with SEN on Facebook were also identified. All pages and groups are formed by different parents' support units of representative organisations in Taiwan. Members of these groups are restricted to parents of children with SEN, volunteers and professionals.

The administrators of each selected web pages and groups were interviewed. All administrators are social workers or physiological counsellors, who are classified as professionals in this research. Six parental SNS-users, including five females, one male, were also interviewed. All parental participants are parents of children with SEN who are still in the educational system or who just graduated from school in 2015. Both snowballing and purposeful sampling strategies were used in my recruiting process.

Findings and Discussions

SNSs were frequently used by parents of children with SEN and professionals as tools for providing and receiving different types of support. All participants suggested that they use SNSs as tools to provide or receive support on daily basis.

Informational support is one of the main types parents support provided within all pages and groups. This includes information about parental activities that promote rights of children with SEN, news about welfare system and educational provision for their children, useful articles about medical resource or assistive device and also some parenting stories of the family of children with SEN. The information was often frequently shared through links of the source website between parents and other SNS users (see Figure 1.) and also by using the 'Share' icon on the SNS.

Figure 1: Example of Information Support on SNS: Sharing

One parents suggested that

> …when I have question, I join the group (parents' group), and I will ask, mostly read, read their experience. … and I shared information from it.
>
> (Parent MSp)

Parents received useful information through the discussions in groups. Some of the discussions could even go really deep into a specific area of knowledge about a specific type of disabilities or medical treatment. These parents then further shared with other parental users in other SNS space or group. One page administrators even suggested that some parents were even more of a 'Professional' than they are in these area.

Sharing and receiving these accessible knowledge and information from SNS empowers this group of parents. It gives these parents a sense of control of knowledge and resource and allows them to understand more about their children's situation, which then enabled them to communicate with the professionals with more confident. This empowerment of parents through the controllable information and knowledge as resource on SNS supports the findings in Itzhaky and Schwartz's (2001) research about empowerment of parents of children with disabilities. The more parents feel they are in control of the situation when facing their children's difficulties, the more they perform better parenthood (Itzhaky and Schwartz, 2001).

Most of the parents suggested that SNS also provides them an important platform to advocate for their children. With this internet platform, they could show other SNS users who they and their children are by sharing parenting experience, posting pictures of their children and sharing articles that introduced the different types of disabilities. They also stated that SNSs are important platforms for educating others about children with SEN and to raise attention to the basic rights of their children, such as the right to have friendly learning environment. However, all these acts of advocacy were mostly displayed in their private space, such as personal profile or private groups.

Even though most parental users were less likely to leave their personal comment to the posts in the public pages, they prefer to click the 'Like' icon (see Figure 2.) to show their support or agreement than to posts within public groups and pages. One parent shared in her interview that clicking Like is an important symbol that you absorb and agree with the information you read.
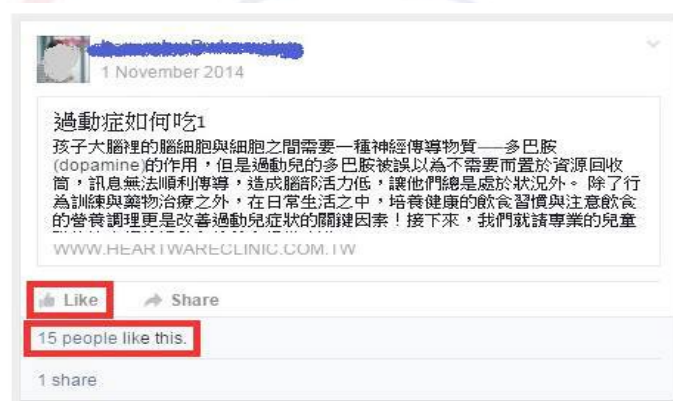

Figure 2: A typical example of a post without comments but with like and share.
Some parents also suggested that clicking like demonstrates their state of support without leaving too much personal information on the internet space.

Clicking 'Like' is a unique way of demonstrating support within SNSs environment. SNS users express their approval, agreement and encouragement to a post and its author by clicking the interaction icon at the bottom of the post. The icon often appears with a 'thumb up' or heart shape with the word 'Like' on top, so in most SNSs, it is called the Like. When clicking it, your SNS user name will be shown on the post, and all other SNS users will see your name with the Like you click.

This finding of clicking Likes among parents as support is in agreement with Gerlitz & Helmond's (2011) finding which also suggest clicking 'Likes' provide a faster and convenient way to claim one's support and agreement. However, some other

researchers argued that SNSs user may over use the function and lead to an dissatisfaction when the number of Like is low or being over sensitive with the number of like (Bachrach et al., 2012). This action of clicking Like should not be underestimated and should be paid more attention to its influence on SNS support, especially emotional support for parents of children with SEN.

Within public space, besides clicking Likes, parents would also leave short comments of encouragement and emotion icons (See Figure 3.) on the posts.

Figure 3: Encouragement in comments.

This type of comment was frequently found within the findings of this pilot study. However, most parental participants suggested that they would never share too much within the comments and also would never share their personal feeling on SNS. These parents argued that there might be some concern and potential threat to their personal privacy if sharing their personal status on SNS. Some suggested that privacy of their personal life was crucial to them, and sharing it on the internet may damage it.

In this pilot study, the privacy setting of the SNS spaces was found highly influencing the interactions of support among SNS users. Bronstein (2013) suggested that when sharing or posting within 'protected spaces' (2013:162) such as private spaces within the SNSs where only 'Friends' could access the space, SNS users are more likely to show their emotion and personal details in life.

'Friend' on SNSs stands for users who the page owner allowed his or her personal information and private space being accessed by. They were mostly person who are their friend, families or colleague in real life. This process of approving SNS users were called Friending (Facebook, 2015). In SNS, Friending is important social practice between its users. Bronstein (2013) suggests that the sharing between friends on SNS provide certain 'satisfaction' (2013:174) for the person who shared. Similarly in this pilot study, two parents also suggested the 'satisfaction' when they shared and received comments from their friends. Thus, this could possible points out the

importance of this unique Friending relationship on SNS and also its high potential of influencing the practice of support for parents of children with SEN on SNS.

Most of the page administrators also suggested that their Friending relationship with the parents of children with SEN also helps improve their relationship with these parents. Due to this relationship of Friend, some even leads to actual relationship of friends in real life. One administrator suggested that she gradually became just as friends to some of the parents after she started to interact with them on her SNS. One parental participant also said that she was blessed to interact with professionals through SNS and become friends with them.

However, few administrators said that they were sometimes overwhelmed with this relationship as Friends with parents on SNS. They sometimes struggle with answering the overloading amount of private messages from parents in their private time. One administrator said that

Some parents overly relay on my reply on SNS. She even text me about question of spelling. I am really really tired answering this sometimes.
(Administrator GE)

To avoid this situation, some administrators said that they created different SNS identity or account to avoid their personal account being 'friended' by parents.

Some administrators also said that some argument with parents also occurred due to this tense relationship, and few emotional comments and arguments which involved swearing and complaining were also found attached to some of the discussions. Many of the emotional comments connect tightly with the identity of parents of children with SEN, for example,

> Only people who are parents of children with SEN could understand what we are facing!!

(Page B, post of a parent on 23rd March 2015)
These comments wrote that parents of children with SEN are a unique group of parents who shared the same difficulties. They suggested that only people who also have children with disabilities could understand the difficulties they are facing. Few parental participants said that their identity as parents was the main reason and motivation to comfort other parents who is also facing the same difficulties.

One of the possible reasons of this strong identity may be due to the networking function of SNS, which allows parents to build up their social cycle easily and rapidly

by connecting to other parents who shared the same identity. Sense of identity as parents of children with SEN was built stronger through this networking process. In most of the situation, this is a positive networking support for these parents. As Scharer (2005) suggests that this development of a support network for parents could enables parents to have a strong voice on SNS to advocate about their rights and the children's right.

However, the concern is that if this identity of parents were created focus on the disadvantage of being a parent of children with SEN or the negative part of the identity, difficulties of providing support to this group of parents would occur. Segregation in some situation may also happen. For example, when negative emotion evoked, parents could segregated themselves by rejecting support due to the self-pity based on the negative focus of their identity. Thus, healthy parenting support on building positive and healthy parental identity should be provided on SNSs to prevent this situation.

The professional plays an important role in promoting the positive identity of these parents. In this research, some administrators suggested that they would support these parents who commented negatively on SNS by not replying the comment directly in the public space but contact the parent privately and individually through message or phone. Positive language and neutral information related to the issue posted were also suggested to be used for responding most posts and comments in the public pages and group by the administrators. All page and group administrators also stated that they avoid posting controversial information or negative stories unless it is urgent or important.

However, as mentioned in the previous section, while providing support for this group of parents by building a close relationship with them on SNS, the professional also found themselves in the dilemma of being overwhelmed of the work they have even in their private time. The findings in this pilot suggest that this situation could damage the support system on SNS and also the relationship between the professionals and parents. Thus, for development of future parent's support of SNSs, more focus should be set on how to balance the relation between the professionals and the parents. So that support on SNS could not only benefit parents, but also develop into mature system that could also support the professionals and even educate the general public.

Conclusion

SNSs are important platforms of providing parents' support for parents of children with SEN, empowering parents and also standing a critical position in the relationship between the parents and professionals in the modern Taiwanese society. Parents are now more capable to speak up and also built their relationship with the professionals, such as social workers or teachers, through SNSs comparing to the traditional support system when professionals were seen as authorities that controls the resource. This research also demonstrate an exciting but somehow worrying change in relationship between the parents and professional after the SNS became one of the main tools for providing support for parents of children with SEN in Taiwan. Thus further research on healthy parent-professional Friending relationship and influence of privacy settings of SNS on parents support should be conducted in order to fully understand the influence of SNS based parental support.
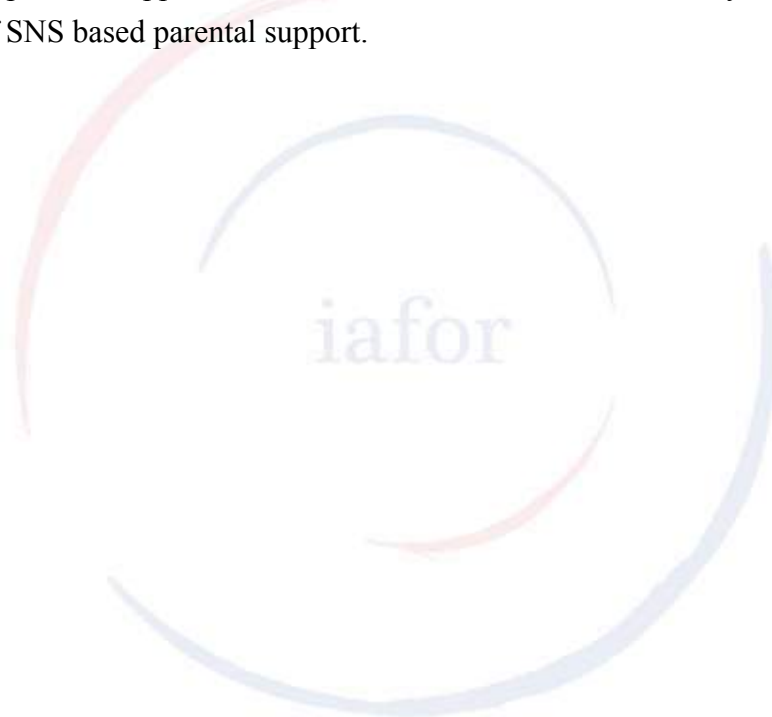
Reference

Al-Kandari, H.Y. (2014), Parents' and Professionals' Perceptions of the Services of Families of Children with Intellectual Developmental Disabilities, *Child and Adolescent Social Work Journal, 31(2),* 119-142.

Bartholomew, M. K., Schoppe-Sullivan, S. J., Glassman, M., Kamp Dush, C. M., &Sullivan, J. M. (2012).New parents' Facebook use at the transition to parenthood, *Family Relations, 61(3),* 455-469.

Barling, J., MacEwen, K. E. (1988). Manipulating the type and source of social support: An experimental investigation, *Canadian Journal of Behavioral Science, 20(2)*, 140-153.

Baum, L.S. (2004) Internet parent support groups for primary caregivers of a child with special health care needs. *Pediatric Nursing* 2004*, 30(5)***,** 381-8.

boyd, d. m. & Ellison, N. B. (2007) Social network sites: Definition, history, and scholarship, *Journal of Computer-Mediated Communication,13(1)*, 210-230.

Bryman, A (2012) *Social Research Methods. 4th Edition,* Oxford: OUP.

Cheung, C. M. K., Chiu, P.-Y., & Lee, M. K. O. (2011). Online social networks: Why do students use facebook? *Computers in Human Behavior*, *27(4)*, 1337–1343.

Cohen, L., Manion, L. and Morrison, K. (2011) *Research Methods in Education.7th Edition.* London: Routledge Falmer

Dichtelmiller, M., Meisels, S. J., Plunkett, J. W., BOZYTNSKI, M. E. A., Claflin, C., & Mangelsdorf, S. C. (1992). The relationship of parental knowledge to the development of extremely low birth weight infants. *Journal of Early Intervention*, *16(3),* 210-220.

Ding, C., Chen, Y., & Fu, X. (2013). Crowd Crawling : Towards Collaborative Data Collection for Large-scale Online Social Networks, 183–188.

Facebook (2015). Facebook Homepage. < https://www.facebook.com/FacebookUK >. (updated 2015, accessed 11th September 2015).

Gabbert, T.I., Metze, B., Bührer, C. & Garten, L. (2013). Use of social networking sites by parents of very low birth weight infants: Experiences and the potential of a dedicated site. *European journal of pediatrics,172*, 1671-1677.

Gerlitz, C., & Helmond, A. (2011) Hit, link, like and share. Organising the social and the fabric of the web.*Digital Methods Winter Conference Proceedings*, 1-29.

Herring, S. C. (1996) Posting in a different voice: Gender and ethics in computer-mediated communication. In C. Essed. (1999)*Philosophical Perspectives on Computer-Mediated Communication*, 115-45. Albany: Suny Press.

Herman, J., Mock, K., Blackwell, D., and Hulsey, T. (2005) Use of pregnancy support web site by low-income African American women. *Journal of Obstetric, Gynecologic and Neonatal Nursing, 34,*713–720

House, J. S. (1981) *Work Stress and Social Support.* Reading Mass: Addison-Wesley Huang, G. H. C., & Gove, M. (2012). Confucianism and Chinese families: Values and practices in education. *International Journal of Humanities and Social Science, 2(3),* 10-14.

Hudson, D.B., Campbell-Grossman, C., Keating-Lefler, R., & Cline, P. (2008) New Mothers Network: the development of an Internet-based social support intervention for African American mothers. *Issues in Comprehensive Pediatric Nursing. 31,* 23–35

Itzhaky, H.& Schwartz, C. (2001) Empowerment of Parents of Children with Disabilities: The Effect of Community and Personal Variables, *Journal of Family Social Work, 5(1),* 21-36.

Jang, J. & Dworkin, J. (2014) Does social network site use matter for mothers? Implications for bonding and bridging capital.*Computers in Human Behavior, 35*, 489-495

Janvier, A., Farlow, B. &Wilfond, B.S. (2012) The experience of families with children with trisomy 13 and 18 in social networks, *Pediatrics, 130(2)*, 293-298.

Kraut, R., Olson, J., Banaji, M., Bruckman, A., Cohen, J., & Couper, M. (2004). Psychological research online: report of Board of Scientific Affairs' Advisory Group on the Conduct of Research on the Internet. *The American psychologist, 59(2)*, 105–17.

Lea, M., & Spears, R. (1992). Paralanguage and social perception in computer-mediated communication. *Journal of Organizational Computing and Electronic Commerce, 2(3-4),* 321-341.

Lenhart, A., Madden, M., Smith, A., Purcell, K., Zickuhr, K., &Rainie, L. (2011). *Teens, kindness and cruelty on social network sites. Pew Internet and American LifeProject.*http://www.pewInternet.org/Reports/2011/Teens-and-social-media.aspx [accessed 23 August 2014].

Madden, M., Cortesi, S., Gasser, U., Lenhart, A., & Duggan, M. (2012). *Parents, teens,and online privacy.Pew Internet and American Life Project.* http://pewinternet.org/Reports/2012/Teens-and-Privacy.aspx [accessed 24 August 2014]

Madge, C., & O'Connor, H. (2006). Parenting gone wired: Empowerment of new mothers on the internet? *Social & Cultural Geography, 7*, 199-220.

Nieuwboer, C. C., Fukkink, R. G., &Hermanns, J. M. (2013). Peer and professional parenting support on the Internet: a systematic review. *Cyber psychology, Behavior, and Social Networking*, *16(7),* 518-528.

Pandolfini, C., Impicciatore, P., & Bonati, M. (2000). Parents on the web: risks for quality management of cough in children. *Pediatrics*, *105*(1). e1.

Plantin, L., & Daneback, K. (2009). Parenthood, information and support on the internet. A literature review of research on parents and professionals online.*BMC Family Practice*, *10*(1), 34.

Riordan, M. A., Markman, K. M., & Stewart, C. O. (2013). Communication accommodation in instant messaging: An examination of temporal convergence. *Journal of Language and Social Psychology*, 32 (1), 84-95

Scharer K (2005) Internet social support for parents: the state of the science. *Journal of Child and Adolescent Psychiatry,*18, 26–35.

Shapka, J. D., & Law, D. M. (2013). Does one size fit all? Ethnic differences in parenting behaviors and motivations for adolescent engagement in cyberbullying. *Journal of youth and adolescence*, 42(5), 723-738.

Tufekci, Z. (2008). Can you see me now? Audience and disclosure regulation in online social network sites. *Bulletin of Science, Technology & Society*, *28*(1), 20-3

UNICEF (2010) *Advocacy Toolkit: A Guide to Influencing Decisions that Improve Children's Lives.* [Available at: http://www.unicef.org/ evaluation/files/Advocacy_Toolkit.pdf]

Yau, M. K and Li-Tsang, C. W. P. (1999)Adjustment and Adaptation in Parents of Children with Developmental Disability in Two-Parent Families: A Review of the Characteristics and Attributes. *The British Journal of Development Disabilities*, 45(88), 38–51

Winton, P. J., Sloop, S., & Rodriguez, P. (1999). Parent education: A term whose time is past. *Topics in Early Childhood Special Education*, 19(3), 157–160.

Zickuhr, K., & Smith, A. (2012). *Digital Differences.Pew Internet and AmericanLife Project.* http://pewInternet.org/Reports/2012/Digital-differences.aspx. Retrieved 26.04.12. [accessed11 July 2014]

Contact Email: i-jung.lu@postgrad.manchester.ac.uk

Improving Working Mindfulness by Multisensory Smart-Office with Cloud Computing

Chieh Jen Chen, Institute for Information Industry, Taiwan
Chia Hung Kao, National Taitung University, Taiwan

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Abstract
Trying to recall our day life in office, we rarely can stay on our seat and focus on the job all the day. There are so many factor cause we lost our mindfulness on our job, for example, the chair is not fit for our body, the desk is too high to comfortable our arms…etc. Depends on the digital technologies, now we can sense human body by different sensor or camera, to log human body's status such like their skeleton, the pressure from their chair and desk, analyzing the sensing data and find out the relationship between environment comfort and human mindfulness. This paper is trying to define some parameters that connect with human feeling and body comfort, how to sense those factors, analysis them, and in the end, is it possible to use the final result to change the environment. We show an idea to enhance employee's working mindfulness, by sensing human acts through beacon, pressure sensor, camera…etc., collect those parameters and computes in cloud server, analysis collected data and find the best working model. We assume the experiment field is a smart office, lights and air conditioning are programmable, even the chair and desk are so on. Based on our behaviors patterns and environment mapping model, trying to make the environment fits our best working model, to ensure employees are always in a perfect working ambience.

Keywords: Body sensing, smart office, cloud computing, data analysis, interactive environment

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Introduction

Trying to recall our day life in office, we rarely can stay on our seat and focus on the job all the day. There are so many factor cause we lost our mindfulness on our job, for example, the chair is not fit for our body, the desk is too high to comfortable our arms…etc. In the past, we can't make our office to fit every employee, not to mention that everyone's requirements might change every day by different propose. Depends on the digital technologies, now we can sense human body by different sensor or camera, we can analysis those sensing data and trying to figure out is a person comfortable or not, according to that result, controlling the environment parameters to make him feels more comfort.

This paper is trying to define some parameters that connect with human feeling and body comfort, how to sense those factors, analysis them, and in the end, is it possible to use the final result to change the environment.

Body Sensing & Environment

Human's mindfulness is affected by environment factors. Temperature, lighting, humidity, noise… etc., can always interfere our body to distract our work. In the other, a good environment can make us concentrate on the job. About the relationship between environment and mindfulness, Hiroshi Ishii had mentioned in Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms (Hiroshi Ishii, Brygg Ullmer, 1997). He put forward this idea that how to make environment message combine with an office area in a not interfere, but can be aware easily way. This is a way to make human can focus on their job, without too many environment message distribution. In our research, we want to follow the idea which environment is connect with human mindfulness, but revers, we are trying to control the environment to fit human requirements.

Here are some body and environment sensor we may use in this research:

Camera

The most important factors in this paper is a human upper body skeletal tracking, we can find out a person's fatigue through their sitting posture, the degrees of curved spin, the angle of head and neck, two shoulders position…etc., those parameters can be good resource to define human fatigue level. In this research, we use Kinect Camera and its Joint Hierarchy (see Figure 1) to capture human skeleton. The original hierarchy has 20 different joints. In our research, we are using SDK 1.8 which has Seated Mode to capture upper body only. And it's able to detect Hierarchical Rotation and Absolute Player Orientation (see Figure 2); these are making us easily to get the correct value from the target.
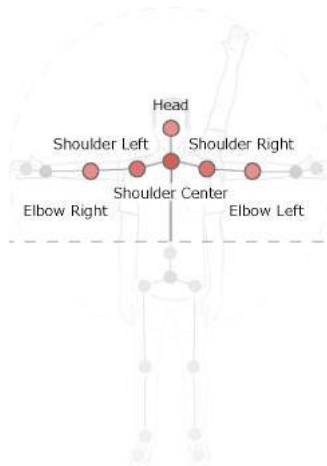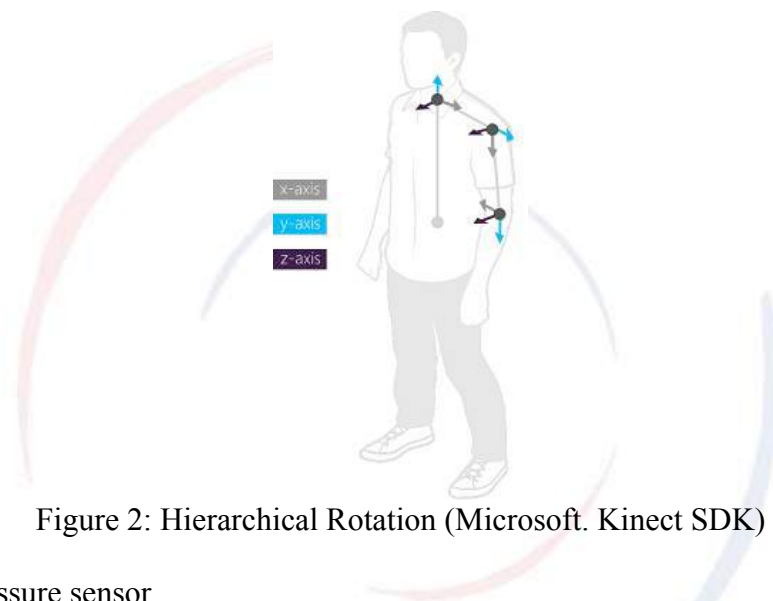
Figure 1: Joint Hierarchy (Microsoft. Kinect SDK)

Figure 2: Hierarchical Rotation (Microsoft. Kinect SDK)

Flexion/Pressure sensor

Normally, human will relaxing their body by leaning back on their chair when we feel exhausted. According to our fatigue level, this action will give chair different extents pressures. We can quantize this pressure value to mapping into a fatigue level list, getting a relative value about human fatigue. In this research, we use simple flexion sensor (which can measure the amount of deflection caused by bending the sensor (SensorWIKI. Sensors: Flexion) also called bend sensor) to measure this pressure value, we set it up in the back of chair, especially the joints of chair, lightly leaning back or strong lie down on the chair will get different value and feedback, and we collect those values as computing resources. (see Figure 3)
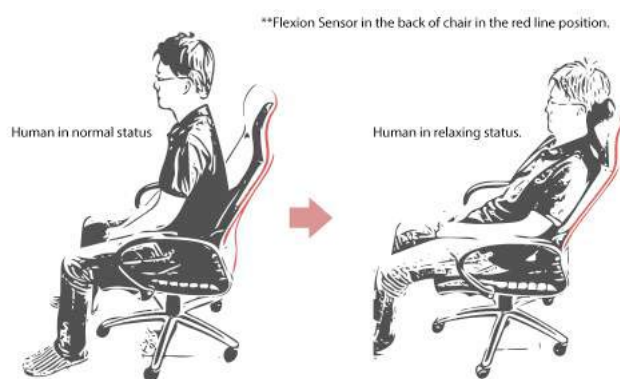
Figure 3: Fatigue measuring through flexion sensing on chair.

Environment sensing

Expect the factors of human body exhausted, sometimes people will lost their mindfulness because of some external factors. It's hardly to define which external factors exactly affect human and how do they affect us, so we just consider some controllable environment factors: Temperature, Humidity and Lights. We record those factors' data value, and choose some colleagues to be experiment subjects, recording their behaviors such like relaxing on the chair, leaning back, which we get the information form flexion sensor on their chair.

In some cases, people doesn't feel exhausted but just want to take a walk in the office, we also define this action as mindfulness loses behavior. We setup some beacons on our office (as Figure 4), and use them to trace single person's moving path, use these data to create a pattern to recognize those mindfulness loses patterns. And mapping into the data we got form thermometer, Hygrometer, and Photometer to get a measureable model about environment and human mindfulness.
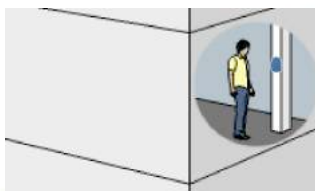

Figure 4: beacon in the aisle in office.

Clouding Compute & Data analytic

All the patterns and models creation we just mention on last section, we are using a service that calls Bistro, which is design by Institute for Information Industry (III, Taiwan). This service is a big data analysis platform, it integrated U.C. Berkeley BDAS (AMPLab–UC Berkeley, 2015), and Apache Hadoop (Wikipedia. 2015. Apache Hadoop), become a cross open source software platform (see Figure 5.)
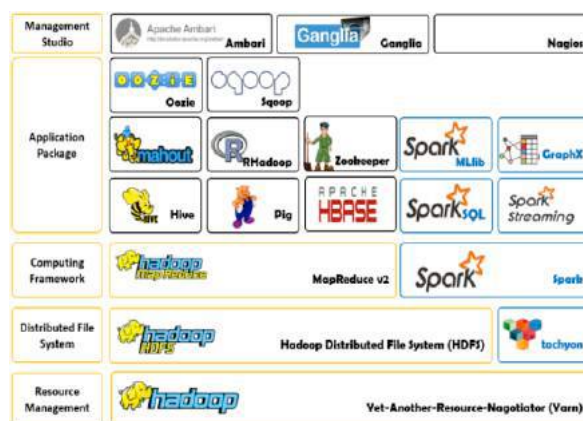
Figure 5: Bistro structure model.

Bistro allow users input data sets, calculates by customized function model, generalize and analysis those data to get particular patterns, models, or data analysis reports. In this case, all of the sensors are connected to our intranet, and the data of sensing logs will be sending to Bistro through RESTful APIs. According to our pattern recognize function, generating human mindfulness and environment mapping model (Figure 6).
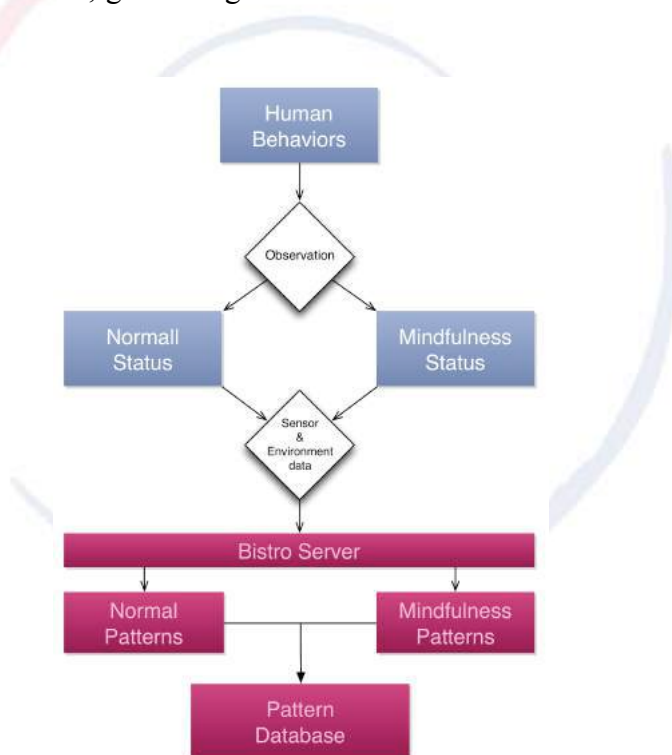

Figure 6: Human behaviors pattern contraction flow.

Environment control

According to the early result in this paper, we can use those sensors to recognize which employee is in mindfulness loses status or event close it, and follow our human mindfulness and environment mapping model to control the environments to make him feel comfort and become concentrate.

The programmable lights and electronic curtain can adjust indoor lighting, air-conditional can change temperature and humidity, electronic control desk and chair

can help human to sit on a correct pose to avoid getting tired. Those products are issued in smart office domain, but can be implementing on our research result. (Figure 7)
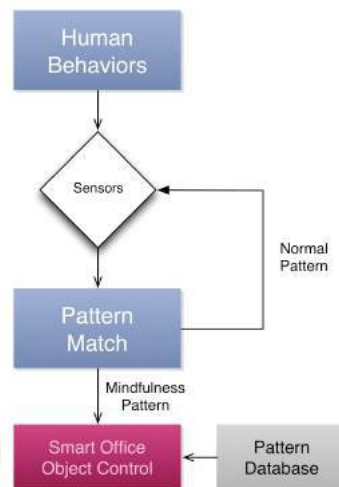

Figure 7: human behaviors and environment mapping model

Conclusion

In this paper, we are trying to define the connection between human mindfulness and environment; we are using some sensing technologies to detect human body factors, to determine people are losing their concentration or not. Final goal is we hope we can make human working or living in a perfect environment, if they are not, we can control the environments to comfort them without aware this progress.

Acknowledgements

References

Hiroshi Ishii, Brygg Ullmer. 1997. Tangible Bits: Towards Seamless Interfaces between People, Bits and Atoms. Proceedings of CHI '97.

Microsoft. Kinect SDK:Joint Orientation. MSDN Library. https://msdn.microsoft.com/en-us/library/hh973073.aspx

SensorWIKI. Sensors: Flexion. http://www.sensorwiki.org/doku.php/sensors/flexion

AMPLab–UC Berkeley. 2015. Software. Available: https://amplab.cs.berkeley.edu/software/

Wikipedia. 2015. Apache Hadoop. Available: http://en.wikipedia.org/wiki/Apache_Hadoop

Portfolio Optimization Using
Multi-Objective Particle Swarm Optimization

Viriya Yimying, National Institute of Development Administration, Thailand
Ohm Sornil, National Institute of Development Administration, Thailand

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Abstract
Portfolio optimization is an important problem in finance. Its goal is to discover an efficient frontier which yields highest expected return on each level of portfolio variance. The problem has multiple objectives, and its search space is large. Multi-objective particle swarm optimization is a multi-objective optimization method, developed from particle swarm optimization, by incorporating non-dominated sorting and crowding distance. This research proposes a portfolio optimization technique based on multi-objective particle swarm optimization. Two objectives used in the research are maximization of return and minimization of portfolio risk. The technique is evaluated using daily stock total return index gross dividends from Stock Exchange of Thailand between 2006 and 2014. The technique is deployed in unknown trading periods, and the results are compared with standard market benchmarks. The results show that the proposed technique performs well in comparisons with the market benchmarks.

Keywords: Portfolio optimization, Multi-objective particle swarm optimization, Markowitz's model, portfolio management

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Introduction

Investors throughout the world are interested in portfolio management. The main focuses for this problem are on expected return and risk management. Portfolio theory, first introduced by (Markowitz, 1952, 1959), is applied to portfolio allocation to aid security selection and asset allocation to gain the highest expected return while having an acceptable risk level. Later on, this theory was developed into others theories such as the capital market theory.

There are many constraints that a fund manager has to consider before making decisions on investment allocation, such as those defined by the investment committee and by the securities and exchange commission, such as the maximum and the minimum weights of shares, the portfolio risk, and the acceptable value at risk. Besides, there are other factors that the fund manager should consider such as liquidity and dividend yield (Clarke et al., 2002). Because the search space of portfolio optimization is large and not suitable for the Brute force method while the population random sampling yields inconsistent solutions. A better approach is needed to obtain accurate and suitable solutions quickly.

Multi-objective particle swarm optimization (MOPSO) is developed from particle swarm optimization (PSO), introduced by Eberhart & Kennedy (1995), and based on the herd's behavior or swarm intelligence. A flock of birds or a swarm seeks for food by communicating with one another to assemble where they find good food. Along the way, if better food sources are discovered, they communicate back and fly to the best sources together. Later, Moore & Chapman (1999) applied PSO to search for multi-objective solutions, and there currently are numerous researches on applying PSO to various problems. At the same time, Raquel & Naval Jr. (2005) presented MOPSO which employs non-dominant sorting and crowding distance methods from Non-Dominated Sorting Genetic Algorithm-II (NSGA-II), created by Deb et al. (2000) and mutation by Coello et al. (2002, 2004). MOPSO has the same principle as PSO which males it suitable to find the best search space spot in a short time. PSO uses real-valued encoding and vector-based calculation and thus lends itself well to real-valued problems (Coello et al., 2002). Moreover, Mishra et al. (2009) compared the results of MOPSO and those of NSGA-II on a portfolio optimization problem without investment constraints. The results show the superiority of MOPSO over NSGA-II.

This research presents a portfolio optimization technique using MOPSO with investment constraints. In the rest of the paper, Section 2 presents the proposed technique. In Section 3, the technique is evaluated using actual stock prices from the stock exchange of Thailand, and the results are presented. Section 4 provides concluding remarks.

Proposed Technique

PSO is a population-based search algorithm, simulating the social behavior of birds within a flock. It is found to be very effective in a wide variety of applications and able to produce good results at a very low computational cost. PSO relies on two mechanisms: parent representation and fine tuning of the parameters.

A particle is a member (individual) of the swarm. Each particle represents a potential solution to the problem being solved. The position of a particle is determined by the solution it currently represents. PSO uses an operator that sets the velocity of a particle to a particular direction. The direction is defined by both the particle's greatest success (personal best or *pbest*) and the best particle of the entire swarm (global best or *gbest*). If the direction of the personal best is similar to the direction of the global best, the angle of potential directions will be small, whereas a larger angle will provide a larger range of exploration. Particles are flown through the search space. Changes to the positions of particles within the search space are based on the social-psychological tendency of individuals to emulate the success of other individuals.

The solution set of a problem with multiple objectives does not consist of a single solution. Instead, in multi-objective optimization, we aim to find a set of different solutions, i.e., the Pareto optimal set. In MOPSO, a swarm is first initialized. A set of leaders is also initialized with the non-dominated particles from the swarm. The set of leaders is usually stored, and quality measures are calculated for all the leaders. At each generation, a particle is flown. The particle is evaluated, and its corresponding *pbest* is updated. A new particle replaces its *pbest* particle usually when this particle is dominated or if both are incomparable (i.e., they are both non-dominated with respect to each other). After the particles are updated, the set of leaders is updated. Finally, the quality measure of the set of leaders is recalculated. This process is repeated for a certain number of iterations.

Portfolio Optimization Using MOPSO

The MOPSO process is shown in Figure 1. First, a number of particles are defined. Too few particles will not yield inclusive solution while too many particles will slow down the MOPSO process. From experiments, we find that the most suitable number is 200 particles, which is then set as the number of particle vectors. Elements of a vector are variables of a solution, i.e., portfolio weights. The initial values of weights are randomly set, and the sum of all weights w_i is equal to 1.

$$\sum_{i=1}^{n} w_i = 1$$

where w_i is the investment weight of security i, and n is the number of elements in a vector.
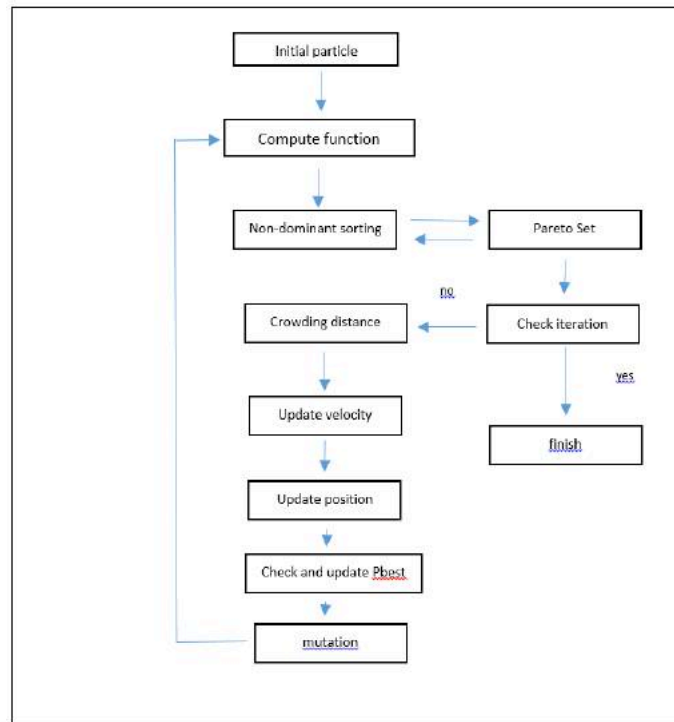
Figure 1: The MOPSO algorithm

Each vector is checked for any violation of the constraints. Objective values for each vector are then calculated. Two objective functions used in this study are:

Objective 1: Maximizing the expected return:

$$\text{Maximize } E(r_p) = \sum_{i=1}^{n} w_i r_i$$

where $E(r_p)$ is the expected rate of return of portfolio p
        w_i is the investment weight of security i in portfolio p
        r_i is the expected rate of return of security i.

Objective 2: Minimizing the portfolio risk

$$\text{Minimize } \sigma_p^2 = \sum_{i=1}^{m} w_i^2 \sigma_i^2 + 2\sum_{i=1}^{m} \sum_{j=1}^{m} w_i w_j \sigma_{ij}$$

The covariance of securities i and j (σ_{ij}) can be calculated as:

$$\sigma_{ij} = \frac{1}{n} \sum_{k=1}^{m} (r_{ik} - E[r_i])(r_{jk} - E[r_j])$$

where σ_p^2 is the portfolio variance
        σ_{ij} is the covariance of securities i and j
        m is the number of days

σ_i^2　　　is the variance of security i

r_{ik}　　　is the daily return of security i on day k.

When i is equal to j, σ_{ii} becomes σ_i^2 (the variance of security i). The daily return r_{ik} can be calculated as:

$$r_{ik} = \left[\frac{close\ price_{ik} \times number\ of\ shares_{ik}}{(close\ price_{i,k-1} \times number\ of\ shares_{i,k-1}) \pm (adjust\ price_i \times adjusted\ shares_i)} - 1\right] + total\ dividend\ yield_{ik}$$

$$total\ dividend\ yield_{ik} = \frac{dividend\ per\ share_i \times number\ of\ shares_{i,k-1}}{(close\ price_{i,k-1} \times number\ of\ shares_{i,k-1}) \pm (adjust\ price_i \times adjusted\ shares_i)}$$

where　$close\ price_{i,k}$　　　is the closing price of security i on day k
　　　　$number\ of\ shares_{i,k}$　　is the number of outstanding shares i on day k
　　　　$dividend\ per\ share_i$　　is the cash dividend per share of security i
　　　　$adjust\ price_i$　　　is the price after adjustment (by the corporate)
　　　　$adjusted\ share_i$　　is the number of shares after adjustment.

Non-dominant particles yield values on the Pareto front which are the best solutions of a multi-objective problem. Non-dominant sorting is performed to find non-dominant particles by comparing each particle to other particles with respect to each objective. If a particle is worse than any particle in an objective, that particle is dominated and eliminated. When non-dominant results are obtained, they are stored in the Pareto set in a sorted order, and crowding distances between two consecutive particles are calculated from the population. The crowding distance of particle i can be calculated as follows:

$$d_i = \sum_{j=1}^{n} \left(\frac{f_{j,i+1} - f_{j,i-1}}{f_{j,max} - f_{j,min}}\right)$$

where n is the number of objectives, and j is the particle order. Once the crowding distances for all particles are obtained, they are sorted from maximum to minimum before selecting the values to be the goal selection. From experiments, we find that the selection should be performed in steps. If the size of the Pareto set is less than 5, all particles are selected while if there are more than 5 particles, select the top 30 particles. Then, the *gbest* values are determined. Each particle value is *pbest* to calculate the velocity in order to find its new position x_{ij} according to the equation below:

$$x_{i,j}(t+1) = x_{i,j}(t) + v_{i,j}(t+1)$$

$$v_{i,j}(t+1) = \omega v_{i,j}(t) + c_1 r_{1,j}(t)[pbest_{i,j}(t) - x_{i,j}(t)] + c_2 r_{2,j}[gbest_j(t) - x_{i,j}(t)]$$

where　$x_i(t)$　　is the i-th particle's position at iteration t with respect to objective j
　　　　$v_{i,j}(t)$　　is the velocity of particle i at iteration t with respect to objective j
　　　　c_1, c_2　　are constant velocities where $c_1 + c_2 \leq 4$

r_1, r_2 are random values for speed adjustment where $r_1, r_2 \in U(0,1)$

ω is the inertia weight where $\omega > \frac{1}{2}(c_1 + c_2) - 1$

In our research, we adopt a commonly used values of $c_1 = 1.494$ and $c_2 = 1.494$ (Van den Bergh, 2006), and r_1 and r_2 are random values between 0 and 1, and they are independent from each other. The number of iterations is set at 3,000. However, we find that after 1,500 iterations, the Pareto front generally is unchanged. The inertia weight ω helps reducing the velocity of a particle to control severe movements. Its value is varied according to (Corazza & Komilov, 2009) as follows:

$$\omega = w_{max} - (\frac{w_{max} - w_{min}}{iteration_{max}}) \times iteration$$

where w_{max} and w_{min} are the maximum and minimum allowable security weights.

Portfolio Optimization Constraints

Two constraints are imposed on weights of securities in a portfolio. First, to not overemphasize on a particular stock, each stock must account for no more than 10% of the total portfolio. In addition, the proportion of an industry must not exceed 40% of the total portfolio.

Mutation Operation with Constraints

After updating velocity, the mutation operation is performed. Our mutation operation is a modification from the original operation by Coello et al. (2002) which mutates only one variable of a particle vector. Since a portfolio optimization problem considers many constraints, mutating only one variable decreases the effects of mutation. Our modified mutation makes changes to every value in a vector to expand the search space, as shown in Figure 2.

```
for unit = 1 to number_of_particles
    mutation_rate = 0.5;
    if (1-iteration/max_iteration)^(5/mutation_rate) > rand
        for element = 1 to vector_size
            mutation_range = (weight_max – weight_min) *
                             (1-
            iteration/max_iteration)^(5/mutation_rate);
            UB = particle(unit, element) + mutation_range;
            LB = particle(unit, element) – mutation_range;
            particle(unit, element) = (rand(1)*(UB-LB))+LB;
        end for
    end if
end for
```

Figure 2: The mutation operation

Each weight in a particle vector is verified if there is any violation of the constraints. If any, adjustments are made to limit the weight values according to the constraints. The industry proportions are checked, and adjustments are performed to limit those proportions by equally updating the weights that are in the same direction of the difference. Then, the final adjustment is made in order for the total sum of weights in a portfolio to be 1(or 100%). After adjustments, the process of finding non-dominant particles as described earlier is repeated until reaching the specified number of iterations.

Experimental Evaluations

According to the capital market theory by Markowitz (1952), risk can be divided into two types: systematic risk and unsystematic risk. Systematic risk cannot be eliminated because it is the stock market risk while unsystematic risk can be eliminated through diversification. This is because stocks and shares in different industries have different returns depending on the business cycles. For this reason, we select 5 stocks with highest capitals from each industry group, i.e., Agro and Food (AGRO), Consumer Products (CONSUMP), Financials (FINCIAL), Industrials (INDUS), Property and Construction (PROPCON), Resources (RESOURC), Services (SERVICE), and Technology (TECH) industries, as follows:

AGRO industry consists of CPF, MINT, TUF, TF and KSL
CONSUMP industry consists of SUC, ICC , MODERN, TR and SITHAI
FINCIAL industry consists of SCB, KBANK, BBL, KTB, BAY and TPC
INDUS industry consists of TPC, STANLY, TCCC, VNT and SSI
PROPCON industry consists of SCC, CPN, SCCC, LH and PS
RESOURC industry consists of PTT, PTTEP, GLOW, TOP and RATCH
SERVICE industry consists of CPALL, AOT, BDMS, MAKRO and BIGC
TECH industry consists of ADVANC, INTUCH, TRUE, DELTA and JAS.

The proposed method is evaluated using four sets of data which span 4 different periods of time which are: set 1 (2006 – 2010), set 2 (2007 – 2011), set 3 (2008 - 2012), and set 4 (2009 – 2013).

Results

To find an optimal portfolio, financiers typically apply a proportion variation calculation to create an efficient frontier line. The Monte Carlo method is a popularly used one. It randomizes the variables according to the constraints for a portfolio. Once a random portfolio is obtained, portfolio risk and expected return are calculated. The portfolio with the highest return at the same risk level will be on the efficient frontier.

Efficient Frontiers Generated by MOPSO and the Monte Carlo Method

Results of portfolio optimization by MOPSO and the Monte Carlo method are shown in Figures 3, 4, 5 and 6. We can see that MOPSO yields better efficient frontiers than does the Monte Carlo method.
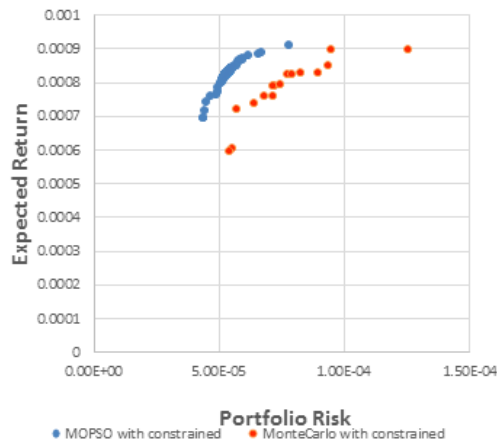
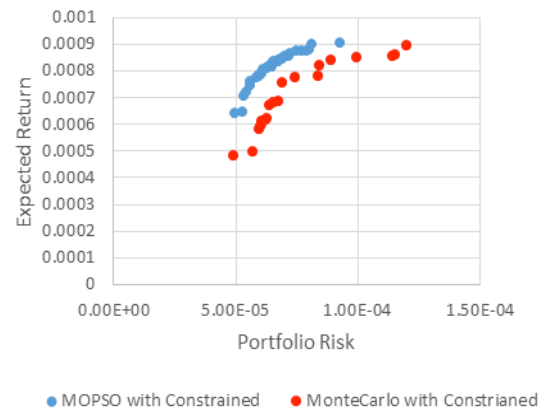Figure 3: Efficient frontiers by MOPSO and Monte Carlo methods 2006 - 2010

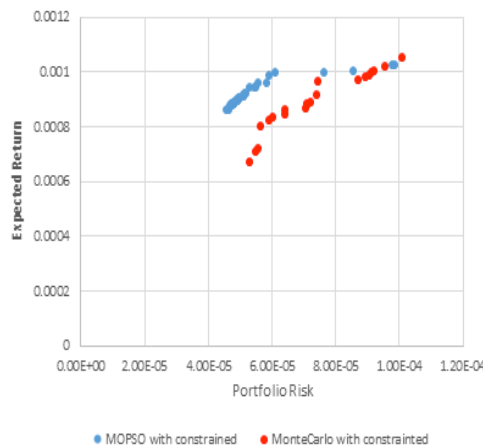Figure 4: Efficient frontiers by MOPSO and Monte Carlo methods 2007 - 2011

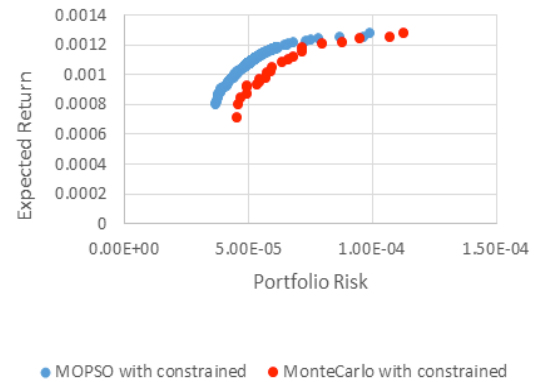Figure 5: Efficient frontiers by MOPSO and Monte Carlo methods 2009 - 2012

Figure 6: Efficient frontiers by MOPSO and Monte Carlo methods 2009 - 2013

Trading Results

In order to evaluate the trading performance of the proposed method, three types of portfolios by MOPSO are selected, and their returns are calculated which consist of:

1. Portfolio with the highest expected return,
2. Portfolio with the lowest portfolio risk, and
3. Portfolio with the minimum coefficient of variation.

We compare the returns of the 3 types of portfolios generated by MOPSO with the performance of SET, SET50, SET100 and SETHD indices. These indices are the market representatives and used as the standard comparative indices for investment.

Table 1: Total returns of MOPSO and benchmark indices

Total Return							
Portfolio Type Investment Period	Minimum Coeff. of Variation	Maximum Return	Minimum Risk	SET	SET50	SET100	SET HD
2011	15.84%	15.65%	18.27%	3.69%	3.74%	3.23%	NA
2012	45.07%	59.70%	34.49%	40.53%	35.94%	37.69%	26.14%
2013	-1.99%	3.55%	0.04%	-3.63%	-3.53%	-4.07%	-8.57%
2014	15.44%	19.18%	12.25%	19.12%	16.98%	18.18%	8.91%

The results are shown in Table 1. The results show that the portfolio with the highest expected return outperforms all other portfolio types and all indices in every year. The portfolio with the minimum coefficient of variation performs better than all indices in almost every year. Only in 2014 that it generates the return which are 3.68%, 1.54%, and 2.74% less than SET, SET50, and SET100 indices, respectively. The portfolio with the lowest risk performs better than all indices in 2011 and 2013 while it performs worse than the indices (except for SETHD) in 2012 and 2014. Overall, we can see that the proposed technique generate portfolios that perform well in comparisons with standard investment indices.

Conclusion

Portfolio optimization aims to discover an efficient frontier which shows highest expected return on each level of portfolio variance. Due to large variations of variables and constraints, manual portfolio optimization is inefficient. Multi-objective particle swarm optimization is an optimization technique which is suitable for solving numeric optimization and yields high quality results. It is used in this research to construct efficient frontiers for portfolio optimization. The proposed method is evaluated using daily stock total return index gross dividends from Stock Exchange of Thailand between years 2006 and 2014. Its performance in actual trading is compared with the total returns net dividend from SET, SET50, SET100 and SETHD, widely used investment performance indices. The results indicate that the returns from the proposed method are better than the standard indices in most investment periods.

References

Clarke, R., De Silva, H., & Thorley, H. (2002). Portfolio constraints and the fundamental law of active management. *Financial Analysts Journal*. 58(3), 48-66.

Coello, C. A., Toscano, P.G., & Salazar, L.M. (2004). Handling multiple objectives with particleswarm optimization. *IEEE Transactions on Evolutionary Computation*, 8(3), 256–279.

Coello, C. A., Lamont, G. B., & Van Veldhuizen, D.A. (2002). *Evolutionary Algorithms for Solving Multi-Objective Problems*. Boston : Kluwer.

Corazza, M., & Komilov, N. (2009). *Praticle Swarm Intelligence: an alternative approach in Portfolio Optimization*. Facolta di Economia, Universita CA Foscari Venezia.

Deb, K., Agrawal, S., Pratab, A., & Meyarivan, T. (2000). A Fast and Fast and Elitist Multiobjective Genetic Algorithm: NSGA-II. *Proc. Parallel Problem Solving From Nature VI Conf*, 849 -858.

Eberhart, R. C., & Kennedy, J. (1995). Particle Swarm Optimization. *IEEE International Conference on Neural Networks*, 1942-1948.

Goldberg, D. E. (1989). *GeneticAlgorithm in Search, Optimization, and Machine Learning*. Addison Wesley.

Markowitz, H.M. (1952). Portfolio Selection. *The Journal of Finance*, 7 (1), 77-91.

Markowitz, H.M. (1959). *Portfolio Selection. Efficient Diversification of Investments*. NewYork: John Wiley.

Mishra S. K., Panda G., & Meher S. (2009). Multi-objective particle swarm optimization approach to portfolio optimization. In *Nature & Biologically Inspired Computing, NaBIC 2009, World Congress*, 1612-1615.

Moore, J., & Chapman, R. (1999). *Application of Particle Swarm to Multiobjective Optimization*. Department of Computer Science and Software Engineering, Auburn University.

Raquel, C.R., & Naval Jr, P.C. (2005). An Effective Use of Crowding Distance in Multiobjective Particle Swarm Optimization. In *Proceedings of the Genetic and Evolutionary Computation Conference (GECCO-2005)*, 257–264.

Van den Bergh, F. (2006). *An analysis of particle swarm optimizers*. Doctoral dissertation, University of Pretoria.

Contact email: viriyay@sso.go.th