

The Circles of Connections: An evidence-based social visualisation tool to diagnose strengths and weaknesses of your social connections

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In modernity, there is a growing obsession with tracking various aspects of an individual's life, that is the 'quantified self'. The latest trends in technology have made it much easier to track many elements of life such as heart rate, weight loss, fitness activity, and sleep patterns. The list can be extended by collecting data on others as well (such as a baby or pet), leading to the notion of the 'quantified other'. This new wave in quantified self/other data has an impact on social and behavioural science research as well, moving the field away from a focus on survey studies towards more complex data-driven approaches. However, feasible ways of measuring the more intangible aspects of life such as connectedness, feelings, and resilience are rarely on offer in the self-quantified market. To address this, in partnership with Red Cross Australia, we have developed a social visualisation tool that helps people to assess their social connections,

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and understand how these connections contribute to aspects of social capital such as participation, support, feelings of safety and trust. We believe having such a tool to self-quantify an individual's social connections offers the potential for better public health outcomes. The greater impact can be made at a community level to understand and facilitate social connections of diverse communities and raise awareness about their needs. Enriching such information with other spatial or sociodemographic data can help organisations like the Red Cross for provision of targeted supports particularly around areas of disaster management and engaging marginalised or vulnerable populations, and thus to build more resilient communities.

Keywords: Social connectedness, Quantified self, Social visualisation, Social isolation, Community resilience, Non-Government Organisations (NGO).

Introduction

Study of the self has been of keen interest to many disciplines including sociology, psychology, anthropology, public health and neurophysiology. Historically, this widespread interest has been known since ancient times when the Greeks pilgrimaged to the Temple of Apollo at Delphi and were greeted with the inscription 'Gnothi seauton' or 'Know thyself'¹. From a pragmatic point of view, an individual can attain self-knowledge about their habits, activities, and thoughts, just using a pen and paper. Today, with advances in sensor technologies and self-tracking gadgets, it is even more straightforward to measure many aspects of life. Fitness trackers such as Fitbit and FuelBand are examples that help people to track heart rate, weight loss, calories consumed, fitness activity, and sleep patterns.

The new wave in self-knowledge via data opens up exciting opportunities for social science research as well. The field is evolving from a focus on survey studies towards more complex data-driven approaches. Researchers and practitioners have already used computers and other aspects of Information and Communication Technology (ICT) in social science research, either to query people regularly as they engage in their normal lives or to record activity using devices' built-in sensors. The grand challenge here is not merely data collection, but also interpreting data on 'fuzzy' subjects that are difficult to delineate in quantitative terms. One of these fuzzy subjects, which is the main focus of this study is *social connectedness*.

We conceptualise social connection here as a personal connection that could be human or non-human. Personal connections are considered those that are not solely based on business or professional transactions, though people from an individual's realm of business, work, volunteering or caring roles could become part of their 'personal connections' (Dunbar & Spoors, 1995). Human social connections are ones in which an individual has reciprocated personal social exchanges. These could be through face-to-face, written, telephone or technology-mediated interactions. Non-human entities are

¹ Self-knowledge is also known by other names, such as 'quantified self', 'personal informatics', 'personal analytics', 'living by numbers', 'self-surveillance' and 'self-tracking' (Li, Dey & Forlizzi, 2010).

also included, for example animals, meta-physical entities like a god, a place or the concept of country. Though these are not easily defined as ‘reciprocal personal social exchanges’, we are interested in the potential that these connections may provide, in the individual’s assessment, some form of reciprocal feeling and social benefit.

Being socially minded, it is crucial for people to grow and maintain healthy social connections. The idea of maintaining such healthy connections and its effects has been explored within several disciplines from sociology to anthropology, psychology, neurophysiology and public health. Through these, there is a shared perspective that social connections can produce positive effects, as long as an individual’s connections do not have negative attributes. Kaniasty and Norris found that individuals with more social connections received more assistance following a disaster, most of which were often non-financial (Kaniasty & Norris, 1995). Holder and Coleman found that positive friendship and family were the highest predictors of future happiness in 9- to 12-year-olds (Holder & Coleman, 2009); and Elliot et al. demonstrated the importance of social participation in feelings of neighbourhood belonging (Elliott, Gale, Parsons, Kuh & HALCyon, 2014). Holt-Lundstad suggested that social connectedness could be an antidote to a proposed loneliness ‘epidemic’ (Holt-Lundstad, 2018). Whether or not social isolation is actually a greater risk for modern society than in the past, generating greater social connection can be interpreted as underpinning a significant part of ‘everyday’ humanitarian work.

Our Australian Red Cross partners have been fundamentally interested in how to build social connection. While working on domestic projects around building resilient communities and disaster preparedness, optimising the inclusion of vulnerable groups, and building an inclusive, diverse and active humanitarian movement, the Australian Red Cross realised that they were dealing in various ways (using a range of evidence and advice from different disciplinary perspectives) with social connection, and thus resolved to identify a coherent and practical model (Australian Red Cross, 2018).

To the best of our knowledge, there is no definitive coherent model for self-assessment of an individual’s social connectedness. Therefore, in this study, we propose a social connection model developed through an iterative process from (a) a pragmatic review of recent social connection literature, (b) a review of Australian Red Cross internal reports and key documents, and (c) discussions with Red Cross practitioners – two ‘brainstorming’ discussions with senior Red Cross social innovation practitioners and two further group discussions to test the first stage prototype model with Red Cross staff working in one way or another in social connection, these included participants from different Australian States, with different practical experiences, expertise and cultural affiliations.

To make our model operationalised, a social visualisation tool has been developed to assist in validating and further improving our initial model. The idea of our tool, called *The Circles of Connections*, is that individuals can use it to identify their own social connections, observe the time and emotional attachment spent in maintaining these connections, and assess the range of feelings and resources that can be gained from different types of social connections. At this stage, our tool is purely intended to raise

awareness about social connections, and though we envisage such capacity in its future, currently it is not for measuring the quality of those connections.

In addition to being research partners on this project, the Australian Red Cross has also co-funded the project with the Social Innovation Research Institute, Swinburne University of Technology.

Contributions

The goal of this research is to provide a coherent understanding of social connectedness. This includes identifying inputs to social connections and quantifying outputs of social connections in terms of resources and feelings that those connections provide. To achieve this goal, we collated the disparate literatures via searches of Google Scholar and Ebscohost using a range of synonymous search terms for ‘social connection’, generally confined to 2008-2018, with inclusion criteria of English language and peer-reviewed journal articles only. The full process of this search is covered in another article (Farmer et al., 2018). We conducted a thematic analysis of findings and assembled the themes to provide an ‘ideal type’ model that made intuitive sense when discussed with practitioners and researchers; and did not emphasise potential deficit issues such as referencing loneliness. We propose that this model has use as a foundation for future research about social connection by those working in Non-Governmental Organisations (NGOs) and the community sector who wish to signpost potential points for intervention and change on issues related to social isolation, community resilience, cohesion and capacity-building.

In summary, the contributions of this work are listed as follows:

1. introducing a transdisciplinary model for diagnosing social connections,
2. developing an interactive visualisation tool to operationalise the above model using open-source JavaScript libraries,
3. prototyping a data collection infrastructure about social connectedness that in conjunction with other existing population surveys such as Victorian Population Health Survey (VPHS, 2016) provides empirical evidence for disaster preparedness and health service provisioning in Victoria.

In particular, the last contribution has the potential for ‘datafication’ to translate social actions into online quantified data, thus enabling a novel scientific approach for explanatory and predictive social analysis (Cukier & Mayer-Schoenberger, 2013). Again, ICT development is necessary to augment this kind of analysis with massive sources of social data and research along this line is at the forefront of the field right now (Conte et al., 2012).

The rest of this article is structured as follows: In the next section: Key concepts and methods, we review some of the key concepts on social connection and the literature that resonates with this area. In the Section: Our proposed model, we propose our social connection model in detail, and in Section: Circles of Connections in Action, we

demonstrate our operationalised tool, *The Circles of Connections*. The discussions and future plans are presented in the following section.

Key concepts and methods

In this Section, we look at major concepts and theories related to social connection that emerged from a combination of our thematic literature review and discussions with Red Cross practitioners about notions in social connectedness that they found relevant. Note that because of the space limit, we cannot review all literature that might have a bearing on social connection. Instead, we restrict ourselves to describing concepts required to understand our proposed model.

Social Capital:

Social capital is a multidisciplinary and multifaceted concept that helps in describing the characteristics of our social connections. For instance, in sociology, Lin defined social capital as the resources embedded in a social structure accessed or mobilised purposely by the social actors (Lin, 2017). Putnam defined social capital as a combination of patterns of community participation and social cohesion (Putnam, 2000). Social cohesion refers to the absence of latent social conflict and is often determined by the level of trust, sense of belonging, generalised reciprocity, and social harmony (Harpham, Grant & Thomas, 2002). Likewise, in business literature, social connection is linked with the idea of social capital to highlight the value of social relationships and networks in easing business development and entrepreneurship (Granovetter, 1973; Uzzi, 1999).

Social Networks

Another concept often applied to demonstrate subtleties and nuance in how social connections are conceptualised or measured emerges from theories on Social Network Analysis (SNA). A social network is defined as a set of social actors (e.g., people or organisations) and a relationship among them (e.g., friendship or co-working) in the form of dyadic *relationship ties* (Robins, 2015). Much of social network research can be seen as working out how these different kinds of relationships or ties affect each other. The most common procedure for eliciting network data is to run a survey or an interview and get respondents (*egos*) to identify people (*alters*) with whom they have various kinds of relationships and then to also ask the ego about the relationships between some or all of the alters.

An interesting fact that has implications for measurement studies is that a social network may also provide social capital to the actors within it (Borgatti, Mehra, Brass & Labianca, 2009). For example, Lin studied an actor's range of acquaintances across a variety of different employment categories (e.g., doctor, banker) to assess the social resources an actor can access (Lin, 2017).

Tie strength

The literature suggests that a variety of ties can co-exist in a social interaction. Granovetter's study in economic sociology distinguishes between strong and weak ties in relationships, where tie strength depends on time spent together and emotional intensity of relationships, resulting in greater intimacy of mutual disclosure and reciprocity (Granovetter, 1973). While the importance of having strong ties is undeniable, weak ties are also vital in terms of exposure to new ideas and information because those ties tend to connect to a wider variety of social circles and may also provide more opportunities to access resources (Borgatti et al., 2009).

Community

Gusfield distinguished between two (non-mutually exclusive) definitions of the term 'community' (Gusfield, 1975): (a) It may evoke a particular territorial and geographical place (such as neighbourhood, city, town), and (b) It can refer to a relational concern with quality of character of human relationship (such as familial relationships). In modern society, community may also develop around interests and skills more than around locality (McMillan & Chavis, 1986). The ideas and discussion in this article, can equally apply to all these definitions of community.

Dunbar's Numbers

In 1992, anthropologist Robin Dunbar established an elegant model of brain cognitive capacity, called *social brain hypothesis* (Dunbar, 1993). According to this model, the ability of primates, including humans, to maintain large social networks appears to depend on the ratio of the neocortex to the rest of the brain. The hypothesis further states that human social connections form 'layers' involving the deployment, by individuals, of differing amounts of *emotional attachment* and *time* to each connection (Dunbar, 1993; Dunbar, 1998; Dunbar, Arnaboldi, Conti & Passarella, 2015). In other words, an increasing number of alters is found at each decreasing level of intimacy. An 'ideal type' layering pattern of 5:15:50:150 social connections involving intimate inner layers through to outer layers involving less frequent personal connections, is found in numerous examples of human social grouping including average size of medieval villages, hunting tribes and army units. The pattern is also replicated in individual's patterns of social connections in studies of Facebook, Twitter, online computer gaming and mobile phone use (Mac Carron, Kaski & Dunbar, 2016).

Social Visualisation

Broadly speaking, information visualisation is the study of transforming data, information, and knowledge into interactive visual representation. Social visualisation is a subset of information visualisation and refers to the visualisation of social data for social purposes (Karahalios & Viégas, 2006). Social network diagrams (sociograms) that were mentioned above, can be also considered as a form of social visualisation. In essence, *The Circles of Connections* is a social visualisation tool as it engages users to

represent their social connections and other associated feeling/resources associated with those connections in a dynamic and attractive form. The micro-level social purpose here is diagnosing an individual's social connections as well as increasing opportunities for social connectedness and social support. The macro-level social purpose would be increasing community cohesion in terms of disaster preparedness and recovery.

In the next section, we describe our model in detail.

Our proposed model

Dunbar's social brain hypothesis was the basis of our proposed model (Dunbar, 1998). We have extended Dunbar's model by defining the following four variables:

1. Social connection layers (circles)
2. Social connection types
3. Inputs
4. Outputs

It is significant to highlight that all the above variables were identified and validated through our literature review mentioned above and thematic analysis, and have also been verified through discussion with Red Cross practitioners. Nonetheless, as we have stated, this is a preliminary model that is 'evidence-informed' and not based on exhaustive literature review. It is, in essence, a transdisciplinary theory that now requires testing and validation or adaptation. To exemplify influence of items from the literature: for instance, connection layers and connection types are derived from neurology, media and communication literature, whereas output variables are mostly gathered from sociology and social capital theory. In the following, we explain how we understand all these variables in detail.

Social connection layers (Circles)

As mentioned in Section: Key Concepts and Methods, according to the social brain hypothesis, there is a pattern of highly intimate to less intimate layers of social connection as a result of cognitive and time constraints. This layering pattern has been also recognised in popular online social network websites such as Facebook. It is interesting to recall that, in the early days of its presence, Facebook used a flat model of connections between users, but later on the 'smart-lists' was introduced that enabled users to organise their connections into different lists².

In our model, there are four kinds of layers namely 'Close Circle', 'Supporters Circle', 'Band Circle', and 'Village Circle'. Alters in the Close Circle are connections from whom an ego often seeks advice and support in particular in times of severe emotional or financial distress. Supporters Circle members are those key social allies that have a supportive role and whose death would be personally devastating. Band Circle members

² https://www.facebook.com/help/153715971383754?helpref=faq_content

³ This notation means the maxim number of connections for Close, Supporters, Band and Village Circles are 5, 15, 50 and 150 respectively.

are those an ego knows one-to-one and makes effort to keep up with them. Finally, alters in the Village Circle are those acquaintances that are known from social events or community groups (similar to weak ties explained in Section: Key Concepts and Methods). As we will explain later, the definitions of these circles are highly correlated with the combination of input variables namely, time and emotional attachment. It is evident that relationships within the layers will change over time and the layers represent the number and 'strength' of social connections at a given time (Mac Carron et al., 2016).

In our model, we still adhere to the ideal laying pattern of 5:15:50:150 social connections³ involving intimate inner layers through to outer layers. Nonetheless, we accept the possibility of having larger numbers for each layer mainly due to compression heuristics (Brashears, 2013). This states that humans adaptively make use of *schemata*⁴ as compression heuristics to discard social information on specific ties in favour of rules that permits the ties to be reconstructed from partial information.

Social connection types

One of the fundamental problems in the literature was to find a common typology of connections or friendship modes. This is mainly because the practice of making/maintaining a connection itself is imprecise and poorly defined (Thoits, 2011). However, for the sake of introducing a model, we propose a typology of connection types based on information gleaned from the literature review. In our model, we enumerate the number of connections for each social circle in the following seven categories:

- Family member
- Friend
- Online Family/Friend
- Neighbour
- Colleague
- Member of a group
- Other non-human types including animals (e.g., a pet), metaphysical connections (e.g., a god), and human replacements (e.g. a robot)

There are two major distinctions applied to the above categories – human-to-human and human-to-other connections. Considering differences between types of human connections, there is some evidence that varying amounts of investments are required for family versus non-family connections because family ties require less ongoing time to maintain due to some fundamental quality from kinship (Roberts & Dunbar, 2011). Neighbours too have a particular attribute, in that they may be able to provide the resource of practical assistance often more quickly than other connections due to their

⁴ Schemata are mental models (or cognitive patterns) that organise the processing of information and influence its recall from memory (Brashears, 2013).

proximity and therefore a separate category for neighbours is defined. We also have unique categories for colleagues and group members, as these may provide the key attributes of ‘weak ties’ as highlighted in Section 2.

On the part of non-human connection types there is evidence that: (a) pets can provide substantive connections for companionship needs for all individuals but particularly for those that have limited physical or wellbeing capacity to make or maintain human connections (Amiot & Bastian, 2015), and (b) connections with metaphysical phenomena such as god(s), country or nature can also produce personal connection and a sense of belonging that provides wellbeing benefits (Kingsley & Townsend, 2006; Green & Elliott, 2010).

Inputs

Our model is based on the assumption that every individual has stocks of time and emotional attachment to invest in building and maintaining his or her social connections. These two variables constitute the inputs for forming a social connection. Social connections inside ‘Close Circle’ and ‘Supporters Circle’ need more emotional attachment to maintain them. In research studies, frequency of contact is often used as a proxy measure for emotional attachment, while time is a finite resource and thus measurable (Roberts & Dunbar, 2011). Furthermore, communicating with one another and carrying out activities with these connections consumes time, therefore the cost of time in maintaining relationships, constrains the number of relationships one can maintain at a given level of emotional intensity at any given time. This then limits the number of connections within the closest circles.

Outputs

The outputs in our model represent the features that individuals may consciously or unconsciously feel they want, or need, to maintain their wellbeing. We call these features ‘resources and feelings’, based on the types of evidence we found from our literature review. Resources are aspects individuals *get* from their social connections, and feelings that people *emote* through and from their connections. Our analysis of the literature revealed that – though different disciplines had different conceptualisations and terms around such outputs – they coalesced around apparently similar ideas. Therefore, we typologise the feelings and resources as follows:

- Feelings
 - Sense of own identity; Self-esteem; Happiness; Empathy; Trust; Sense of security; and Sense of belonging.
- Resources
 - Access to advice, information, knowledge and assistance to solve information & decision problems; Practical assistance/physical proximity; Affection; Shared traumatic experiences, coping with these, healing together, responding together; Trust from others; Encouragement; Help meeting new people.

More information about the above variables can be found in these references which underpin and verify our identification of the resources and feelings (Thoits, 2011; Roberts & Dunbar, 2011; Amiot & Bastian, 2015; Kingsley & Townsend, 2006; Green & Elliott, 2010; Gonzales & Hancock, 2011; Diener & Seligman, 2002; Seppala, Rossomando & Doty, 2013; Walton, Cohen, Cwir & Spencer, 2012; Baumeister & Leary, 1995; Aldrich, 2012; Arendt & Alesch, 2014; Every & Richardson, 2017; Norris, Stevens, Pfefferbaum, Wyche & Pfefferbaum, 2008). In the next section, we describe how we have operationalised this social connectedness model with our proposed tool that we have called ‘Circles of Connections’.

Circles of Connections in Action

We conducted an ongoing review over months, trying to track the existence of online or app-like tools to measure social connectedness. We performed Google searches of products, searched literature and held ad hoc discussions with experts. Through this pragmatic review looking for self-quantified technologies targeted at social connections, we could not find any comparable product. A pragmatic search such as this is the best we can offer for several reasons: (a) social connection is an ambiguous term to search for and can be approached in numerous ways, (b) the field of online tool development is in constant flux, and (c) people may be developing tools but not written articles about them or posted to the internet about them.

The result is that – to the best of our knowledge – the field is characterised by only a few tools to diagnose professional social networks and career development. Gargiulo’s Social Capital Tool is an example of such tools drawn solely on the basis of social capital theory (Gargiulo, 2002). However, the visual design of the tool and the long list of questions asked of the user, create a prohibitive experience, and thus may be unappealing to the average or occasional user. Socilab is another social network analysis tool using JavaScript and the LinkedIn API to calculate several social network metrics and generates a dynamic network graph of a user’s contacts classified by industry sector (Socilab, 2014). Despite the engaging features, Socilab does not support exploration of a user’s social connections in non-professional contexts. The more recent tool that we found was SocialVillage (Akbaritabar, Hezarjaribi & Jullien, 2015) that measures the social capital embedded in online social networks such as Facebook and Google Plus. This tool is a gamified social survey asking questions about an individual’s network of friends and, based on their answers, the socio-economic positions of the user’s friends are calculated. The main barrier for using this tool is gaining access to the user’s social media account, which might violate individual’s privacy⁵.

Given this apparent gap in the field, and looking for a solution, we developed a functional prototype to demonstrate our social connectedness model. Based on discussions with our Red Cross partners and trialling of the tools discussed above, in this section; we have identified a series of design goals for our social visualisation tool:

⁵ We were not able to launch the SocialVillage tool that might be because of new terms and conditions imposed by Facebook.

- User-friendly visualisation: it is absolutely critical for us to engage end-users to identify and recall their social connections in an easy-to-understand and user-friendly manner.
- Open access: most of the time, the sheer cost of technological infrastructure makes it difficult to deploy scalable data collection. Therefore, we aim to build a public and free social visualisation tool based upon open-source technologies that provide access to large-scale social data for non-profit endeavours.
- Comply with legal obligations: considering the risks of providing some sensitive data, we need to ensure compliance with the terms of service in order to collect, use or retain personal data. Therefore, we aim to minimise access to any sensitive data provided by other third-parties such as social media platforms.
- Reproducibility: research studies are often difficult to replicate and this therefore discourages further investigation. We attempt to mitigate this problem by offering a standard ontology for the storage, reference, and usage of social observations.

The resulting Circles of Connections that we have made, is an online tool that draws on current evidence from different disciplines, and outlines the inputs and outputs necessary for an individual to maintain social connectedness⁶. The designed user flow (also called UX flow) for our tool that consists four pages is shown in Figure 1. For visualising data in a Web browser, we used a preeminent JavaScript library called Data Driven Documents or D3.js⁷ that was created by researchers from Stanford University's Visualisation Group. This library binds arbitrary data to a Document Object Model (DOM⁸), and then applies data-driven transformations using Scalable Vector Graphics (SVG). Let us explain these four pages in the following.

⁶ The tool can be obtained from the first author on request.

⁷ <https://d3js.org/>

⁸ https://developer.mozilla.org/en-US/docs/Web/API/Document_Object_Model/Introduction



Figure 1: UX flow for Circles of Connections

Sign-up

Starting from a sign-up page, some demographic information such as name, gender, age group, and postcode are recorded. This sociodemographic data would help us in later data analysis and prediction, however, for privacy reasons individuals can opt out of personally identifying themselves. This data is transmitted to our server using OAuth 2.0, an industry standard for security authentication and the only method compliant with Facebook's methods for information retrieval (OAuth 2.0). This helps us for future sign-in integration with Facebook through the user's social identifier.

Populating social connections

The user interface for this page is shown in Figure 2. The core part of the visualisation, the floating and animated bubbles is built using reusable D3.js⁹ and jQuery.js. All the other ingredients for our model can also be seen in Figure 2 including the social circles (4 concentric circles), connection types (baskets), inputs (time and emotional attachments), and outputs (14 variables of feelings and resources).

⁹ This particular visualisation took inspiration from the Circle Packing example as shown here: <https://bl.ocks.org/mbostock/4063530>.

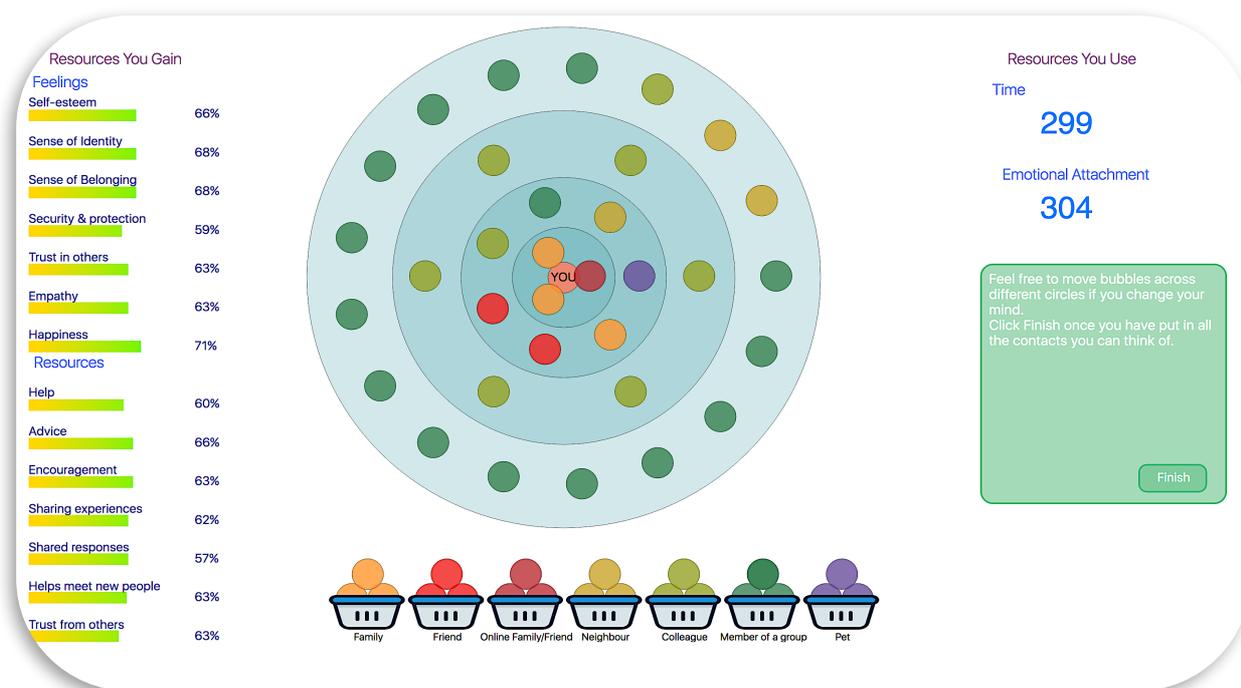


Figure 2: Populating social connections within circles – Completed by a user.

A user (ego) starts by populating his or her connections (alters) within the four circles. Even though we tried to clarify the definitions of circles in Section: Social connection layers (Circles) with respect to ‘expenditure’ of time and emotional attachment, there are some unwritten rules of membership that people might use to recognise who is part of their circles and who is not. One thing to note is that we do not wish to understand the interconnections that might exist among connections. It is evident from Figure 2 that by populating the social connections within the circles, the output variables are updated. This not only helps users understand the range of feelings and resources that are *ideally* received by investing in social connections, but also remind them of opportunities for augmentation of those outputs (for example by making friends with neighbours, or on social media) that may otherwise tend to go missing from the ever-shifting landscape of social relations. This data along with demographic data are stored in an encrypted database.

Assessment of social connectedness (gained feelings and resources)

The next page in our design provides a summary of existing social connections, remaining input variables (time and emotional attachment) and outputs (feelings and resources) as shown in Figure 3. This has two main advantages:

1. Individuals can reassess their connections and whether those connections are giving them needed resources or feelings. For example, a relationship with a partner might be emotionally close and time-consuming and expected to be fulfilling in affecting feelings and resources gained, but this will not occur if the relationship is violent and/or abusive. This can be revealed by comparing feelings, such as happiness, that are calculated by our model and the actual feelings experienced by the user.

- Individuals can understand whether forming more connections is feasible (from a cognitive viewpoint) based on the remaining time and emotional attachment.

The above assessment, however, might raise a question of ‘Am I normal?’. We understand that our model is highly rational and that it is probably not a good idea to measure ourselves in the context of others (Neff & Nafus, 2016). To avoid such statistical thinking, we allow users to change the values of output variables. This further gives us the opportunity to validate our model in terms of calculating feelings and resources. As awareness becomes more nuanced, a different model or calculation might be needed. For example, having the tool used by diverse communities with a range of cultural expectations who may ‘rate’ the feelings and resources they get from connections differently, will provide data that will then re-inform calculations in the tool accordingly. This will also help to re-evaluate the model. Additionally, marginalised communities or communities at risk of disaster may expect or require different resources from their connections, this validation will go some way to help to identify gaps in social connection, or the types of connections needed in particular situations. We envisage that in these circumstances this tool, with its ability to promote social interaction and understanding of connections, could ensure access and knowledge sharing within groups, thus providing resilience and empowering communities with a ‘collective ability to self-adjust’ and absorb sudden shock or disruption (Hespanhol, 2017, page 113).

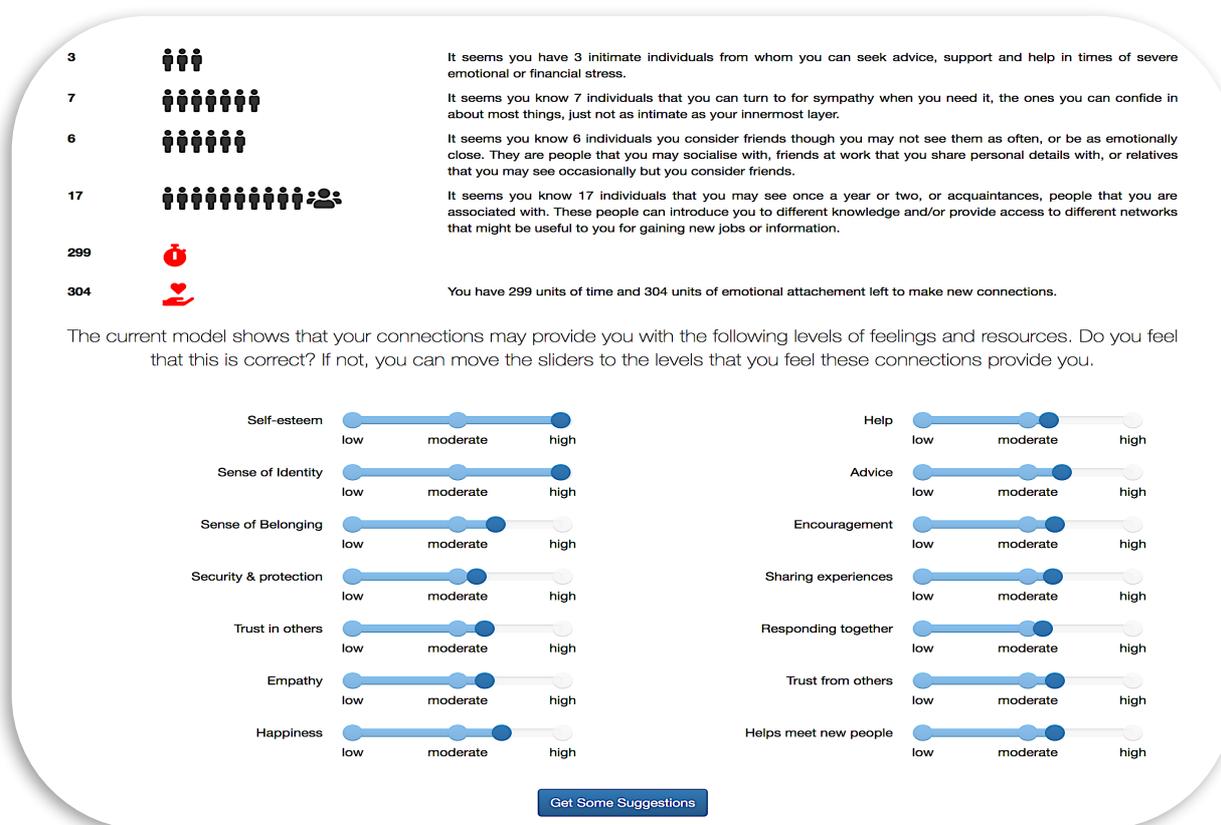


Figure 3: Assessment of social connectedness

Suggestions for increasing social opportunities

From the very beginning, we emphasised that our ultimate goal was to increase opportunities for social connectedness and social support, as well as building resilient communities to support people in disasters. Social resilience depends on the development of greater awareness of people connections with others and multiple capacities for social action that can lead to the attainment of both personal hopes and social purposes. While this is a highly ambitious goal, we decided to recommend a few tips to increase social connectedness such as making friends with neighbours, attending social events nearby, and joining a social or recreational community. An example of such social actions in Victoria is Neighbourhood Renewal, which is shown to deliver positive outcomes for people living in disadvantaged areas (Neighbourhood Renewal Unit, 2008). We understand that solely putting some links on a screen will not increase awareness or trigger an influx of connectedness. Yet, arguably, this can be a first step towards our goal. As Gould-Werth noted, one burning issue in social connection is the lack of awareness among people about their connection patterns (Gould-Werth, 2018). Perhaps if they had such awareness, they would pay more strategic attention to building and maintaining fulfilling connections.

Discussion and future work

In this study, we drew together the literature on social connectedness from disciplines including psychology, health, sociology, entrepreneurship, anthropology and communications. Combining this literature, we developed *The Circles of Connections* tool, based on a set of inputs, outputs and investment ‘decisions’. If applied to raise awareness of typical benefits from connection, it is possible to compare one’s connections and the feeling and resources with expected norms, prompting reflection on the level of benefits gained as returns on time and emotional investments. One may argue that this has a negative effect in terms of being an outlier. In defence of our model, we give an example of using a ‘normal curve’ in science, which is bell-shaped with most data points being in the centre. Scientists are aware that not all phenomena follow bell-shaped distributions, but nevertheless being outside an imagined ‘centre’ might be associated with something problematic, or the difference between high or low and the centre may be simple variation. Likewise, our model produces output variables based on the combined literature, but then users may decide for themselves whether this variation has a real cause or whether it is simply a matter of being different from the crowd. Understanding the impact of the variation is something that requires in-depth knowledge of the user’s personality and other social and environmental factors. Hence, our approach is mainly a guiding tool rather than a definitive assessment.

We believe our tool is a useful and easily understandable first step toward operationalising the various literatures on social connection. Developing tools and technologies that are effective for facilitating social impact requires a solid grasp of the user’s experience and insights into their behaviour. The important question that we need to ask is ‘Could this goal be achieved with this tool?’ rather than ‘What tool could we build?’. For us answering this question is essential and that is why as the next step, we will conduct a follow-up usability study to validate our model and its effectiveness.

Drawing on numbers

The follow-up study should ideally empower us with data and numbers on social connectedness. Table 1 shows a summary of captured data and the corresponding knowledge that can be inferred about an individual using *The Circles of Connections*. We have also searched for any similar statistics of social connectedness across Australia, in particular national census data maintained by Australian Bureau of Statistics (ABS, n.d.).

Table 1: Summary of recorded data by *The Circles of Connections*

Data	Knowledge	Explanation
Connection Type	Diversity of social ties	A greater diversity of connections represents bridging ties with different types of people.
Number of connections (per type)	Social isolation and loneliness, social resilience and support	This knowledge may help us to find the minimum number of connections that are necessary for social resilience and disaster preparedness.
Remaining time and emotional attachment	Cognitive capacity for making new social connections	
Level of access to resources and feelings (calculated by our model)	Disaster preparedness, Community cohesion	This could help us in finding statistically significant data on feelings and resources that are supposed to be attained from social connections.

Connection types and the numbers of those connections are the two major variables that are captured with our tool. These are mainly translated into a diversity of social connections. While diversity of social ties may be important for social support and our capacity to access resources and knowledge, it would appear that Australians tend to connect with people who are similar to them (that is, from similar social groups). According to the Australian General Social Survey, over half of the people surveyed had friends of similar educational background, 73% of similar ethnic background and 66% of similar age. The number of connections is an important indicator of loneliness as there is strong evidence between social isolation and social connections. In Australia, it is anticipated that there will be between 2.8 and 3.7 million people living alone by 2026 compared to 1.8 million in 2001. The number of older Australians living alone will also increase to between 34% and 39% (VIS, 2015).

In terms of access opportunities to feelings and resources, there is not much data available through Australian survey studies. The pertinent dataset is collected through the health indicator survey of approximately 23,000 adult Victorians undertaken by the Department of Health Victoria (VicHealth) every four years on a wide range of factors known to influence individual and community wellbeing (VIS, 2015). The relevant metrics to our model are three social capital indicators on people’s perception of their

local neighbourhood namely people’s willingness to help each other, sense of close-knit neighbourhood, and trust. VicHealth has subsequently aggregated the responses across a fixed range of geospatial regions of Victoria (i.e. Local Government Authorities (LGA) and Statistical Local Areas (SLA)).

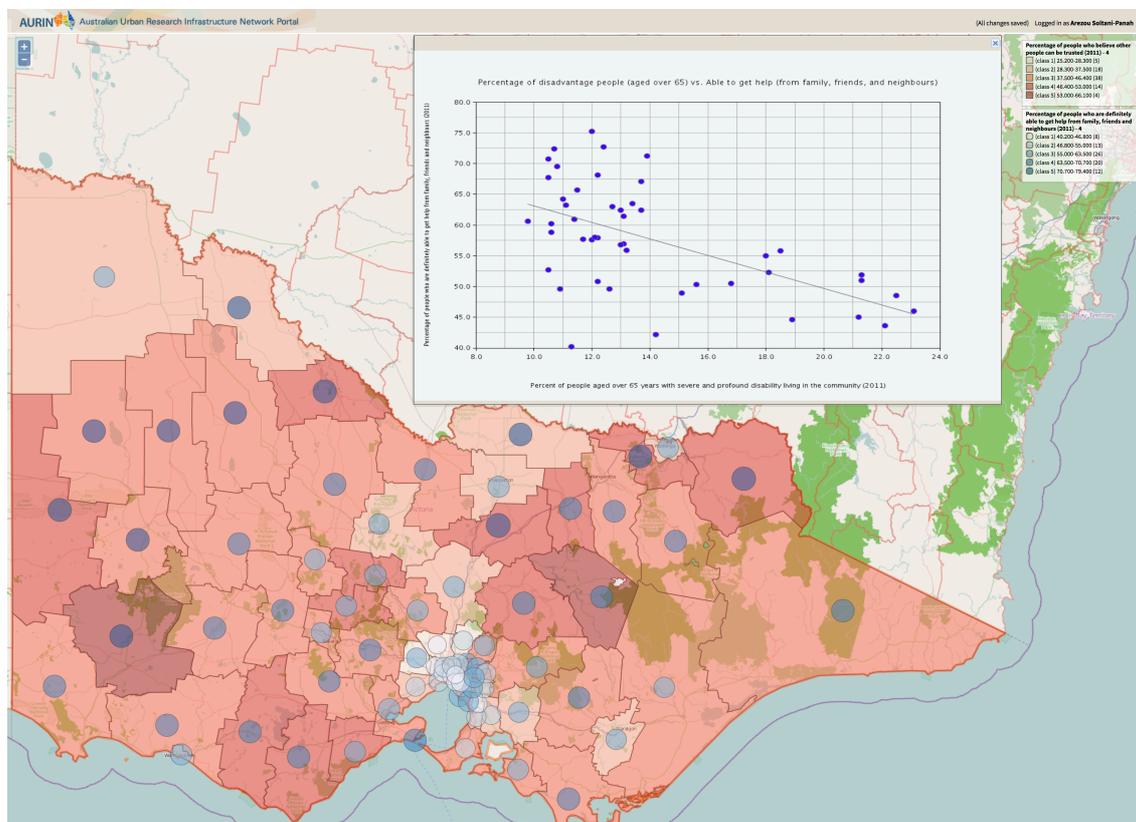


Figure 4: A sample of VicHealth’s health indicator data on people’s neighbourhood perception.

Figure 4 is generated from the online spatial-statistical platform, known as the Australian Urban Research Infrastructure Network (AURIN, n.d.). This figure shows the linear regression between the help indicator that was described above and percentage of disadvantaged people (aged over 65 with profound disability in the community), along with two choropleth maps showing the areas with higher/lower levels of trust (given as reddish polygons) and help (given as blue centroids). With respect to perception of their neighbourhood, the data suggests that three-quarters of Victorians agreed that people in their neighbourhood were willing to help each other out and seven out of 10 agreed that people in their neighbourhood could be trusted. This data also shows less access to help and support for disadvantaged people in the community. The other difference in neighbourhood perception can be inferred from spatial distribution: people in inner metropolitan areas are less likely to trust other people in their neighbourhood compared to those in rural areas. The same pattern can be observed for being able to get help from others.

As you can see above, having such aggregated information enables us to not only better diagnose an individual’s connectedness but also shed light on different communities’ wellbeing, such as neighbourhood cohesion or life satisfaction. As already pointed out,

to the best of our knowledge, there is no study/survey that looked at all the variables of our model beyond social capital indicators.

Caveats

We recognise that our model has some limitations. Firstly, it is rational and does not consider other contextual information related to the characteristics of the individual to calculate feelings and resources such as individual disposition, culture, health, financial and gender factors. The model might also suggest that having more social connections is always positive and fulfilling which will not be true for problematic relationships like those with physical or emotional violence. The fact is that these limitations drive us to conduct further validation studies with diverse cohorts of individuals to further improve our model. This would also help us in developing a hypothesis on factors that have major impacts on social connectedness, as without such experiments one cannot falsify or verify a hypothesis that does not even exist.

Secondly, the identification of a social connection from an individual point of view could be sometimes problematic. Speaking in social network analysis terminology, this approach is an egocentric scheme that constitutes a 'network of me' or a network of actors (alters) with whom the respondent has some relationship. It is well-known that egocentric data collection is subject to mis-measurements due to a variety of cognitive mechanisms such as forgetting. To overcome this issue, we have made a small revision to our visualisation scheme such that a user can add names and some other information to the connections (bubbles). This reduces the cognitive burden of recalling egos beyond just numbers.

Conclusion

This article described the development of a model to facilitate awareness about social connectedness in the hope that people, once aware, may pay more attention to building or maintaining them. We have demonstrated that our model was developed based on a review of literature ranging from social anthropology, public health, neurophysiology, sociology, communications, and psychology. We then presented our operationalised model as our Circles of Connections tool, using open standard Web technologies including D3.js and HTML5. The main challenge of our study was due to the disparate literature. The authors think there is an indisputable need for bridging between the different disciplines resulting in a shared view that is accurate and that communicates clearly what is meant by social connectedness. We believe our work takes an important step along this path and helps to fill the gap in literature towards understanding social connectedness and increasing social resilience. Future work will focus on improving prototype usability and identify potential problems of using our tool. We hope this study will encourage further work in the development of technologies expressly designed for increasing social opportunities.

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