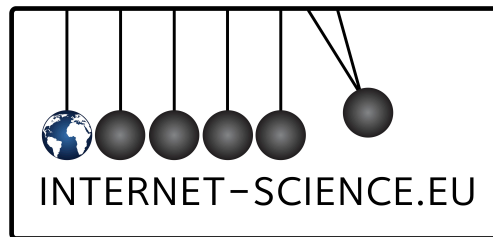**ICT - Information and Communication Technologies**

FP7-288021

Network of Excellence in Internet Science

D2.1.1 Repository of methodologies, design tools and use cases

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TABLE OF CONTENTS

1 Executive Summary

JRA2 is about the design of complex, large-scale systems such as the Internet. It bridges design groups working in Internet Science areas, whether concerning technological, socio-economic or human factors.

One vehicle to structure, share and make sense of the deep knowledge in this community is the use of a repository of methods, methodologies and exemplars. Such a repository pools materials that can be used throughout EINS and beyond.

This document describes EINS Deliverable 2.1.1, the first step to achieving this vision: D2.1.1 establishes a repository of 27 Internet Science design methods drawn from diverse disciplines including Architecture, Economics, AI, HCI, Software Engineering, Ethnography, Anthropology, Systems Engineering, Social Science, Health Sciences, Law, Contemporary History, New Media, Media Studies, Transport, Logistics and Urban Planning.

This document includes: a description of the process used to design the structure of a single repository element; links with other repositories; the implementation of the repository; the process of populating the repository with methods; an analysis of the disciplines and application contexts evident in the methods; and an annex containing the current content of the repository.

2 Introduction

This report documents the design, implementation and population of a repository of design methods relevant to Internet Science, sourced from a diversity of disciplines. This involved collating and making available design methods used in the context of large-scale, diverse and complex systems from areas such as computer science, economics, HCI and psychology. To make these methods available in a structured, coherent way that facilitates a) navigation and b) analysis, it was necessary to determine the best way to structure these methods. It was also key to make the repository an open resource that can be used by the wider design community.

Section 3 of this document describes the process of designing the repository, starting from an analysis of disciplines and application contexts within Internet Science, through to using that analysis to design the structure of a repository entry and consider the link between this repository and one other. Section 4 describes the technical requirements of the repository, the solution chosen and where this can be found online. Section 5 describes the process used to populate the repository with methods and the status of the repository at the time of writing, in addition to providing an analysis of the disciplines and application contexts associated with repository methods. Section 6 presents conclusions of this work, while Annex I: Methods in the JRA2 Repository describes each of the 27 methods within the repository at the time of writing.

3 Designing the repository

A repository of methods, methodologies and exemplars such as that envisioned by EINS JRA2 is a complicated construct, drawing as it does on inputs and epistemologies from wildly disparate disciplines and usage contexts. As such, a key step in constructing the repository is to ensure that the categorisation used is clear and grounded by evidence.

This section falls into three parts. First is a description of research into disciplines and application contexts within Internet Science. Second is the structure of a repository entry based on outputs of the preceding section. Finally is a discussion of the link between this repository and one other.

3.1 Analysis of disciplines and application contexts in Internet Science

Until this point, there has been a lack of empirical data as to what disciplines are present within Internet Science. In response to this issue, and motivated by the desire to obtain an evidence-based categorisation of Internet Science design methods, analysis was conducted of a corpus of relevant interdisciplinary materials. This subsection reports on work done in this area, which was also reported at WebSci'13 [1]. The work described in this subsection was conducted in collaboration with colleagues at the Digital Research Institute, National University of Ireland, Galway.

The method was as follows:

1. Assemble a corpus of publications in the field in question
2. Use natural language processing to extract keywords from that field (using Saffron[1], a tool for analysing academic texts)
3. Use graphing and visualisation tools (e.g. Gephi[2]) to understand the meaning of the resulting network of keywords, e.g. by (i) using community detection algorithms and (ii) examining top-ranked keywords with measures such as betweenness centrality
4. To map keywords to disciplines, run an expert survey: consult experts in the field of interest to find how they map top-ranked keywords to disciplines.

The first test of this method used a corpus from the well-established Web Science community. The precise delineation between Internet Science and Web Science is not clear: one might argue that WebSci is a subset of InternetSci (because web technologies are a subset of internet technologies), while at a recent WebSci / InternetSci workshop [2] it was argued that one could view InternetSci as a subset of WebSci. Meanwhile, many so-called Web Science materials concern internet-level issues. For instance, WebSci'13 papers addressed topics including location-based privacy [3], trust [4], measurement of time on networks [5], methodology [6] [7], open data [8], URIs [9], and even art as a

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[1] http://saffron.deri.ie/

[2] http://gephi.org/

source of innovation in knowledge work [10]; many other papers examined social media, which may be web-based (e.g. weblogs, wikis, microblogs) or internet-based (e.g. IM, VOIP, P2P file sharing).

In sum, the line between Web Science and Internet Science is rather blurred. This, in conjunction with the availability of a vast WebSci corpus made that corpus a good starting point for this work.

This corpus used consisted of Web Science conferences from 2009 - 2012, the contents of the Web Science journal (Foundations and Trends in Web Science) and the rich set of publications online at journal.webscience.org. We used the above methodology with this dataset (consulting 13 experts in the survey; we gave these experts the top 20 ranked keywords to associate with disciplines). This yielded:

- The top ranked 1000 keywords used across the papers. The top 20 are, in descending order: semantic web; social media; information retrieval; social networking site; social science; search engine; social networking; learning network; web page; personal learning environment; social interaction; mobile device; future research; internet user; uniform resource identifier; web science research; user interface; web community; web application; linked data principle
- Four application contexts, revealed by Gephi's community detection algorithms: information retrieval; personalised/eLearning; semantic web; social networking
- Links between the top keywords and the following disciplines: Communication; Computer Science; (Industrial) Design; Education; Network Science; Pedagogy; Psychology; Sociology

The next step, conducted since publication of the WebSci'13 paper [1], was to carry out a further analysis using additional materials from the Web Science community (i.e. Web Science 2013 publications) and Internet Science materials (the proceedings of the first Internet Science conference held in spring 2013 and publications in the EINS bibliography[3]). The above steps were repeated, and revealed an additional two application contexts: Open data; Machine learning.

These results let us structure the EINS repository of methods. The key to the approach is to produce 'overlays' that structure the information, for example letting people navigate the repository based on disciplines covered and see which disciplines are or are not represented in the repository. Nodes in the overlay without repository entries represent gaps, which can be filled by contacting the relevant research community for the updated repository in D2.1.2. In addition, overlays can be created based on research communities, yielding two separate but related navigational maps: application contexts and disciplines.

3.2 The structure of a repository entry

Based on the previous analysis, we have created overlays on the repository materials as follows:

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[3] http://internet-science.eu/biblio

By application context:

- Information retrieval
- Personalised/eLearning
- Semantic web
- Social networking
- Open data
- Machine learning

By discipline:

- Communication
- Computer Science
- (Industrial) Design
- Education
- Network Science
- Pedagogy
- Psychology
- Sociology

Clearly, any method described in the repository will require a title and description. In addition to information about discipline and application context, it is logical to also include relevant publications and links. Finally, as well as recording who contributed the method, we decided to include freeform tags with which contributors could mark their methods.

This yields the following structure for a method in the repository:

Title of method

Description (from one paragraph to one page)

Links

Link	Description
A URL	A brief description of the website. For example, a GitHub page; a forum; an online shop selling the related book
Another URL	Another description

Publications

Publication	Description

A citation	A brief description of what the publication provides. For example, a description of the method; its application in a specific domain; how it is used by professionals from a certain context
Another publication	Another description

Disciplines: Related disciplines

Application context: Any application contexts the method fits with

Tags: Any freeform tags about the method / tool

Contributed by: Name of contributor (organisation of contributor)

An example method included in the repository follows:

Cultural Probes

Cultural probes are a design technique used to gain open-ended insights into people's lives, particularly in terms of capturing their personal and cultural values. Probes are small packages sent to participants: the packages contain artefacts for interaction, such as postcards, maps or a camera. Instructions are open-ended, and might be, for example, "What advice or insight has been important to you?" "Tell us about your favourite device?" (on postcards), "Where have you been in the world?", "Where do you go to be alone?" (on maps), or "Take a photo of the first person you see today", "Take a photo of something boring" (on cameras).

Cultural probes yield rich, qualitative data that can help bridge the gap between researchers/practitioners and their subjects. Outputs from cultural probes can form a valuable input into the design process.

Links

Link	Description
http://en.wikipedia.org/wiki/Cultural_probe	The Wikipedia entry about cultural probes

Publications

Publication	Description
Bill Gaver, Tony Dunne, and Elena Pacenti. 1999. Design: Cultural probes. interactions 6, 1 (January 1999), 21-29. DOI=10.1145/291224.291235	The seminal publication which first described use of cultural probes

http://doi.acm.org/10.1145/291224.291235	

Disciplines: HCI, Design

Application context: None of those suggested

Tags: Qualitative methods; design research; cultural research; user-centred design

Contributed by: Clare Hooper (IT Innovation)

3.3   Linkage with other Internet Science resources

It is of note that EINS JRA3 includes deliverable D3.2.1, entitled: *Online experimental and empirical evidence base for Internet Science: datasets, tools and methodologies*. The JRA2 and JRA3 leadership maintained strong communication links throughout development of their respective deliverables to ensure clarity regarding the differences between methods listed within each deliverable.

The emphasis of the JRA3 deliverable is on open data sets, related tools (i.e. for experiment repetition, data collection and analysis, quality assessment of experimental results), and e-infrastructures. This makes for very little overlap with the JRA2 repository, which focuses on design methods and tools.

Nonetheless, the two deliverables clearly have some overall aspects in common, that is the provision of resources relevant for Internet Science. As such, we deemed it appropriate to include a prominent link to the JRA3 materials with the repository.

3.4   Conclusions

This section described an analysis of Web and Internet Science publications to identify application contexts, top ranked keywords, and links with disciplines, before describing how the results of this work guided our structuring of repository entries and discussing linkages between this repository and one other.

4 Implementing the repository

Having determined an appropriate structure for repository entries, the next step was implementation of the repository of methods. This section describes that process in three steps: subsection 4.1 describes technical requirements, subsection 4.2 enumerates the technologies considered, while subsection 4.3 describes the decision made.

4.1 Technical requirements

The following features were identified as essential:

- Version tracking to allow for controlled updates to material
- Provenance tracking of contributions (who added what)
- Support for integration of images (diagrams, examples, etc.)
- Support linkage to files
- Encapsulation of each method in some kind of 'container' that collates text, links, images and files
- Support overlays for navigation and analysis of repository content
- Open access by the broader community to facilitate uptake of the repository and outreach by EINS

The following features were identified as desirable, but not essential:

- Support for integration of slides (e.g. steps within a method)
- Support discussion of contributions, capturing any such dialogue
- Support for offline access
- Database of publications related to methods
- Tagging capability to improve search and indexing of materials
- Integration of interactive toolkits, such as mind map integration or Java applets

4.2 Technologies considered

The requirements identified in subsection 4.2 were used to guide our consideration of candidate technologies for the repository. The following technologies were identified as candidates for usage:

1. A GitHub-like repository, with packages of material for each design method. Each package can be treated as an open source project with contributors. Packages can be forked or merged, and issues can be tracked for continuous improvement.
2. A wiki, which offers the opportunity to document methods and integrate community aspects such as discussion, as well as accommodating multimedia material.
3. Mailing lists related to particular methods or sets of methods can be hosted, potentially linked to the internet-science.eu domain.
4. Software such as Mendeley or Zotero, with which to manage related research papers.

4.3   Implementation

The EINS wiki fulfils all of the essential requirements and some of the desirable requirements, while strongly maintaining the repository's identity as an EINS initiative. For this reason, the repository is hosted on the EINS wiki at:

http://wiki.internet-science.eu/index.php/Repository_of_design_methods

We can reflect on how the wiki relates to each requirement. Of the essential requirements:

- Version tracking: available via the 'history' view of each page
- Provenance tracking: as per version tracking
- Support for integration of images: available via the embedded image syntax
- Support linkage to files: available via standard hyperlinks
- Encapsulation of each method in some kind of 'container': available by adding one page per method
- Support overlays for navigation and analysis of repository content: can be implemented by creating a page that acts as an index into the categories and a way to browse them. This page can list disciplines and application contexts as headings, with links to the related methods listed beneath each heading.
- Open access by the broader community: available, the wiki is run as an open resource

Desirable requirements:

- Support for integration of slides (e.g. steps within a method): available via web-based slide software such as SlideShare
- Support discussion of contributions, capturing any such dialogue: available via the 'Discussion' view of each page
- Support for offline access: this could be provided by including a downloadable PDF summary of methods. Such a PDF would not include the history or discussion for each method.
- Database of publications related to methods: citations can be included with methods as plaintext, but are not automatically separately marked up. The wiki could be augmented by building a Mendeley (or equivalent) library of publications referenced in the repository: a discussion is planned on the value of taking this approach when the repository is updated at D2.1.2.
- Tagging capability to improve search and indexing of materials: not included automatically, but tags can be included on each page by hand, and if desired, a separate page indexing tags could also be manually created.
- Integration of interactive toolkits, such as mind map integration or Java applets: not included at this time. It is appropriate to re-consider approaches to integrating such

toolkits when the repository is updated at D2.1.2, at which time more will be known about the nature of potential interactivity requirements.

5 Populating the repository

This section describes the process of populating the repository, discussing firstly the process of sourcing contributions and secondly presenting analyses of the distribution of a) disciplines and b) application context across the methods.

5.1 Sourcing contributions

Having determined an appropriate structure for repository entries and instantiated the repository on the EINS wiki, it was necessary to set about populating the repository. JRA2 partners were of course the primary contributors, but in addition to their inputs, the EINS community as a whole was approached, as indeed was the Internet and Web Science community. For example, inputs were solicited from targeted communities such as the Digital Culture group of the University of Bergen, the Web and Internet Science Research Group at the University of Southampton, and the Digital Enterprise Research Group at the National University of Ireland. Furthermore, social media was used in the form of Twitter and blogging to further propagate the call for entries.

Contributions to the repository were received from EINS participants (including but not limited to JRA2 partners) and some external contributors, as follow: Andrea Passarella (CNR), Richard Holzer (PASSAU), Nidhi Hegde (TCLR), Clare Hooper (IT Innovation), Serge Fdida (UPMC), Dimitri Papadimitriou (A-LBELL), Panayotis Antoniadis (ETH Zurich), Dirk Trossen (TecVis), Sofie Verbrugge (IMINDS), Athena Vakali (Aristotle University of Thessaloniki), Konstantinos Kafetios (Aristotle University of Thessaloniki), Despoina Chatzakou (Aristotle University of Thessaloniki), Maria Giatsoglou (Aristotle University of Thessaloniki), Frances Griffiths (University of Warwick), Jill Walker Rettburg (University of Bergen).

When disseminating the call for methods, the request asked, for each relevant method, that respondents describe the seven items of data described in Section 3: title, description, links, publications, disciplines, application contexts, tags. We provided suggested disciplines and application contexts based on the work in Section 3.

In total, 27 methods were gathered from a rich diversity of disciplines including AI, anthropology, architecture, communication, computer science, design, economics, HCI, information retrieval, network science and psychology (see subsection 5.2 for more on this). An example method is described in Section 3 and shown as a screenshot from the wiki in Figure 1. The full set of methods can be viewed in Annex I: Methods in the JRA2 Repository.

Figure 1. Screenshot of a repository entry

The methods in the repository show a diversity of foci. For example, some exhibit a stronger emphasis on analysis, while others as situated in a specific domain. What unifies the methods is that all produce results of relevance in the design process when working with large-scale, complex systems.

5.2   Disciplines associated with methods

Categorisation is rarely a simple task, and this applies all the more so when trying to categorise methods with disciplines. For this reason, and because a method may be used in multiple disciplines even if it were generated in one specific discipline, we accepted lists of multiple disciplines per method: the average number of disciplines listed per method was 2.7. Indeed, some responses delved into this complexity, differentiating between the origins of a method and application areas. For example:

> "Social science (Sociology, anthropology, and also used in some branches of psychology. Methods also used often with other methods in health sciences, education, law, contemporary history. Methods are used to inform the development of measurement tools for quantitative research."

We were aware that the suggested disciplines list was non-exhaustive, being based on past Web Science conference calls for papers. We therefore accepted disciplines that were not on the initial list.

The suggested list included Communication, Computer Science, (Industrial) Design, Education, Network Science, Pedagogy, Psychology and Sociology; among these, Pedagogy was the only discipline not to be associated with at least one of the repository methods (although one method was associated with Information and Learning Theory)

Other off-list disciplines to be named include: Architecture, Economics, AI, HCI, Software Engineering, Ethnography, Anthropology, Systems Engineering, Social Science, Health Sciences, Law, Contemporary History, New Media, Media Studies, Transport, Logistics and Urban Planning.

A goal for the repository was that its methods would come from a diversity of disciplines, which has been achieved. It is particularly noteworthy that contributions to the repository included methods associated with Economics, HCI and New Media / Media Studies, which map to disciplines identified in the EINS DoW as relevant to JRA2.

5.3   Application contexts associated with methods

The application context list consisted of the following items: Information retrieval; elearning; semantic web; social networking; open data; machine learning. 5 methods were submitted with application context listed that were not from the suggested list. In one, the respondent had misunderstood what was meant by 'application context' and listed two disciplines (architecture, design) which were moved to the appropriate field. The application contexts listed for the other 4 methods, which were submitted by 2 individuals, appeared to also be the result of a misunderstanding, and were tags (internet investment optimization; network optimization; network economics) which were moved to the appropriate field.

As with disciplines, some methods were associated with multiple application contexts. Of the six suggested application contexts, the numbers of associated methods are as follow:

- Information retrieval: 6 methods
- Elearning: 0 methods
- Semantic web: 2 methods
- Social networking: 12 methods
- Open data: 1 method
- Machine learning: 0 methods

The low number of elearning methods is unsurprising: as hypothesised in the earlier publication on the analysis that yielded these methods [1], it is likely the elearning domain emerged due to the inclusion of proceedings of a non-Web Science elearning conference in the corpus of data. The number of open data methods is probably low due to the youth of the open data movement. The low numbers of methods from the open data, semantic web, and machine learning domains signpost areas to target when seeking further methods to add to this repository.

Finally, after normalising the 5 methods submitted with off-list application contexts, a total of 14 of the 27 methods were not associated any of the identified application contexts. This is not deeply

surprising: the Web Science-heavy corpus (whose analysis is described in subsection 3.1) clearly couldn't cover everything, and it is therefore not surprising that some application contexts will have been missed. An initial examination of those 14 unmatched methods begins to suggest some patterns:

- 2 of the 14 methods are collections of multiple methods (Methods for the evaluation of self-organizing properties of complex systems; Qualitative research methods drawing on a variety of theoretical frameworks in social sciences)
- 4 of the 14 methods are domain agnostic design tools (contextmapping, cultural probes, participatory design, creative problem solving, medium design)
- 4 of the 14 methods are domain agnostic analytical tools (requirements analysis; event sampling emotion recorder; synthetic-analytic method; simulation of urban mobility)

The question is whether we should extend the set of identified application contexts to cover tools that aren't associated with the current set. There are two possible ways this could be done. The first approach is to update the original analysis based on an expanded corpus of Internet Science materials that includes publications related to the unmatched tools, which would presumably refer to the relevant application contexts in which they have been used. It is currently unclear whether this is possible, as the Saffron tool requires a large corpus to produce usable results, and it is unlikely there will be enough papers in at least some cases. The second approach is to use the 14 unmatched methods as a resource upon which to conduct a deeper analysis and reach new understandings. We aim to report further on these methods in D2.1.2.

In conclusion, it can be seen that our use of application contexts as overlays has revealed that the repository contains a number of resources related to information retrieval and social networking, but there are large gaps in the areas of elearning, semantic web, open data and machine learning. These latter areas can be targeted when expanding the repository for D2.1.2. Additionally, the 14 methods with no current application context are a resource which we can explore to identify further application contexts of relevance to Internet Science, again in D2.1.2.

6   Conclusions

This document has described the process of designing, implementing and populating the repository of design methods for Internet Science, available at:

http://wiki.internet-science.eu/index.php/Repository_of_design_methods

At the time of writing, the repository is populated with 27 design methods of relevance to Internet Science, drawn from a variety of disciplines including Architecture, Economics, AI, HCI, Software Engineering, Ethnography, Anthropology, Systems Engineering, Social Science, Health Sciences, Law, Contemporary History, New Media, Media Studies, Transport, Logistics and Urban Planning. Although varied in nature, all of the methods support their users in producing outputs to support design work with large-scale, complex systems.

This work represents the first in a series of steps. The second step involves building on the current repository to understand design *methodologies*, which we distinguish from methods: while a method is a specific approach to achieve a certain goal, a methodology brings together multiple methods for use in sequence or some other interconnected way. The next step, therefore, is to analyse the methods collected here to establish multi-disciplinary methodologies that combine methods to rigorously address complicated ('wicked') design questions. Conducting this challenging activity requires interdisciplinary cooperation and will draw together researchers from diverse backgrounds.

Meanwhile, the repository described within this document supports the community of Internet Science researchers and practitioners, providing a coherent base of design methods with a clear set of metadata regarding their provenance.

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Annex I: Methods in the JRA2 Repository

1. Pattern languages

A pattern language, a term coined by architect Christopher Alexander and popularized by his book A Pattern Language, is a structured method of describing good design practices within a field of expertise. Advocates of this design approach claim that ordinary people can use it to successfully solve very large, complex design problems.

Links

Link	Description
http://en.wikipedia.org/wiki/Pattern_language	Wikipedia entry on pattern languages
http://www.publicsphereproject.org/patterns/	The pattern language project of the PublicSphere project

Publications

Publication	Description
Crumlish, C. (2009) Designing Social Interfaces: Principles, Patterns, and Practices for Improving the User Experience. Yahoo Press	Patterns in the context of social media. See also http://www.designingsocialinterfaces.com/patterns/Main_Page

Disciplines: Computer Science, Communication, Architecture

Application contexts: Social networking

Tags: participatory design

Contributed by: Panayotis Antoniadis (ETH Zurich)

2. Evaluating architectural choices in large-scale networked system

Large-scale networked systems involve multiple stakeholders, each of which influence the realization of technical components within the architecture through (i) design choices; (ii) specific implementation choices (that might limit the overall design); (iii) regulatory policies (that might impact the validity of (i) or (ii)); (iii) business models (that are reflected in utilizing certain interfaces provided by the architectural components). The tussles (i.e., the conflicts) between these stakeholders and their interests directly impact the viability of the choices being made for realizing (particular parts of) the system, while these tussles change over time with the changing policies and interests surrounding them. Hence, large-scale system design and evaluation formulates a system dynamics (SD) problem space where the dynamics are represented through the interests and interactions of the participating parties. Hence, SD as an underlying quantitative model can provide insights into the outcomes of tussles in the Internet and therefore the viability of the system that is design to endure these tussles. This methodology enables a process that involves stakeholders through interviews and graphical tools, capturing crucial aspects for the development of an appropriate SD model that evaluates the system's viability. The tool provides mind mapping techniques for capturing these aspects and guidelines for translating these to SD models in commercially available evaluation platforms.

Links

None as yet, although the methodology material could be hosted on Github in future.

Publications

Publication	Description
Codifying Evolving Tussles For Tomorrow's Internet. PURSUIT Project FP7-INFSO-ICT 257217.	A technical report outlining the methodology.

Disciplines: Communication, Computer Science, Economics, Architecture, Design

Application contexts: None of those suggested.

Tags: design for tussle

Contributed by: Dirk Trossen (TecVis)

3. Creative Emergence

A-LBELL is currently working on creative emergence applied to "socio-information" systems. The concept of creativity refers to the ability or power to create (or design) original and new patterns or objects that are subsequently adopted as new norm/reference (foundational and utility dimensions) and considered as pioneering at the time when they are generated (innovative and inventive dimensions in scientific creation) or offering some form of elegance (aesthetic and imaginative dimensions in artistic creation). This concept combines the capability to "generate through innovative/inventive skills" with its aptitude to "originate existence as result of (inter-)actions". Though, the underlying process is often assumed as non-predictable, it is also non-exhaustive and "inspirational". Thus, one of the fundamental questions becomes whether such process can be stimulated by means of intervention and/or incentives or whether such processes is solely spontaneous (taking as analogy the stimulated vs. spontaneous emission in physics).

The aim of considering general-purposes creativity in the context of "socio-information" systems is to raise their capabilities i) towards human intelligence (aptitude to generate breakthroughs) next to various forms of intelligence being either to artificial intelligence or physical intelligence, ii) beyond narrow-scoped creativity (recent chess software can play in a creative style but the same program cannot prove mathematical theorems), and iii) well-beyond the properties commonly assigned to adaptive / learning based multi-agent systems. In the latter case, a set of interacting or inter-dependent agents adapt their behavior to environmental changes or changes in the interacting parts by means of their capacity to learn from experience (in case of learning agents) which is the opposite of creativity since intrinsically repetitive. The fundamental distinction is that the underlying computational problem cannot be brought back to a decision, an optimization problem or even a function problem.

The concept of emergence refers to new properties, structures, and behaviors of a higher scale that are not present at the lower scale. Information being quantifiable patterns, emergence can also be viewed as information at a higher scale that is not present at a lower scale; thus, involving information transformation, i.e., computation. By describing the system dynamics as a process, the latter is qualified as emergent when it produces novel information, properties and behaviors (output) that were not initially present (input) in the system. One shall note that emergence emphasizes the presence of a novel coherent higher scale emergent property, behavior, structure, etc. resulting from the inter-dependence between lower scale parts whereas self-organization emphasizes the internal dynamics of the process that produces

global structures (patterns) of behaviors from the local interactions of their components without external control. Moreover self-organization tends to reduce information since higher organization (order) is characterized by lower information and lower level of organization (chaos) is characterized by higher information.

Consequently, creative emergence refers to the process through which novel information, properties and behaviors being produced result from the innovative/inventive skills of the system (and not only their computational capabilities). The latter is modeled by considering that the interaction field among system entities expands and intensifies through the combination of a structured process (which requires intervention) and unstructured noisy process until reaching a certain point or a threshold after which the interaction field narrows through the influence of a convergent process before producing new norms. Perturbations including unexpected events and/or information are also expected to trigger convergence; reason why not all skilled systems produce novel output in case the interaction field hasn't sufficiently been expanded.

Links

Link	Description
[link forthcoming]	PDF file listing background reading material.

Publications

None at this time.

Disciplines: Computer Science, Artificial Intelligence, Information and Learning Theory, Collective Behaviour

Application contexts: Social networking

Tags: None at this time.

Contributed by: Dimitri Papadimitriou (A-LBELL)

4. **Affective analysis in microblogs**

By evaluating and quantifying emotions expressed by users in social media posts, it is possible to understand the efficacy of design decisions made on that social media platform with respect to facilitating aspects such as empathy, trust and other specific emotions. This understanding can drive future design iterations and be used in the design of similar systems in related contexts.

This work was conducted based on Twitter, a widely used micro-blogging service. Use was made of a lexicon-based methodology to capture users' emotions, as these imprinted in social media based on Ekman's theory. This work had two dimensions since we didn't only try to capture the users' emotions, but also the emotions' intensities.

The estimation of the sentiment orientation expressed by the tweets' word was based on the Sentiwordnet dictionary, which assigns scores to each word on the basis of how positive or negative they are. Additionally, for a better evaluation of the sentiment expressed in a text we made use of the intensifiers and the negation words. For example the expression "very good" has a stronger emotion in relation to the word "good". Furthermore the expression "not good" has different meaning from the word "good". So, the consideration of them in our analysis was vital.

Before applying our methodology in the texts extracted from the Twitter a very important step was the preprocessing. Appropriate linguistic analysis, based on an English-term dictionary, was used for the removal of words (such as articles and numbers) which have no useful information for the affective analysis process. The last step of the proposed approach was the clustering step which was suitable for grouping the tweets based on the expressed emotion.

Links

None at this time.

Publications

Publication	Description
Despoina Chatzakou, Vassiliki Koutsonikola, Athena Vakali, Konstantinos Kafetsios: Micro-Blogging Content analysis via emotionally-Driven Clustering. ACII 2013.	On the evaluation and quantification of emotions expressed by users in posts on Twitter.

Disciplines: Computer Science, Psychology

Application contexts: Information retrieval, Social Networking

Tags: affective analysis, microblogs, social networks, social media content analysis

Contributed by: Athena Vakali (Aristotle University of Thessaloniki)

5.   Sentiment analysis in smart environments

The design of smart affective environments is a difficult challenge. This affective analysis framework is suitable for offering smart services over mobile devices. The framework is based on affective analysis in microblogs, with the results of the affective analysis used for development of a mobile application suitable for imprinting people's emotions on the basis of topic, location, and time. This application captures crowd pulse as expressed in micro-blogging services the results of which are beneficial for various communities, such as policy makers, authorities and the public in general.

Links

None at this time.

Publications

Publication	Description
Athena Vakali, Despoina Chatzakou, Vassiliki Koutsonikola, George Andreadis: Social Data Sentiment Analysis in Smart Environments - Extending Dual Polarities for Crowd Pulse Capturing. DATA 2013.	Description of the affective analysis framework for offering smart services over mobile devices.

Disciplines: Computer Science, Psychology

Application contexts: Information retrieval, Social Networking

Tags: affective analysis, microblogs, mobile applications, social media content analysis

Contributed by: Athena Vakali (Aristotle University of Thessaloniki)

6. Community detection in social media

A plethora of social media platforms exists, yet it is not clear how to design a successful social media platform that promotes community formation and cohesion. Detecting communities in social networks such as Twitter helps designers understand the affordances of those social networks that promote such formation and cohesion.

Work in this area has examined community detection on Twitter (specifically, within Twitter datasets which were related to Eurogroup meetings), taking into consideration the interactions between users and the intensity of them. The goal was to reveal the type of communities generated with respect to certain events by analyzing them in the dimensions of size, topic diversity and time span.

The proposed approach builds on existing graph clustering methods, in that case the SCAN method, enhancing it with additional elements for better performance, WSCAN and AutoWSCAN. WSCAN is suitable for detecting communities in weighted interaction networks, while AutoWSCAN is an automatic approach that overcome the limitations of parameter selection of SCAN and WSCAN. This approach was validated on a series of synthetic networks. Community meta-analysis provided insights in terms of the dual relationship between real world events and community formation.

Links

None at this time.

Publications

Publication	Description
Publication: Maria Giatsoglou, Despoina Chatzakou, Athena Vakali: Community Detection in Social Media by Leveraging Interactions and Intensities. WISE (2) 2013: 57-72.	Publication describing community detection on Twitter.

Disciplines: Computer Science

Application contexts: Information retrieval, Social Networking, Semantic web

Tags: Community detection, Microblogs, User weighted interaction networks, social networks, social media content analysis

Contributed by: Athena Vakali (Aristotle University of Thessaloniki)

7. Methods for the evaluation of self-organizing properties of complex systems

The design of self-organizing systems is a relatively unexplored area. Work in EINS JRA2 on this topic has considered methods for the evaluation of self-organizing properties of complex systems. Methods have been developed based on quantitative measures for the following properties:

- emergence
- target orientation
- adaptivity
- resilience
- global-state awareness

- autonomy

These methods can be used for analysis, evaluation and optimization of complex systems to increase self-organization and, critically, to extract design guidelines for the design of future self-organizing systems.

Links

Link	Description
[link forthcoming]	Conference slides describing the methods.

Publications

Publication	Description
Richard Holzer and Hermann de Meer and Christian Bettstetter. On autonomy and emergence in self-organizing systems. IWSOS 2008 - 3rd International Workshop on Self-Organizing Systems, Vienna, Austria, December 10-12, 2008, Springer Verlag 2008	Measures for autonomy and emergence
Christopher Auer, Patrick Wüchner, and Hermann de Meer. The Degree of Global-State Awareness in Self-Organizing Systems. In Proc. of 4th International Workshop on Self-Organizing Systems (IWSOS 2009). Zurich, Switzerland, December 9-11, 2009. Springer, LNCS.	Measures for global-state awareness
R. Holzer and H. de Meer. Quantitative Modeling of Self-Organizing Properties. In Proc. of 4th International Workshop on Self-Organizing Systems (IWSOS 2009). Zurich, Switzerland, December 9-11, 2009. Springer, LNCS	Measures for adaptivity, resilience and target orientation
R. Holzer and P. Wüchner and H. de Meer. Modeling of Self-Organizing Systems: An Overview. In Workshop über Selbstorganisierende, adaptive, kontextsensitive, verteilte Systeme (SAKS 2010), Electronic Communications of the EASST, Vol. 27, 2010	Survey of modeling methods of self-organizing systems
R. Holzer and H. de Meer. Methods for Approximations of Quantitative Measures in Self-Organizing Systems. In Proc. of 5th International Workshop on Self-Organizing Systems (IWSOS 2011). Karlsruhe, Germany, February 23-24, 2011. Springer, LNCS.	Approximation algorithms for the evaluation of the measures
Richard Holzer and Hermann De Meer. Modeling and Application of Self-Organizing Systems - Tutorial Paper. Proc. of the 5th Int'l IEEE Conference on Self-Adaptive and Self-	Description of modeling methods and application to some use cases

Organizing Systems (SASO 2011) of IEEE Computer Society Press. 2011	
Matthew Fullerton, Richard Holzer, Hermann de Meer, Cristina Beltran Ruiz. Novel assessment of a peer-peer road accident survival system. IEEE Self-adaptive and Self-organizing Systems Workshop Eval4SASO'12, 2012	Evaluation of the measures for emergence and target orientation in a simulated traffic scenario
S. Lehnhoff, S. Rohjans, R. Holzer, F. Niedermeier, H. De Meer. Mapping of self-organization properties and non-functional requirements in smart grids. In Proc. of the 7th Int'l Workshop on Self-Organizing Systems (IWSOS 2013), Lecture Notes in Computer Science (LNCS), Springer, 2013	Position paper about the usage of quantitative measures in a Smart Grid scenario
Richard Holzer, Hermann de Meer, Cristina Beltran Ruiz. Emergence of Global Speed Patterns in a Traffic Scenario. In Proc. of the 7th Int'l Workshop on Self-Organizing Systems (IWSOS 2013), Lecture Notes in Computer Science (LNCS), Springer, 2013	Evaluation of the measures for emergence and target orientation in a real traffic scenario

Disciplines: Communication, Network Science

Application contexts: None of those suggested

Tags: None at this time

Contributed by: Richard Holzer (University of Passau)

8. Game theory

Game theory is "aimed at modeling situations in which decision makers have to make specific actions that have mutual, possibly conflicting, consequences": understanding such systems enables us to design them online.

Different players in a game can choose amongst different actions. These are often referred to as strategies. Once the players and strategies are defined, and a model is able to calculate the outcome (referred to as payoff), game theoretic concepts can be used for retrieving the most likely (set of) interactions between the players. Equilibrium in a game is the concept used for pinpointing the set of strategies in which no player is inclined to change his strategy. There exist several different equilibrium-definitions of which probably the Nash equilibrium (NE) is the most commonly known and is defined as a situation in which no player can gain by unilaterally changing its strategy. In a pure NE, each player will use a pure strategy, while in mixed NE, the players can play mixes (probabilistic combinations) of strategies [1]. As such, a game with fully rational players (using this equilibrium as criterion) is expected to result in one of the NE being chosen.

There are plenty of applications of game theory within the field of networks/Internet. These include [2] power control, pricing and incentive for cooperation between mobile terminals, security issues, access control to share channels and auctions. In [3], the viability of a 3G introduction was studied under different market circumstances, where both dominant

operators and new entrants compete for market share using different price setting strategies. A comparable price game was researched in [4] for competing wireless operators using a different access technology (3G and WiFi). Other publications focus on competition between wireless operators using other than price strategies [5] or on the competition between fixed broadband network operators[6].

Links

None at this time.

Publications

Publication	Description
1. Felegyhazi, M., & Hubaux, J.-Pierre. (2007). Game Theory in Wireless Networks : A Tutorial. Access, 1(C), 1-15. doi:10.4236/sgre.2010.11005	A tutorial on game theory that uses wireless networks as practical means to indicate the applicability of game theory
2. E. Altman, T. Boulogne, R. El-Azouzi, T. Jiménez, L. Wynter, "A survey on networking games in telecommunications", Computers and Operations Research, 2004, Vol. 33 (2006), pp. 286-311.	Indicates different types of game that can be observed in telecommunications
3. Katsianis, D., Gyürke, A., Konkoly, R., Varoutas, D., & Sphicopoulos, T. (2008). A game theory modeling approach for 3G operators. NETNOMICS Economic Research and Electronic Networking, 8(1-2), 71-90. doi:10.1007/s11066-008-9022-1	Application of game theory for 3G use case
4. Lannoo, B., Tahon, M., Van Ooteghem, J., Pareit, D., Casier, K., Verbrugge, S., Moerman, I., et al. (2009). Game-theoretic evaluation of competing wireless access networks for offering Mobile Internet. Competition and Regulation in Network Industries, 2nd Annual conference, Proceedings	Application of game theory for mobile Internet use case
5. Tahon, M., Lannoo, B., Ooteghem, J. V., Casier, K., Verbrugge, S., Colle, D., Pickavet, M., et al. (2011). Municipal support of wireless access network rollout: A game theoretic approach. Telecommunications Policy, 35(9-10), 883-894. Elsevier. doi:10.1016/j.telpol.2011.06.007	Application of game theory for wireless network rollout use case
6. Casier, K., Lannoo, B., Van Ooteghem, J., Verbrugge, S., Colle, D., Pickavet, M., & Demeester, P. (2009). Game-theoretic optimization of a fiber-to-the-home municipality network rollout. Journal of Optical, 1(1), 30. doi:10.1364/JOCN.1.000030	Application of game theory for FTTH use case

7. Game Theory by Drew Fudenberg and Jean Tirole , August 1991, The MIT Press.	A Game Theory handbook

Disciplines: Economics

Application contexts: None of those suggested

Tags: Network optimization

Contributed by: Sofie Verbrugge (iMinds)

9.   Real options valuation

Relevant to the design of business models online, the real option valuation methodology tries to capture (and include) the value of managerial flexibility present in a business case, much as the flexibility presented in financial options (over stocks) are valued. A financial option gives the right to buy or sell over a limited period the underlying value for a predetermined exercise price. As it is a right (and not obligation) the value of an option will always be positive. Real Options was defined in 1977 (see publications) and applies option pricing theory to the valuation of investments in real assets. It proved especially useful in investment decisions consisting of different (optional) phases. As it adds flexibility to the business case, it alleviates (partly) the estimation of the risk by means of the discount factor as in the calculation of the net present value.

The introduction of flexibility will very often involve an extra cost at the beginning of the project. To make it possible that several options can be exercised in the next phases, some measures have to be taken from the beginning. Examples are the purchase of licenses to cover all possible scenarios, installation schedules for the trains depending on the amount of relations to be rolled out, etc.

The approach applied to technical projects entails the following three steps:

1. identify the key uncertainties
2. identify the options
3. valuation of the options considering the uncertainties

Various real option types can be classified according to a so-called 7S-framework: invest/growth options (Scale up, Switch up, Scope up), defer/learn options (Study) and disinvest/shrink options (Scale down, Switch down, Scope down) (**Table 1**).

Table 1: Types of real options: the 7S framework

Category	Type	Description	Examples
Invest Grow	**Scale up**	Sequential investments in a later stage as market grows	Faster rollout if the take rate is higher than expected
	Switch up	Switch products, process or plants given a shift in underlying price or demand	Upgrading UMTS to HSDPA antennas when more demand is requested
	Scope up	Enter another industry when cost-efficiently possible. Link and leverage	Utility companies investing in fibre access networks
Learn	**Study / start**	Delay investments until more information and/or skills are acquired	Looking at best practices in neighbouring countries before rolling out FTTH

Disinvest Shrink	**Scale down**	Shrink or shut down a project if new information changes the expected payoffs	Several municipal WiFi networks in the USA have been shut down due to disappointing customer adoption
	Switch down	Switch to more cost-effective and flexible assets as new information is obtained	Network cards could be replaced with new version leading to more efficient power usage
	Scope down	Limit the scope of operations in a related industry when there is no further potential	Copper networks could be disintegrated when a full FTTH network is in place

Links

None at this time.

Publications

Publication	Description
Stewart C. Myers, Determinants of corporate borrowing, Journal of Financial Economics, Volume 5, Issue 2, November 1977, Pages 147–175	First reference of real options
W. De Maeseneire, "The real options approach to strategic capital budgeting and company valuation", ISBN: 2-8044-2318-2, Financiële Cahiers, Larcier, 2006	Practical guide, provides an extensive introduction to Real Options theory, with a lot of examples

Disciplines: Economics

Application contexts: None of those suggested

Tags: Internet investment optimization, financial option evaluation

Contributed by: Sofie Verbrugge (iMinds)

10. Teasing Apart, Piecing Together

Teasing Apart, Piecing Together (TAPT) is a method for analysing and redesiging experiences through deconstruction and reconstruction. In addition to analysis and design, it has also been used for evaluation of both software projects and workshop events.
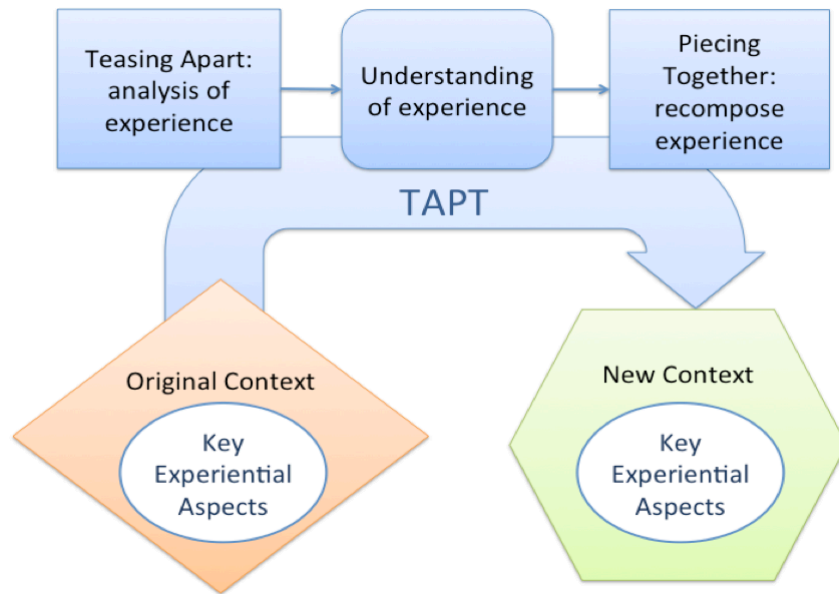
TAPT is particularly useful for supporting physical-to-digital and digital-to-physical redesign. For example, it has been used for scenarios including design of a digital system to support location-based social updates in the office (via analysis of maps, sign posts and tour guides), social networking on the spoken web, and provision of collaborative feedback in a museum, inspired by wiki technology.

TAPT is divided into two phases. In phase one, the experience is analysed with the 'teasing apart' process:

1) The functionality is described, alongside the experience of using it
2) 'Surface elements' of the experience are listed. These are generally nouns and adjectives relating to the design.
3) 'Experienced effects' are listed. These focus on physical, social, intellectual and emotional effects (these are generally abstract nouns, noun/verb pairs, adverbs). They are literal (concrete items) and abstract (relating to emotional and intellectual effects).
4) Important effects are identified.
5) The abstracted experience is described in a neutral sentence.

In phase two, the analysed experience is used as a springboard for creative redesign of that experience in a new context. Steps are:

1) Brainstorm, particularly using key efforts, considering the new context. Aspects to consider include modality, technology, scale, and technologies typically found in the original and new contexts.
2) Use these ideas to build the reconstructed scenario.
3) Check the reconstruction: are the desired effects present? Are unintended effects present? Refine the scenario if needed.

Links

Link	Description
http://www.clarehooper.net/tapt/	Webpage about TAPT

Publications

Publication	Description
Hooper, C. J. and Millard, D. E. (2010)	The first evaluation of TAPT, comparing it

Teasing Apart and Piecing Together: Towards Understanding Web-based Interactions. In: Web Science 2010, April 2010, Raleigh, USA.	with use of scenarios and a baseline approach.
Hooper, C.J. (2011) Using TAPT as an Analytical Method for Understanding Online Experiences. In: Web Science 2011, June 2011, Koblenz, Germany.	Use of TAPT with groups and meta-analysis.
Hooper, C. J. and Rettberg, J. W. (2011) Experiences with Geographical Collaborative Systems: Playfulness in Geosocial Networks and Geocaching. In: Please Enjoy workshop at Mobile HCI.	Use of TAPT for analysis of playful location-based uses of the mobile web.
Hooper, C.J., Soute, I. (2012) TAPT and Contextmapping: Understanding how we Understand Experience. Journal of Literary and Linguistic Computing. doi: 10.1093/llc/fqs019	A comparison of TAPT with contextmapping.
Hooper, C. J. (2011) Analysis, redesign and evaluation with teasing apart, piecing together. In Procedings of the Second Conference on Creativity and Innovation in Design (DESIRE '11). ACM, New York, NY, USA, 359-360. DOI=10.1145/2079216.2079269	A tutorial on TAPT.

Disciplines: Computer Science, HCI, User Experience, Design

Application contexts: Information retrieval, social networking

Tags: User experience, analysis, deconstruction, design.

Contributed by: Clare Hooper (IT Innovation)

11.   Contextmapping

Contextmapping is a cross-disciplinary method for understanding people's experiences, typically to either drive the design of products and services or for research purposes. Contextmapping maps the context of people's interactions with products: people are invited to make designerly artefacts, and tell a story about what they have made. The idea is that making the artefacts lets people access and express their experiences, and helps designers and researchers gain deeper insight into the needs and dreams of prospective users.

Contextmapping falls into five steps:

1. Preparation: identifying goals, selecting participants and choosing techniques.

2. Sensitisation: triggering, encouraging and motivating participants to think, reflect, wonder and explore aspects of their personal context in their own time and environment. This is done with sensitising packages, inspired by cultural probes.

3. Sessions: running meetings in which participants do generative exercises. Participants respond to instructions and expressive components to create artefacts that express their thoughts, feelings and ideas. They explain their artefacts, revealing their experiences.

4. Analysis: artefacts contain many stories related to the topic, which are usually recorded. Transcriptions are made, and the context is explored.

5. Communication: bringing results to the design process, where they can inform and inspire the design team. This might involve conventional written reports, workshops, card sets, or persona displays.

Links

Link	Description
http://studiolab.ide.tudelft.nl/studiolab/contextmapping/	Webpage about contextmapping

Publications

Publication	Description
Visser, F.S., Stappers, P.J., van der Lugt, R. and Sanders, E.B.N. (2005). Contextmapping: Experiences from practice. CoDesign, 1(2):119-149.	An explanation of contextmapping and a description of its use based on several projects from research and years of industry experience.
Hooper, C.J., Soute, I. (2012) TAPT and Contextmapping: Understanding how we Understand Experience. Journal of Literary and Linguistic Computing. doi: 10.1093/llc/fqs019	A comparison of contextmapping with TAPT.

Disciplines: Design, co-design, Industrial Design

Application contexts: None of those suggested

Tags: None at this time

Contributed by: Clare Hooper (IT Innovation)

12. Cultural Probes

Cultural probes are a design technique used to gain open-ended insights into people's lives, particularly in terms of capturing their personal and cultural values. Probes are small packages sent to participants: the packages contain artefacts for interaction, such as postcards, maps or a camera. Instructions are open-ended, and might be, for example, "What advice or insight has been important to you?" "Tell us about your favourite device?" (on postcards), "Where have you been in the world?", "Where do you go to be alone?" (on maps), or "Take a photo of the first person you see today", "Take a photo of something boring" (on cameras).

Cultural probes yield rich, qualitative data that can help bridge the gap between researchers/practitioners and their subjects. Outputs from cultural probes can form a valuable input into the design process.

Links

Link	Description
http://en.wikipedia.org/wiki/Cultural_probe	The Wikipedia entry about cultural probes

Publications

Publication	Description
Bill Gaver, Tony Dunne, and Elena Pacenti. 1999. Design: Cultural probes. interactions 6, 1 (January 1999), 21-29. DOI=10.1145/291224.291235 http://doi.acm.org/10.1145/291224.291235	The seminal publication which first described use of cultural probes

Disciplines: HCI, Design

Application contexts: None of those suggested

Tags: Qualitative methods; design research; cultural research; user-centered design

Contributed by: Clare Hooper (IT Innovation)

13.   Participatory design

Participatory design in software engineering involves bringing stakeholders of a project into various stages of that project, from initial scoping and problem definition through to evaluation of the product during development.

In participatory design, it is typical to hold a workshop with stakeholders, including stakeholders, researchers/developers and a facilitator. Workshops involve varied activities such as: discussion of the problem area, paper prototyping or other low-fi prototyping, feedback and constructive criticism of proposed applications or services.

Links

None at this time.

Publications

Publication	Description
Michael J. Muller. 2002. Participatory design: the third space in HCI. In The human-computer interaction handbook, Julie A. Jacko and Andrew Sears (Eds.). L. Erlbaum Associates Inc., Hillsdale, NJ, USA 1051-1068.	A key chapter about participatory design.

Disciplines: HCI, Computer Science, Software Engineering, Design

Application contexts: None of those suggested

Tags: None at this time.

Contributed by: Clare Hooper (IT Innovation)

14.   Empathic design

In empathic design, researchers and practitioners consider the feelings of their subjects. The steps are:

- Observation
- Capturing data
- Reflection and analysis
- Brainstorming for solutions

- Developing prototypes of possible solutions

Unlike participatory design, empathic design involves movement of researchers and practitioners to their subjects, rather than the other way around. The focus is on observation and interpretation, and more successful observations are made by diverse disciplinary groups, including designers and engineers but also anthropologists or ethnographers.

Links

None at this time.

Publication

Publication	Description
Leonard, D. and Rayport, J.F., "Spark Innovation Through Empathic Design", Harvard Business Review, Nov-Dec 1997	A key paper on empathic design.

Disciplines: Design, Engineering, Ethnography, Anthropology

Application contexts: Social networking

Tags: None at this time.

Contributed by: Clare Hooper (IT Innovation)

15. Requirements analysis

Requirements analysis is a stalwart technique from software engineering and system engineering that produces essential inputs to the design process. It involves at its heart three activities:

1) requirements gathering
2) requirements analysis
3) requirements recording

Requirements must be documented, actionable, measurable, testable, traceable, related to business needs, and defined in sufficient detail for system design to occur.

The activity of requirements analysis can include methods such as interviews, focus groups, observation and prototyping.

Links

None at this time.

Publication

Publication	Description
Alan M. Davis. 1990. Software Requirements: Analysis and Specification. Prentice Hall Press, Upper Saddle River, NJ, USA.	A key book on requirements analysis.

Disciplines: Software engineering, computer science, systems engineering, psychology

Application contexts: None of those suggested

Tags: None at this time.

Contributed by: Clare Hooper (IT Innovation)

16. Event sampling emotion recorder

Understanding affect online is essential to the design of affective systems, and is arguably at the heart of successful social networking sites.

The event (or experience) sampling methodology (ESM) is a sampling technique that allows the study of naturally occurring on-going and 'online' experiences and events in day to day behaviour and life (see Reis & Gable, 2000). Participants record in paper and pencil or electronic devices aspects of their naturally occurring social interactions either online or off-line. Within intense research interests in Personality and Social psychology for the analysis of social interaction (Reis & Gosling, 2010) one form of such methods has been the Rochester Interaction Record (RIR, see Kafetsios & Nezlek, 2012; Nezlek, 2012) that has been fruitfully utilized in our Emotions and social interaction lab at the University of Crete.

Within the REVITAL project we are developing an adaptation of the method for the use in Android systems. This method could be further developed for assessing peoples' affective responses online and offline.

Links

Link	Description
http://www.ambulatory-assessment.org/typo3/ambulatory/index.php	Society for Ambulatory Assessment
http://dingo.sbs.arizona.edu/~mehl/EAR.htm	The Electronically Activated Recorder (EAR)

Publications

Publication	Description
Bolger, N., Davis, A., & Rafaeli, E. (2003). Diary methods: Capturing life as it is lived. Annual Review Of Psychology, 54, 579-616.	A review of diary methods.
Kafetsios, K. & Nezlek, J.B. (2012). Emotion and support perceptions in everyday social interaction: Testing the "less is more hypothesis" in two different cultures. Journal of Social and Personal Relationships, 29, 165-184	On the Rochester Interaction Record that was used in the Emotions and social interaction lab at the University of Crete.
Nezlek, J.B. (2012). Diary Methods for Social and personality Psychology. Sage	On the Rochester Interaction Record that was used in the Emotions and social interaction lab at the University of Crete.
Reis, H. T., & Gable, S. L. (2000). Event-sampling and other methods for studying everyday experience. In H. T. Reis, C. M. Judd, H. T. Reis, C. M. Judd (Eds.), Handbook of research methods in social and personality psychology (pp. 190-222). NY US: Cambridge University Press	On the event-sampling methodology.

Disciplines: Psychology, Social Sciences

Application contexts: None of those suggested

Tags: Mobile devices, Event sampling, Emotion, affective design.

Contributed by: Konstantinos Kafetsios, Athena Vakali, Despoina Chatzakou, Maria Giatsoglou (Aristotle University of Thessaloniki)

17. Qualitative research methods drawing on a variety of theoretical frameworks in social sciences

Qualitative social science research methods involve the collection of data through documentary analysis observation and interviews. These methods are well established and are being used in internet science to study the interaction between the internet and the world beyond the internet, and to study interactions between people via the internet particularly focusing on the content of these interactions. Such understanding is essential to the mindful design (and evaluation) of systems intended to foster certain types of interaction.

Studies take a particular theoretical approach to data collection and analysis. For example, a phenomenological study in interested in the meaning of the internet or interaction on the internet for people and does not consider there to be one true account of an interaction. A realist study would accept that an interaction can be considered to have a reality that is beyond its perception by the people concerned although accepts that the perception of the interaction may be very different for the different people involved. This brief summary of the approaches does not do full justice to them but is intended to be illustrative of the different approaches within social science.

Data is often in text form (documents e.g. emails, web pages), field notes from observation and interview transcripts, but increasingly audio and visual data is being directly analysed. Many software packages exist to assist with data management during the analysis process. The approach to analysis depends on the theoretical framework of the study. Most analysis methods involve close reading/listening/viewing of the data, coding of the data (often by hand but sometimes systems such as word searches are used) so the data can be sorted by theme or by case, then comparison of the data within a theme (e.g. all the data relating to seeking health information) or comparison of the cases (a case might be an event e.g. an interaction so comparison is of the data related to each of the interactions, or a case might be a person or organisation, so comparison is between the data relating to each person or each organisation).

This is a simple summary of the analysis process. It can have multiple stages. Analysis takes account of the context in which the data was collected (e.g. web forum where people are not identifiable or an interview where the person's identity is known; data collected within an organisation or on the web is influenced by the architecture of the organisation or web) and how it was collected (e.g. data collected on a sensitive topic face to face might be different from if it was collected by email; data from, for example Twitter is limited in its breadth/depth by the length limit of Tweets) including the level of interaction between the person giving and collecting the data (there is little interaction when observing a public web forum whereas during an interview the data is co-constructed by the researcher and interviewee - although the researcher should have skills to limit their influence on the data.

Links

None at this time.

Publication

These research methods are standard in social science and there are many books and papers. The methods are adapted for the specific research question, context, access to data collection spaces and type of data available.

Disciplines: Social science, Sociology, anthropology, psychology, health sciences, education, law, contemporary history

Application contexts: None of those suggested

Tags: None at this time.

Contributed by: Frances Griffiths (University of Warwick)

18. Tussle analysis

Tussle analysis was developed in response to the multi-faceted nature of internet ecosystems, and the fact that multiple stakeholders may have needs or desires that conflict with one another. It intends to support decision-making that accounts for technological, economic and social aspects, with a 'tussle' being the natural, continuous quest of internet stakeholders for achieving their goals.

Links

Link	Description
http://www.slideshare.net/ictseserv/a-seserv-methodology-for-tussle-analysis-in-future-internet-technologies-introduction-and-motivation	Slideshare slide introducing and motivating tussle analysis.

Publication

Publication	Description
Costos Kalogiros (ed.) 2012. The Tussle Analysis Cookbook. An output of SESERV, CSA No. 258138.	An introduction to tussle analysis, the methodology and a case study.

Disciplines: Network engineering, software engineering, design

Application contexts: information retrieval; social networking; open data

Tags: None at this time.

Contributed by: Clare Hooper (IT Innovation)

19. Creative Problem Solving

Creative Problem Solving, or CPS, is a structured approach for coming up with a new, innovative and non-obvious solution to a particular problem. At its heart is a two-pronged approach of divergent thinking followed by convergent thinking. The six steps are:

1. Objective Finding
2. Data Finding
3. Problem Finding
4. Idea Finding
5. Solution Finding
6. Acceptance Finding

In the first three steps, the challenge is explored. Step 4 is about idea generation, while the final two steps involve preparing for action.

Links

Link	Description
http://www.creativeeducationfoundation.org/our-process/what-is-cps	The Creative Education Foundation's page explaining CPS.

Publications

Publication	Description
Alex Osborn (1993) Applied Imagination: Principles and Procedures of Creative Problem-Solving. The Creative Education Foundation.	The seminal book on CPS.

Disciplines: Design

Application contexts: None of those suggested

Tags: creativity.

Contributed by: Clare Hooper (IT Innovation)

20. Design of networks starting from (social) mobility patterns of users

This method concerns the design of opportunistic networks: networks where communication is enabled by direct communication between mobile nodes. Such communication becomes possible when two users move close enough for their mobile devices to communicate via a wireless technology in an ad hoc mode (such as WiFi, Bluetooth or similar). The properties of human mobility are clearly fundamental for the performance of this kind of network, as communication occurs only when mobility brings nodes close enough to communicate. Our starting point is thus identifying the impact of certain mobility profiles on the general properties of routing in opportunistic networks, and deriving methodologies for picking the right routing protocol in opportunistic networks based on the mobility properties of the users. Two cases have been considered:

The first case (Boldrini, 2012) assumes that inter-contact times between users follow Pareto distributions, but that specific parameters of the Pareto distribution can change across different pairs of nodes. In this case, focusing on the family of randomised routing protocols, we have derived convergence conditions, i.e. conditions under which, starting from known parameters of the inter-contact times distributions, we can say whether randomised routing protocols will yield finite or infinite expected delay (corresponding thus to convergence or divergence conditions). Specifically, we have considered a large family of routing protocols, differing in (i) the number of parallel copies generated by the sender; (ii) the maximum number of hops allowed for each copy; (iii) the level of memory assumed at intermediate relays (i.e., if relays remember or not of having forwarded messages generated at particular sources and addressed to particular destinations). Our results permit, given a description of the mobility profile, to decide how to configure routing protocols along those three dimensions to guarantee convergence.

The second case (Passarella, 2011; Passarella, 2012) assumes again an heterogeneous opportunistic network as far as inter-contact time distributions are concerned, but inter-contact time distributions can be arbitrary. The focus is the relationship between the distribution of individual inter-contact times and the distribution of aggregate inter-contact times, where the latter is the distribution of the inter-contact times of all pairs taken together. The latter is typically used as a key performance figure to characterise opportunistic networks as with respect to individual distributions it is much easier to collect and entails much lower privacy concerns. The goal of the study is understanding when the aggregate distribution can be used instead of individual distributions to assess the convergence properties of routing protocols. We have developed an analytical model linking individual and aggregate distributions and analysed use cases to show when the aggregate is correct. This provides a "design handbook": starting from a description of the user's mobility profile, one can discern which statistic must be collected (the aggregate or individual distributions).

Users can be provided with very simple charts that help them select the right routing protocol (in the first case) or the right statistic (in the second case). These charts provide (as the "key" used by users to navigate) the description of users' mobility profiles, i.e. the characteristics of the distributions of inter-contact times. For each "key", the chart will provide the set of converging routing protocols and the statistic to be used.

Links

No links at this time.

Publications

Publication	Description
Boldrini, C., Conti, M., Passarella, A., "Less is More: Long Paths Do Not Help the Convergence of Social-Oblivious Forwarding in Opportunistic Networks", Third International Workshop on Mobile Opportunistic Networks (ACM MobiOpp 2012), Zurich, Switzerland, 15-16 March 2012	On the first case described above.
Passarella, A., Conti, M., "Characterising aggregate inter-contact times in heterogeneous opportunistic networks", IFIP Networking 2011, Valencia, Spain, 9-13 May 2011	On the second case described above.
Passarella, A., & Conti, M. (2012). Analysis of individual pair and aggregate inter-contact times in heterogeneous opportunistic networks	On the second case described above.

Disciplines: Network Science, Computer Science

Application contexts: Social networking

Tags: None at this time

Contributed by: Andrea Passarella (CNR)

21.   Properties of mobile opportunistic network content for design

Mobile opportunistic networks are good alternatives to improve user' access to information. While there has been a significant research on how to improve the performance of these networks using mobility and social patterns, little has been said on how to include the properties of the content in the design of opportunistic networks. This work studies different properties of the online content – how content is produced and consumed by mobile users – and to adapt the functionalities of the network to these observations.

The first direction addressed in this work is the design of adaptive caching strategy based on the dynamic evolution of content popularity, beginning with an in-depth analysis on the predictive characteristics of online content. Attention is paid to how fast and how accurately one can predict the popularity of online content. A large dataset of online news articles is analysed, with the predictive accuracy of different prediction methods explored with respect to predicting content popularity [23, 24] and ranking performance [24, 25].

This work can be used for content prioritisation in opportunistic networks to decide which content to store, push, or forward in order to maximize the overall user access to information.

Links

No links at this time.

Publications

Publication	Description
Alexandru Tatar, Panayotis Antoniadis, Marcelo Dias de Amorim, Jérémie Leguay, Arnaud Limbourg, Serge Fdida (2011) Predicting the popularity of online articles based on user comments. International Workshop on Social Data Mining for Human Behaviour Analysis, Sogndal, Norway, May 2011	Work on predicting popularity.
Alexandru Tatar, Marcelo Dias de Amorim, Panayotis Antoniadis, and Serge Fdida, Ranking news articles based on popularity prediction, IEEE/ACM International Conference on Social Networks Analysis and Mining, Istanbul, Turkey, August 2012.	Work on predicting popularity and ranking performance.
Alexandru Tatar, Panayotis Antoniadis, Marcelo Dias de Amorim , and Serge Fdida, From Popularity Prediction to Ranking Online News, Social Network Analysis and Mining (submitted)	Work on predicting ranking performance.

Disciplines: Network science

Application contexts: Social networking

Tags: None at this time

Contributed by: Serge Fdida (UPMC)

22. Influence online

Design can be informed by the emergence of influence and network formation structure in social information networks. As online social networks are increasingly used for sharing content and information, influence becomes important in determining how information is propagated. Current work in this area studies the types of networks that form and the influence paths that emerge when each user in an online social network makes selfish decision in creating links, sharing content and filtering content. Heed has been given to the efficiency of self-organization in such contexts. This area draws on methods of modelling and analysis using game theory, optimisation, and graph theory.

Links

No links at this time.

Publications

Publication	Description
Nidhi Hegde, Laurent Massoulié, and Laurent Viennot. Self-organizing flows in social networks. In Proc. SIROCCO 2013, 20th International Colloquium on Structural Information and Communication Complexity	Introducing 'flow games', a way to model network formation.
Ji Zhu, Stratis Ioannidis, Nidhi Hegde, and Laurent Massoulié. Stable and scalable universal swarms. In Proc. ACM PODC 2013	Characterising the stability of 'swarms' of users on BitTorrent.
Bo Jiang, Nidhi Hegde, Laurent Massoulié, and Don Towsley. How to optimally allocate your budget of attention in social networks. In Proc. IEEE Infocom, 2013	On information propagation in social networks.

Disciplines: Network science, computer science

Application contexts: Social networking

Tags: None at this time

Contributed by: Nidhi Hegde (Technicolor)

23. Medium Design

Lars Nyre and others in the Information and Media Science Department at the University of Bergen offer an approach by which show how scholarship about media can do more than simply criticise and analyse existing media, but in fact create better media.

Links

No links at this time.

Publications

Publication	Description
Nyre, L. (2010) "Experimenting with new media for journalism", in Nordicom Information 32(2-3): pp. 83-93.	An article on the design of media in the context of two-way interfaces and journalism.

Disciplines: New Media, Media Studies

Application contexts: None of those suggested

Tags: None at this time

Contributed by: Jill Walker Rettburg (University of Bergen) and Clare Hooper (IT Innovation)

24.   Synthetic-analytic method

The design of media technologies, media genres and media texts should be an important part of media studies. Design methods in media studies compared to methods in sciences, especially computer science, can yield important results if researchers state their normative position clearly and apply rigorous evaluations of their results. Fagerjord (2012) has analysed Liestøl's synthetic–analytic method as an example of a media design method.

Links

Link	Description
https://www.duo.uio.no/bitstream/handle/108 52/34192/fagerjorddesignsommetodepreprint. pdf?sequence=1	Open access version of Fagerjord's publication in this area (Norwegian)

Publications

Publication	Description
Liestøl, G. (2003) Gameplay: from synthesis to analysis (and vice versa) Digital media revisited. 389-413. MIT Press	Liestøl's synthetic-analytic method.
Fagerjord, Anders. 2012. Design som medievitenskapelig metode. Norsk medietidsskrift 19.3. http://www.idunn.no/ts/nmt/2012/03/design_s om_medievitenskapelig_metode	Fagerjord's analysis of the synthetic-analytic method (Norwegian).

Disciplines: New Media, Media Studies

Application contexts: None of those suggested

Tags: None at this time

Contributed by: Jill Walker Rettburg (University of Bergen) and Clare Hooper (IT Innovation)

25.   Digital methods

The Digital Methods Initiative is a contribution to research on the "natively digital", and can inform design decisions relating to digital interactions online.

Consider the hyperlink, the thread and the tag. Each may 'remediate' older media forms (reference, telephone chain, book index), and genealogical histories remain useful (Bolter/Grusin, 1999; Elsaesser, 2005; Kittler, 1995). At the same time new media environments - and the software-makers - have implemented these concepts, algorithmically, in ways that may resist familiar thinking as well as methods (Manovich, 2005; Fuller, 2007). In other words, the effort is not simply to import well-known methods - be they from

humanities, social science or computing. Rather, the focus is on how methods may change, however slightly or wholesale, owing to the technical specificities of new media.

The initiative is twofold. First, we wish to interrogate what scholars have called "virtual methods," ascertaining the extent to which the new methods can stake claim to taking into account the differences that new media make (Hine, 2005). Second, we desire to create a platform to display the tools and methods to perform research that, also, can take advantage of "web epistemology". The web may have distinctive ways of recommending information (Rogers, 2004; Sunstein, 2006). Which digital methods innovate with and also critically display the recommender culture that is at the heart of new media information environments?

Amsterdam-based new media scholars have been developing methods, techniques and tools since 1999, starting with the Net Locator and, later, the Issue Crawler, which focuses on hyperlink analysis (Govcom.org, 1999, 2001). Since then a set of allied tools and independent modules have been made to extend the research into the blogosphere, online newssphere, discussion lists and forums, folksonomies as well as search engine behavior. These tools include scripts to scrape web, blog, news, image and social bookmarking search engines, as well as simple analytical machines that output data sets as well as graphical visualizations.

The analyses may lead to device critiques - exercises in deconstructing the political and epistemological consequences of algorithms. They may lead to critical inquiries into debates about the value and reputation of information.

References

D. Bolter and R. Grusin (1999), Remediation: Understanding New Media, Cambridge, MA: MIT Press.

T. Elsaesser (2005), "Early Film History and Multi-media: An Archaeology of Possible Futures?" in W. Hui Kyong Chun and T.W. Keenan (eds.), New Media, Old Media: A History and Theory Reader, New York: Routledge.

M. Fuller (ed.) (2007), Software Studies, Cambridge, MA: MIT Press.

Govcom.org (1999), Net Locator software.

Govcom.org (2001), Issue Crawler software.

C. Hine (ed.) (2005), Virtual Methods: Issues in Social Research on the Internet, Oxford: Berg.

A. Kittler (1995), "There is No Software," CTheory, a032.

L. Manovich (2005), "New Media: Capture, Store, Interface, Search," lecture delivered at the University of Amsterdam, 29 November.

R. Rogers (2004), Information Politics on the Web, Cambridge, MA: MIT Press.

C. Sunstein (2006), Infotopia: How Many Minds Produce Knowledge, New York: Oxford.

Links

Link	Description
https://www.digitalmethods.net	Homepage for Digital Methods
https://wiki.digitalmethods.net/Dmi/DmiAbout	A longer introduction to Digital Methods

Publications

Publication	Description
Richard Rogers. 2013. Digital Methods. Cambridge, MA: MIT Press.	The seminal book on Digital Methods

Disciplines: Computer Science, New Media

Application contexts: information retrieval, social networking

Tags: None at this time

Contributed by: Jill Walker Rettburg (University of Bergen) and Clare Hooper (IT Innovation)

26.   Mechanism Design

Mechanism design (sometimes called reverse game theory) is a field in game theory studying solution concepts for a class of private information games. While traditional economic theory deals with the analysis of the performance of a given mechanism, in a design problem the goal function is the main given, the mechanism is the unknown (Hurwicz, Maskin and Myerson received the 2007 Nobel Prize in Economic Sciences "for having laid the foundations of mechanism design theory"). Therefore, in these "games" the game "designer" chooses the game structure rather than inheriting one, so as to achieve a certain outcome of the game.

A game of mechanism design is a game of private information in which one of the agents, called the principal, chooses the payoff structure. The agents receive secret "messages" from nature containing information relevant to payoffs. For example, a message may contain information about their preferences or the quality of a good for sale. We call this information the agent's "type" (usually noted θ and accordingly the space of types Θ). Agents then report a type to the principal (usually noted with a hat $\hat{\theta}$) that can be a strategic lie. After the report, the principal and the agents are paid according to the payoff structure the principal chose.

As a benchmark (cf. revelation principle below) the designer often defines what would happen under full information. Define a social choice function $f(\theta)$ mapping the (true) type profile directly to the allocation of goods received or rendered, $f(\theta)$: $\Theta \rightarrow X$. In contrast a **mechanism** maps the *reported* type profile to an *outcome* (again, both a goods allocation x and a money transfer t) $u(\hat{\theta})$: $\Theta \rightarrow Y$.

 A proposed mechanism constitutes a Bayesian game (a game of private information), and if it is well-behaved the game has a Bayesian Nash equilibrium. At equilibrium agents choose their reports strategically as a function of type $\hat{\theta}(\theta)$. It is difficult to solve for Bayesian equilibria in such a setting because it involves solving for agents' best-response strategies and for the best inference from a possible strategic lie. Thanks to a sweeping result called the revelation principle, no matter the mechanism a designer can confine attention to equilibria in which agents truthfully report type. The revelation principle states: "For any Bayesian Nash equilibrium there corresponds a Bayesian game with the same equilibrium outcome but in which players truthfully report type."

This is extremely useful. The principle allows one to solve for a Bayesian equilibrium by assuming all players truthfully report type (subject to an incentive compatibility constraint).

Highlighted results in mechanism design include the VCG auctions.

Links

None at this time.

Publications

Publication	Description
Hurwicz, Leonid and Stanley Reiter (2006). *Designing Economic Mechanisms*. Cambridge University Press. ISBN 0-521-83641-7.	A book describing mechanism design methodology.
Myerson, Roger B. "mechanism design." The New Palgrave Dictionary of Economics. Second Edition. Eds. Steven N. Durlauf and Lawrence E. Blume. Palgrave Macmillan, 2008.	A book describing mechanism design principles.
Dütting, Paul; Geiger, Andreas (May 9, 2007), *Algorithmic Mechanism Design*, Seminar Report, University of Karlsruhe, Fakultät für Informatik.	A text on algorithmic mechanism design that also describes the revelation principle.
Papaioannou, Thanasis G., Stamoulis, George D. A mechanism that provides incentives for truthful feedback in peer-to-peer systems. Electronic Commerce Research, 10(3-4), pp. 331-362	A sample incentive mechanism to achieve truthful reporting of peer performance during service/file exchanging in p2p networks.

Disciplines: Economics, Social Sciences, Computer Science

Application contexts: None of those suggested

Tags: mechanism design, revelation principle, incentive compatibility, individual rationality, reverse game theory, network economics

Contributed by: Thanasis Papaioannou (CERTH)

27. Simulation of Urban MObility (SUMO)

As has discussed at such venues as Thinking Architecturally (http://wiki.internet-science.eu/index.php/Workshop_on_Thinking_Architecturally), there is much to be learned regarding the design of large-scale complex systems such as the Internet from large-scale complex systems elsewhere, whether in biology, economics, or entomology. The study of distributed systems such as road traffic networks offers another approach to insight into such systems, and can inform our design decisions.

SUMO is an open source, highly portable, microscopic and continuous road traffic simulation package designed to handle large road networks. It is meant to be used in simulations from small sized road networks to networks of a city's size. It allows simulation of how a given traffic demand which consists of single vehicles moves through a given road network. The simulation allows to address a large set of traffic management topics. It is

purely microscopic: each vehicle is modeled explicitly, has an own route, and moves individually through the network. SUMO supports visualization of multiple vehicle types (cars, buses, motorcycles, etc.), accurately portrays junctions and traffic lights, and support the import of real city maps e.g. from http://www.openstreetmap.org/

Links

Link	Description
http://sumo-sim.org/	Homepage for SUMO simulator
http://sumo-sim.org/userdoc/Publications.html	Listing of related publications.

Publications

Publication	Description
M. Behrisch, L. Bieker, J. Erdmann, D. Krajzewicz. SUMO - Simulation of Urban MObility: An Overview In SIMUL 2011, The Third International Conference on Advances in System Simulation (October 2011), pp. 63-68	An overview of the SUMO simulator

Disciplines: Computer Science, Transports, Logistics, Urban Planning

Application contexts: None of those suggested

Tags: Traffic simulation, VANETs, distributed systems, networks

Contributed by: Thanasis Papaioannou, Harris Niavis (CERTH)