Graduate School of Fundamental Science and
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博 士 論 文 概 要
Doctor Thesis Synopsis

論 文 題 目
Thesis Theme

Cloud and Crowd Powered
Personal Knowledge Management

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In 2012, Twitter send 340 million tweets a day, Tumblr publish 27,000 new posts a minute, and Foursquare perform 2,000 check-ins every 60 seconds: big user base, big data, big noise. A problem for individuals to seek, create and share valuable knowledge? No, an opportunity.

Personal knowledge management activity is evolving. At first, it is in a person-to-person model, which refers to the activities of one person simply shares the knowledge to another. Then the technology development provides methods to massively publishing the knowledge, e.g., printed or digitalized books. Most recently, the Internet has became the revolutionary power especially with the widely spread of emerging Web 2.0 services, cloud computing infrastructure, and crowdsourcing movement. For the first time in human history we came into the We-Media era, where almost every ordinary people could playing an active role in the process of collecting, creating, reusing, analyzing, and disseminating knowledge, ubiquitously.

This phenomenon also poses new design challenges when building tools for supporting personal knowledge management tasks:

Supporting knowledge re-usage and remix. The sever side main infrastructure has shifted to Cloud Computing, now those User Generated Content data is often stored in the Cloud thus also potentially available for re-using by other users. In the meanwhile, in the recent years we have witnessed the raising of Remix Culture, which refers to the a global activity consisting of the creative and efficient exchange of information made possible by digital technologies and is supported by the practice of cut/copy/paste. Consequently, remixer are those users who require different types of media in creative processes and thus the suitable content in the Cloud could become an integral part of their remix creation processes.

Support contextual knowledge seeking. The rising demands of context-awareness applications changes the traditional knowledge exchange process as well, user not only seek for existing knowledge that is stored in a database, but also contextual knowledge, such as time-oriented knowledge (real-time knowledge where the value of information is strongly affected by time) and location-oriented knowledge (local knowledge that is valid in specific location). On the other hand, in many situations machine sensors and sensor networks have met difficult problem to extract high layer contextual knowledge from environment, such as human activities, social environment, and group emotions. Therefore, a knowledge seeking application should contain a different model to collect such dynamic and machine sensor un-extractable high layer knowledge and information in addition to search data on the Web or certain databases.

Support serendipitous knowledge discovery: The term of serendipity is generally defined as the art of making an unsought finding. It describes the moment when people meet fortunate discoveries by chance, or in other words, the accident of finding something interesting or useful without looking exactly for it. Such magic moments often consist of two different but equally important characteristics: the item or the information should be to- tally unexpected to the person that comes upon it, but she would feel it is valuable and interesting once presented to her. Design for serendipity has used to be a challenge for urban planners, because a in a free and peace society the understanding between people from different social class is often achieved by discussions and communications, and now it has also become a design requirement for digital designers of Internet services.

This thesis lays out a **general framework** that is addressed above-mentioned challenges and applicable for Internet based systems that are designed to support personal knowledge exchanging, managing and creating in the era of the big data, the wisdom of crowds, and the social computing.

This framework combines three main components in general. The first, the models of re-usable knowledge seeking, are proxies that searches and collects suitable knowledge items source from different databases in the cloud. The second, the models of non-existing knowledge seeking, are proxies that identify specific knowledge workers who can potentially provide the required knowledge using social web crowdsourcing. The third, the end user applications, are various client side programs that user could use to access the services. The end user tools could be independent applications, or add-ons of existing knowledge creation tools such as PowerPoint. The output of the services may be stored in the databases for future re-use.

This thesis develops this framework through a series of prototype systems.

Knowledge creation applications cater poorly to one very common usage: situations in which the users need material that they do not own and for which they are unwilling to pay. Finding and using externally produced knowledge material is currently a cumbersome process. Often, users locate the content using a search engine, copy it into their work, cross their fingers, and hope they do not infringe on any copyrights. While the authors have shared hundreds of millions of media content with permissive licenses (e.g., Creative Commons licenses), the license terms are too complicated for other users to follow. We therefore introduce an **Open Media Retrieval** model to remedy this problem and supplement it with prototypes that access various legal media sources directly within the creative work flow and provide automatic credits to the original authors. The model integrates searches into the user's creative workflow and automates the attribution process. It treats the remix process as a collection of tightly coupled searches. The media creation application's role is to act as a composing platform through which the user controls how the search results are presented to the audience. Our goal has been to minimize the tasks a user needs to perform to import Creative Commons works into the media creation application. The OMR model reduces the task load from twelve to two tasks: 1) users enter a query and 2) users select a media file to be attached. The second task can be avoided if the system enables the automatic insertion of suggested media from the best-matching search results. Optionally, the user can refine the search to include only certain media sources or search for more media.

The OMR model is independent of the media format that is remixed. Depending on the media format, the content needs to be embedded differently. In our implementation, we focused on CC-licensed images. While Google and Wiki- media Commons provide ways to search CC-licensed content, Flickr is the only service that provides the means for making the required meta-data requests. To evaluate the model, we developed two search functionalities for open content retrieval.

Open Content Ribbon is our implementation of the OMR model for one of the most popular remix platforms: Microsoft PowerPoint. It runs as an add-on, providing a sidebar so the user can perform queries for CC-licensed images. Integrating search and retrieval into PowerPoint saves the user from leaving the program and performing the multiple copy-and-paste tasks. Following the OMR model, the Ribbon can do these tasks automatically, letting the user focus on the choice of keywords and browsing the results. Every time the user inserts an image that the plugin has retrieved into the presentation, the Ribbon automatically adds an attribution to a separate attribution slide to the end of the presentation. **AudioImager** is a video editor that can be used from a web browser. It helps users turn audio files into videos. Users create videos by typing keywords while they listen to the audio file. When a user types a keyword and presses Enter, the application automatically retrieves CC-licensed image that matches the keyword and inserts it on the timeline. After the initial round of insertions, the user can change the images as needed from the selections shown on both sides of the video window. Also the exact transition times of the images are adaptable through image border dragging. When the user chooses to publish the video, the system creates the required attribution information as end credits.

These studies were focused on Creative Commons-licensed image use, but the lessons and the Media Retrieval model apply to other copyrighted media as well.

After addressing the legal issues of knowledge remixing, we have built tools to further support productivity and efficiency of knowledge creation tasks. An example of such end-user tools is **SidePoint**, an add-in for PowerPoint a peripheral panel that shows concise knowledge items relevant to the content of the current slide as it is being created. We source these knowledge items from *NeedleSeek*, which offers semantically relevant facts and descriptive sentences before processing and displaying them in a concise, browsable format. These items can provide value in two ways. The first is directly by left-clicking an item to copy to the notes section of the slide. The second is indirectly through item information-scent: right-clicking on an item loads a Web browser showing literal search results for that item to explore details of the information. Future improvements in knowledge base technologies can directly transfer to interfaces like SidePoint. Using SidePoint as a technology probe, we have shown that peripheral knowledge panels have the potential to satisfy both the *active needs* (that the author is aware of) and the *latent needs* (that she is not aware of until she encounters content of perceived value) in ways that transform presentation authoring for the better.

Recently *crowdsourcing* is becoming a popular approach for completing knowledge works, as there are still a large number of knowledge tasks that current computers cannot do while humans could easily handle. To our best knowledge, most of such systems use paid crowdsourcing model. Which means the task assigners should pay some amount of money to the task workers for completing every piece of work. However, we argue that, for some

types of task, existing social networking sites can potentially provide a free and on-demand knowledge worker pool for a real-time human-powered solution.

In this thesis we introduce **UbiAsk** as an example. UbiAsk a social media crowdsourcing appli- cation built on top of existing social networking infrastructure. UbiAsk provides translation services and situational advice to mobile users in unfamiliar environments. Instead of applying machine algorithms, we draw on the power of ordinary people in the cloud via social networks to solve the difficult computational problems such as image recognition and text translation. Since the workload of each task in the image-based mobile translation/search service is lightweight enough to be described as a micro-task, the tasks are perfectly suitable to be distributed to large groups of casual workers.

In UbiAsk, users can issue requests via several channels that use a common API. Native mobile applications and email are the currently implemented channels. The requested task is pushed to a community of voluntary local experts in the form of an open call via different social media platforms (Twitter, Facebook, etc.) and email. The crowdsourced result data are not only returned to requesters but also visualized on location-based social mapping and augmented reality (AR) platforms (e.g., Sekai Camera and Ushahidi). This gradually results in an information pool that constitutes a public good. To incentivize participants' contribution, we implemented social psychology incentives and game based incentives in the system and compared the performance.

Since the birth of the *Ubiquitous Computing* (UbiComp) vision, one of the key challenges is how to extract context information from the physical environment. Without such information, UbiComp applications cannot provide genuine context-aware services. The ordinary approach is using sensors and sensor net- works. However, the capacity of these machine sensors is still limited to gathering somewhat low-level physical environmental data, e.g., speed, temperature, and pressure, but for context-aware applications, it is important to also have higher-level information, such as local knowledge, human activity, social environments, and so on. We extended the original idea of *Human as Processor* to *Human as Sensor*, where human users of existing social media sites become part of sensor networks and report local information around them using portable devices. Using such an approach, a system can collect information that is difficult (if not impossible) to obtain by machine sensors, thus offering the ability to generate a richer contextual model.

In this thesis, we present **MoboQ**, the location-based real-time question answering service that is built on top of a microblogging platform. In MoboQ, end users can ask location- and time-sensitive questions, such as whether a restaurant is crowded, whether a bank has a long waiting line, or if any tickets are left for an upcoming movie at the local cinema; these are questions that are difficult to answer with ordinary Q&A services. MoboQ analyses the real-time stream of microblogging service Sina Weibo, searches for the Weibo users who are most likely to be at the given location at this moment based on the content of their microblog posts, and pushes the question to those strangers. Note that the answerers in this system are Sina Weibo users, not MoboQ users, and might not even be aware of the existence of MoboQ. This design takes advantage of the popularity and furious growth rate of Weibo, which provides us with the confidence to foresee that microblogging users will be regularly available at any reasonably popular Point-of-Interest (POI) in the near future. The real-time nature of microblogging platforms also makes it possible to expect a faster response time than traditional Q&A systems. To some extent, MoboQ utilizes the strangers on Weibo as local human sensors and allows a question asker to extract context information on any given location by asking the local "human sensors" about what is happening right now around them. To the best of our knowledge, there is no other similar system that has been deployed in the field before; thus, we are the first to evaluate real-world usage of the fundamental concept of *strangersourcing*.

The contribution of this thesis, therefore, is a general way of think about the convergence of Crowd Computing, Social Computing, Open Content, and Big Data for comprehensively supporting seeking, sharing, and creating not only existing re-usable knowledge but also non-existing contextual knowledge. Whereas previous models have not covered a number of the critical user requirements in the era of big data and pervasive computing such as legal issues, serendipity knowledge discovery, knowledge re-purposing, and contextual-oriented knowledge collecting.

The results of the thesis are currently in use by over 100,000 people. Overall these systems point to a future where social web *crowd* and big data in the *cloud* are central elements of personal knowledge management.

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Journal	"Drawing on Mobile Crowds via Social Media" ACM/Springer Multimedia Systems Journal, Volume 18, Issue 1 (2012), Page 53-67 Yefeng Liu, Vili Lehdonvirta, Todorka Alexandrova, and Tatsuo Nakajima. [Impact Factor=1.176] "Autonomous Node Allocation Technology for Assuring Heterogeneous Streaming Service Under the Dynamic Environment" IEICE TRANSACTIONS on Communications Vol.E94-B No.1 (2011), Page 30-36. Xiaodong Lu, Yefeng Liu, Tatsuya Tsuda, Kinji Mori [Impact Factor=0.359]
Conference & Workshop	"Using Stranger as Sensor: Temporal and Geo-sensitive Question Answering via Social Media" The 22nd International World Wide Web Conference (WWW 2013), May 13 - 17, 2013. Yefeng Liu, Todorka Alexandrova, and Tatsuo Nakajima. [15% acceptance rate, Best Student Paper Nominee] "SidePoint: A Peripheral Knowledge Panel for Presentation Slide Authoring" The ACM Conference on Human Factors in Computing Systems (CHI '13), April 27 - May 2, 2013 Yefeng Liu, Darren Edge, and Koji Yatani. [20% acceptance rate] "< Insert Image>: Helping in the Legal Use of Open Images" The ACM Conference on Human Factors in Computing Systems (CHI '12), May 5 – 10, 2012 Herkko Hietanen, Antti Salovaara, Kumaripaba Miyurusara Atukorala, Yefeng Liu. [23% acceptance rate] "Case Study on Crowdsourcing for Serendipity" IEICE Technical Report, Artificial Artificial intelligence and knowledge-based processing, Volume 111, Issue 447 (2012), Page 1-4 Satoshi Hirade, Ping-Hui Lin, Han Chen, Yefeng Liu, Todorka Alexandrova, and Tatsuo Nakajima. "Gamifying Intelligent Environment" Workshop at ACM Multimedia 2011 (ACM MM'11), Nov 28 - Dec 1, 2011. Yefeng Liu, Todorka Alexandrova, and Tatsuo Nakajima. "Mobile Image Search via Local Crowd: a User Study" International Workshop on Cyber-Physical Systems, Networks, and Applications (CPSNA '11), Aug 28th, 2011 Yefeng Liu, Todorka Alexandrova, Vili Lehdonvirta, and Tatsuo Nakajima. "Engaging Socal Media - Case Mobile Crowdsourcing" Workshop at International World Wide Web Conference 2011 (WWW 2011), Mar 28, 2011 Yefeng Liu, Vili Lehdonvirta, Todorka Alexandrova, Ming Liu, and Tatsuo Nakajima.

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Work-in-Progress & Posters	"A Crowdsourcing Based Mobile Image Translation and Knowledge Sharing Service". The 9th International Conference on Mobile and Ubiquitous Multimedia (MUM 2010), Dec 1-3, 2010 Yefeng Liu, Vili Lehdonvirta, Mieke Kleppe, Todorka Alexandrova, Hiroaki Kimura, Tatsuo Nakajima. "Facilitating Natural Flow of Information among 'Taste-based' Groups" The ACM Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA'13), April 27 - May 2, 2013 Yefeng Liu, Todorka Alexandrova, Satoshi Hirade, and Tatsuo Nakajima. [45% acceptance rate] "Achieving Sustainable World base on Micro-level Crowdfunding" The ACM Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA'13), April 27 - May 2, 2013 Mizuki Sakamoto, Tatsuo Nakajima, Yefeng Liu, and Todorka Alexandrova. [45% acceptance rate] "Family Interaction for Responsible Natural Resource Consumption" The ACM Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '12), May 5 – 10, 2012 Francisco Lepe Salazar, Tetsuo Yamabe, Todorka Alexandrova, Yefeng Liu, Tatsuo Nakajima. [32% acceptance rate] "Real-time Crowd Computing using Social Media" Academic Poster Session at 2nd Crowdsourcing Conference (CrowdConf '11), Nov 1 – 2, 2011 Yefeng Liu, Vili Lehdonvirta, Todorka Alexandrova, and Tatsuo Nakajima. "Real-time Crowd Computing" Poster Session at The 8th Global COE International Symposium on Ambient SoC, Jul 1-2, 2011 Yefeng Liu, Vili Lehdonvirta, Todorka Alexandrova and Tatsuo Nakajima [Best Poster Award] "A User Study of Crowd Powered Mobile Image Search" Poster Session at Symposium on Interaction with Smart Artifacts, Bilateral DFG-Symposium between Japan and Germany, Mar 7-9, 2011 Yefeng Liu
Monograph	"Service Composition Workspace - a Semantic Web Approach" ISBN 978-3-639-37740-8, VDM Publishing, Saarbrücken Germany, Aug 24, 2011 Yefeng Liu.

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