CHANG HU | RESEARCH STATEMENT

An enormous potential exists for solving certain classes of computational problems through rich collaboration between humans and computers. Crowd-based systems are able to address more and more complex tasks by generating fine-grained sub-tasks for crowds of workers. However, most crowdsourcing systems do not differentiate between workers to whom the tasks are assigned, assuming that every worker can complete every task. This homogeneous view of workers is limiting when it comes to complex tasks whose potential workers are very few. My research focuses on **computationally enabling collaboration between two crowds with complementary skills**, so that they can solve a new set of problems that neither crowd could address alone. Through my research, I would like to enable a much larger population to help solve hard problems by including those who do not have all the skills needed.

EXISTING RESEARCH

My current research focuses on establishing the feasibility of crowdsourcing with complementary crowds and identifying issues in its application. My dissertation work is on enabling translation among monolingual crowds. Translation by monolingual crowds (people who speak only one language) is a good representative of crowdsourcing with complementary crowds because it is a problem for which 1) automatic solution is progressing but still limited; 2) few people have all the skills to solve; and 3) most people have one skill to contribute. In particular, the state-of-the-art machine translation systems are still far from high quality translation, and while a good part of the world's population is multilingual, people are still effectively monolingual for most of the possible language pairs.

I took an iterative approach in this work. I first established its feasibility through a protocol for monolingual translation, then iterated through several systems that support this protocol, conducting studies with increasingly larger user populations and more realistic scenarios. The research cycle is finished with a real-world system deployment and identification of related issues.

Feasibility of crowdsourcing with complementary crowds

As a first example of crowdsourcing with complementary crowds, the feasibility of monolingual translation is demonstrated by a translation protocol between two monolingual crowds (Figure 1)[1]. This protocol uses a crowd of source language speakers and a crowd of target language speakers interacting through a machine translation channel with limited quality and an additional, annotation channel. The protocol supports various annotations, enabling the two crowds of monolingual speakers to iteratively improve translation quality via a form of negotiation. It creates a feedback loop between the two complementary crowds. For either side, the human task is to: 1) infer the intended meaning to the extent possible given all the information available; 2) correct the text to produce a grammatical sentence in one's own language conveying that meaning; and 3) use the interface to provide feedback to users on the other side. The goal state is for the source language speaker, looking at the latest back-translation, to be sufficiently confident that the originating candidate translation contains the correct meaning. Since candidate translations in the target language are typically fluent and grammatically correct (by definition of the target speakers' task), it therefore constitutes a valid translation and the task is complete.

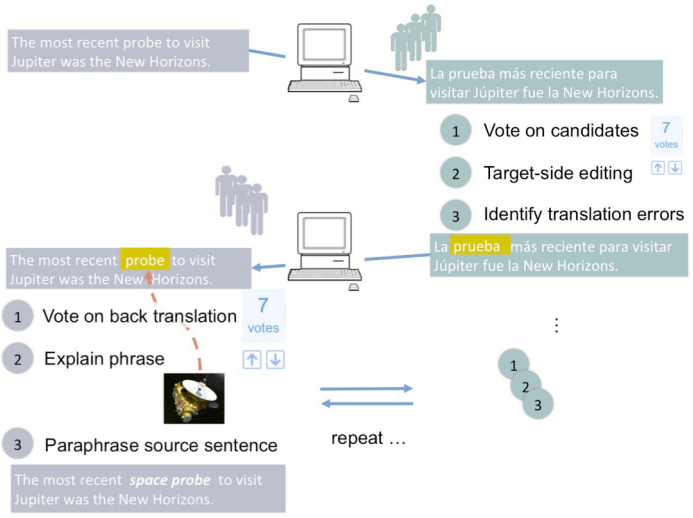

Figure 1. Illustration of the MonoTrans iterative protocol translating an English sentence into Spanish between two crowds of monolingual people

I built a web-based system called MonoTrans[1][2] (Figure 2, left) to test this monolingual translation protocol. In an experiment translating children's books, MonoTrans was able to substantially close the gap between machine translation and human bilingual translations. The percentage of sentences rated highly fluent and accurate by native bilingual evaluators increased from 10% for machine translation output to 68% for MonoTrans. Further analysis shows that by encouraging and enhancing communication between two complementary crowds, MonoTrans was able to convey the original meaning across the language barrier. This not only establishes the feasibility of complementary crowdsourcing, but also has vast implications for the ways in which it can be performed. It shows that a feedback loop along with iterative improving can enhance knowledge transfer from one crowd into the other, and is therefore an effective way for complementary crowdsourcing.

Real-world issues of working with complementary crowds

I am also interested in the issues related to design and deployment when working with two or more complementary crowds. I attempted to identify these issues through two monolingual translation studies enabled by the monolingual translation protocol.

Simulated Scenario: Translating Haitian Creole SMS. I applied MonoTrans to translating

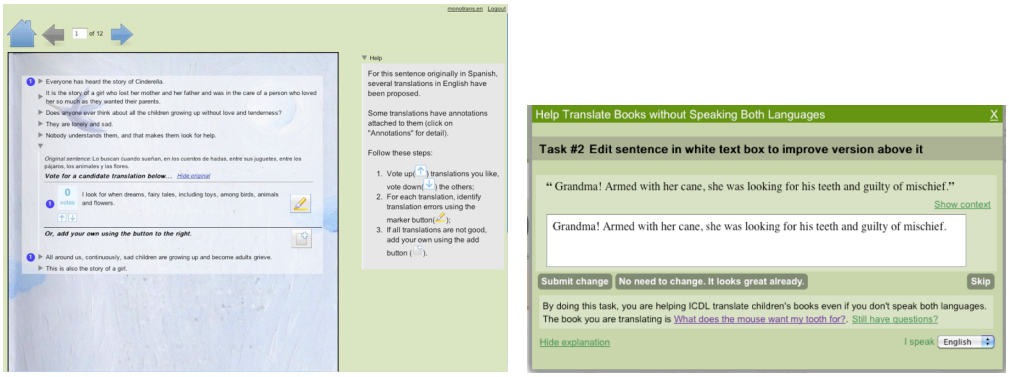

Figure 2. Left: MonoTrans website UI showing a book page being translated; Right: One of the MonoTrans Widgets deployed on ICDL showing a short editing task for target-side monolingual English user.

text messages (SMS) generated after the 2010 Haitian earthquake[4]. Although the translation took place well after the actual event, the robustness and effectiveness of MonoTrans was put to test with monolingual Haitian Creole speakers recruited directly from Haiti (who were also less versed with and had limited access to computer technology). Although the material, the workers and the workers' access to technology were vastly different from previous experiments (with children's books and workers in the United States), MonoTrans still obtained highly improved translation results over machine translation (from 25% to 40%).

Real-world Scenario: MonoTrans Widgets "in the Wild". I designed and built MonoTrans Widgets[3] (Figure 2, right), a set of small, embedded web pages with short monolingual tasks tailored for casual web users. MonoTrans Widgets are deployed on every book reading page on the International Children's Digital Library website (for example, at bit.ly/monotrans_widget), where the MonoTrans Widgets received hundreds of daily submissions. MonoTrans Widgets obtained much improvement over pure machine translation (from 31% to 52%).

The MonoTrans Widgets system is the first attempt to deploy a crowd-sourcing system that draws expertise from multiple different crowds "in the wild". Deploying MonoTrans Widgets live on ICDL allows us to identify several design issues that are unique about drawing from multiple crowds with different skills.

FUTURE RESEARCH

It is an increasingly important research problem to **support large crowds with computation so that they can solve complex problems neither humans nor computers can solve alone**, and this is my main research interest. My research agenda will contribute to its solution in the following ways:

Extend and study MonoTrans: As an immediate plan, I would like to continue my research on MonoTrans by adding new translation tasks, studying the effect of different tasks on translation quality, and translating a wider range of materials among more languages.

Study new designs for crowdsourcing systems: I would like to explore a general protocol to enable collaboration between different crowds. Although tasks in monolingual translaiton were designed specifically for translation, the basic idea behind (and beyond) monolingual translation is that crowds can be linked together by a feedback loop, and that the communication between crowds can enable them to complete more complex tasks or to increase output quality. This idea can easily be applied to domains besides translation. For example, in a system that employs seeing people to provide photo-to-text recognition for visually impaired people, simple feedback such as whether text is well positioned in the photo can greatly improve the recognition results. In fact, in every crowdsourcing system where there is a crowd of end-users, it is possible to introduce a feedback loop and apply a design similar to the iterative protocol in monolingual translation.

This new design opens up an interesting opportunity for crowdsourcing systems: tasks are no longer dependent on a single crowd of workers with certain skill. On the other hand, it also poses several new problems such as coordinating between multiple crowds. MonoTrans Widgets represent some attempt to solve these problems (for example through task prioritization based on crowd size), and I would like to continue my research in this direction.

Study the fostering of crowds with new skills: Crowdsourcing with complementary crowds initiates collaboration between two crowds to generate new knowledge and is therefore possible to foster a new crowd: experts who have skills from both previous crowds. For example, by allowing two monolingual crowds to interact, it is possible to help some monolingual users to learn the other language and become bilingual. It is also possible to create a community of such experts (for example, adding monolingual users to the existing body of ICDL volunteer translators). By extending beyond my research on monolingual translation, I would like to study how collaboration between crowds with different skills can be used to foster a new crowd with new skill sets.

In the long term, I am well positioned to work on a range of problems that combine human and computer effort. While standalone AI is a laudable goal, the only way to get excellent results for many real-life problems is to combine human effort with the best that automated systems have to offer. My experience enables me to pursue a range of these kinds of explorations.

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[1] Full publication list available upon request