Research Overview Yan Chen

My research aims to leverage human computation and machine intelligence to effectively solve complex tasks that require domain expertise, such as software development, program synthesis, and crisis informatics. My research approaches are a) to study challenges and identify types of the problems that users face with existing tools and methods [2], b) to build computational systems that users can efficiently get assistance via direct collaboration with the crowd [1] and hybrid intelligence of the crowd and the machine [3]. My research goal is to help users effectively solve problems with the assistance of interactive systems that can transfer domain knowledge from other human and artificial intelligence. Not only is this important in enhancing the individual and team productivities in conducting tasks, but also the findings from my work can be generalized to the development of intelligent systems that will benefit people from how experienced users better understand the world in various contexts.

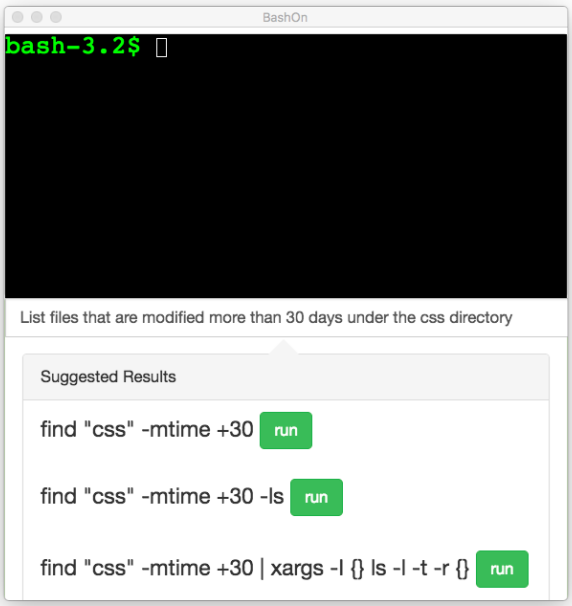
On-demand Expert Support for Software Development

Motivational Studies: To improve the productivities of programmers, I first created a new programming support paradigm for developers -- on-demand expert support for software development [5] -- to address the lack of personalized support provided by existing tools like Stack Overflow. I conducted multiple motivational studies [2] which provided strong evidence for a variety of issues with current technologies, such as frequent interruption of developers' workflow and lack of code context for mutual understanding, and also highlighted substantial opportunities and challenges for this new support paradigm. The design features I drew from this line of research not only helped to inform future systems for programming support, but also shed light on important questions about how to best support collaboration, communication, and coordination in a variety of domains.

Interactive System: Driven by these opportunities, I developed a collaborative programming support tool called Codeon [1] to instantiate the on-demand expert support paradigm. Codeon enables more effective task hand-off between developers and remote helpers by allowing asynchronous responses to on-demand requests. One key objective of Codeon was to minimize developers' effort to complete their coding tasks by providing them nearly real-time personalized support and enabling them to control their own workflow by deciding when they want to interact with helpers. Another important aim was to create an approachable user interface to simulate an ideal programming support scenario in practice--one in which a developer can ask a question to a co-located helper simply by speaking and pointing to content on the screen. Codeon was tested via a series of validation tests exploring the tradeoffs among understandability, speed, and accuracy of each technique for different system components [4]. For example, Codeon supports voice requests, and the request audio recording is synchronized with developers' interactions within the editor (e.g., highlighting, scrolling, file switching) and can be replayed in the helper's interface. The multimedia request jointly embodies the dynamics of voice signals and the visual content references, providing a rich, natural context for communication. My approach proved successful in the domain of software development, but can be generalized to

many other areas like graphic design or UI prototypes that exist novel challenges in finding dependencies, conflicts, and content relationships.

A Hybrid Workflow for Program Synthesis



While appreciating the power of human computation, I realized the recent advance in machine learning has been pushing forward the development in many areas. I started to investigate the strength of human and machine intelligence in solving complex tasks, including programming and scripting, and sought to better coordinate human and machine intellect to problem solving in a more efficient, coordinated manner. I first explored program synthesis, examining the performance of existing methods, and investigating the competency of unskilled crowd workers from platforms such as Amazon Mechanical Turk in a variety of microtasks in this domain (e.g., parsing natural language requests for Bash commands). I then developed a hybrid workflow to augment a recurrent neural network (RNN) for program synthesis using human intelligence. The workflow is of a mix between crowd-powered and machine learning supported components, resulting from our in-depth analysis and comparison of multiple combinations of these components. BashOn [3] is a system that I built to instantiate this workflow. It interleaves the effort of crowd workers and RNN to translate natural language queries to Bash commands. The performance evaluation revealed that the joined effort of human and machine intelligence yields significantly higher accuracy than the RNN technique performances alone (30%). This promising result opens many new opportunities to explore problems in a multitude of areas like information retrieval or data analysis using the same approach.

Current Project: Workflows for Crisis Video Data Analysis

Now, continuing in the vein of hybrid intelligence workflows, I am exploring ways to programmatically support video data analysis for experts through conversational interactions for crisis response. Video and image sharing on social media sites can play a vital role in spreading information during crisis events, but the volume and speed of new posted content during crises tend to be extremely high, making it hard for disaster-affected communities and professional emergency responders (experts) to process the information in a timely manner. Furthermore, posts tend to vary highly regarding content and usefulness; they vary from being entirely

off-topic or personal in nature to containing critical information that augments situational awareness. I am examining the following questions:

- How to create a conversational (or like) system for real time crisis data analysis for experts with the high volume and speed, crowd-generated, live streaming video?

- How to extract the structure in the queries from conversations, like inner dependency, to form formal database search query (or task)?

- How to retrieve information from the video data?

- How to annotate the video data in response to those queries?

- How to better guide the crowd or develop techniques in iteration on the original queries by creating new constraints or surprising findings?

The outcome of my research will be cross-domain knowledge that can be generalized, as my findings have been in the past, across several domains including programming support, and program synthesis. The commonality is that these tasks require users with domain knowledge, and the existing support or tools are still far reliable. Thus, my response to addressing these problems is exploring and developing workflows and tools that support collaboration and coordination by better utilizing human expertise and machine intelligence. The validation process of the outcome will be carefully conducted considering academic disciplines of human computer interactions, crowd-sourcing, and CSCW, as I recognize that approaches to complex cannot be justified only by efficiency. I hope use my interdisciplinary research background to contribute to broader research domains by transforming ways in which people interact with each other and computer systems.

References

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