

**Efficient and Flexible Crowd sourcing of Specialized Tasks with Precedence Constraints**

**Abstract:**

Many companies now use crowdsourcing to leverage external (as well as internal) crowds to perform specialized work, and so methods of improving efficiency are critical. Tasks in crowdsourcing systems with specialized work have multiple steps and each step requires multiple skills. Steps may have different flexibilities in terms of obtaining service from one or multiple agents, due to varying levels of dependency among parts of steps. Steps of a task may have precedence constraints among them. Moreover, there are variations in loads of different types of tasks requiring different skill-sets and availabilities of different types of agents with different skill-sets. Considering these constraints together necessitates the design of novel schemes to allocate steps to agents. In addition, large crowdsourcing systems require allocation schemes that are simple, fast, decentralized and offer customers (task requesters) the freedom to choose agents. In this work we study the performance limits of such crowdsourcing systems and propose efficient allocation schemes that provably meet the performance limits under these additional requirements. We demonstrate our algorithms on data from a crowdsourcing platform run by a non-profit company and show significant improvements over current practice.

**Existing System:**

To servers is a central problem in computer science, communication networks, and operations research. The skill-based crowdsourcing setting, however, poses new challenges for task allocation in terms of vector-valued service requirements, random and time-varying resource (agents) availability, large system size, a need for simple decentralized schemes requiring minimal actions from the platform provider, and the freedom of customers (task requesters) to choose agents without compromising system performance. Some of these issues have been addressed in recent work but previous work does not address precedence constraints or step flexibility. Task allocation with precedence constraints has been studied in theoretical computer science, as follows. Given

several tasks, precedence constraints among them, and one or more machines (either same or different speed), allocate tasks to minimize the weighted sum of completion times or maximum completion time. In crowdsourcing, we have a stream of tasks arriving over time and so we are interested in dynamics.

**Proposed System:**

Dynamic task allocation with precedence constraints has recently been studied in for Bernoulli task arrivals. This is different from crowdsourcing scenarios, and the optimal scheme is required to search over the set of possible allocations, which is not suitable for crowdsourcing systems due to their inherent high-dimensionality (many types of tasks). Additional challenges in a crowdsourcing platform are: (i) random and time-varying agent availability; (ii) vector-valued service requirements; (iii) fast computation requirements for scaling; and (iv) freedom of choice for customers.