

Selling Multiple Items via Social Networks [AAMAS'18]

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Auction Items via Social Networks without Advertising

- **SETTING:** Consider a seller sells multiple units of a commodity in a social network. Each node/buyer in the social network can only directly communicate with her neighbours. Initially, the seller is not aware of the whole network.
- **QUESTION:** Without advertising via third party platforms such as newspapers or search engines, **how could the seller sell the items to EVERYONE in the social network?**
- **ASSUMPTIONS:**
 - Every agent in the social network demands at most one item.
 - Every agent has a private valuation on the items.
 - Every agent owns a private neighbour set to whom she can share information.
- **CHALLENGE:** Design auctions that not only incentivize all agents in the social network to **share the sale information** to all their neighbours, but also improve both the **allocation efficiency** and the **seller's revenue** compared with holding an auction among the seller's neighbours only.

Selling one item in the social network [Li et al. AAAI'17]

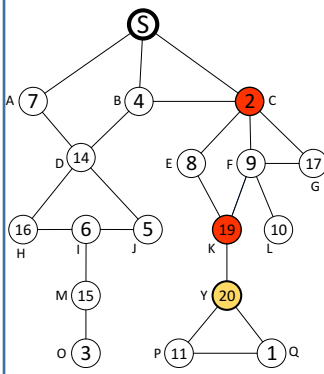


Fig. 1: An instance of social network

Information Diffusion Mechanism

- Identify the buyer with the highest valuation, denoted by m .
- Find m 's critical diffusion sequence $C_m = \{C, K, Y\}$.
- Allocate the item to the first buyer i in C_m whose bid is the highest bid when diffusion critical node $i+1$ does not participate in the auction.
- The winner w pays the highest bid without her participation.
- Each buyer in $C_w \setminus w$ is rewarded the payment increase (not social welfare increase) due to her diffusion action.

Theorem [Li et al.]: IDM is incentive compatible (i.e. reporting valuations truthfully and sharing sale information to all neighbours is a dominant strategy) and individually rational. The revenue of the seller given by IDM is at least the revenue given by VCG among the seller's neighbours only.

Our Contribution: Generalize IDM for K items

Generalized Information Diffusion Mechanism

- Identify the **optimal allocation tree** based on the reported data.
- **Allocation Policy:** The allocation is done with a DFS-like procedure in the optimal allocation tree. Initially the seller gives w_i (no of winners in the efficient allocation under i 's subgraph) items to each i in **Children(s)**. Repeat the allocation process defined in the following until all items are allocated.
 1. Let Q be a (LIFO) stack, initially $Q = \text{Children}(s)$. Remove a node i from Q , add i to winner set W if i receives an item when **some** of her children don't participate.
 2. Update every w_i according to allocated items.
 3. For each child j of i , if $w_j > 0$, give w_j items to j and add j into Q .
- **Payment Policy:** For all $i \in N$, her payment is:

$$\begin{cases} SW_{-D_i} - (SW_{-C_i} - v_i) & \text{if } i \in W, \\ SW_{-D_i} - SW_{-C_i} & \text{if } i \in \bigcup_{j \in \mathcal{P}_i} P_j \setminus W, \\ 0 & \text{otherwise.} \end{cases}$$

where SW_{-x} denotes the feasible maximum social welfare when allocating K items among agents of $-x$. The set $-D_i$ and $-C_i$ are carefully designed for achieving desirable properties.

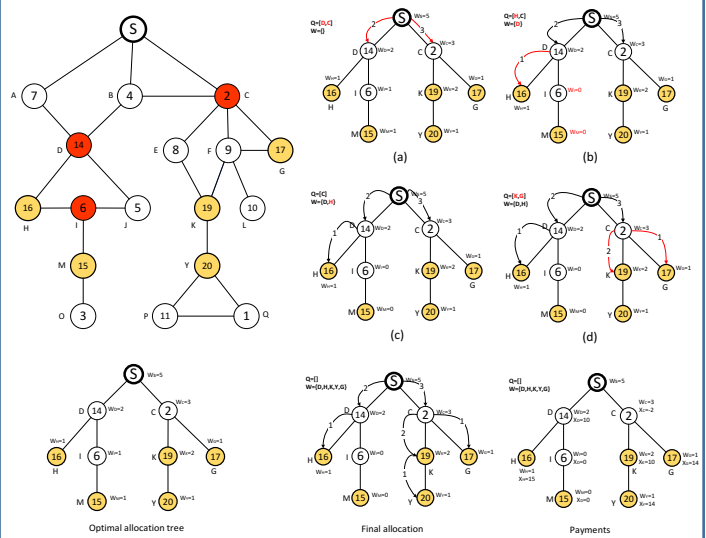


Fig. 2: A running example for selling 5 items

Theorem: The generalized information diffusion mechanism is individually rational and incentive compatible. The revenue of the generalized information diffusion mechanism is greater than or equal to $K \times v_{K+1}$, where v_{K+1} is the $(K+1)$ -th largest valuation report among seller's neighbours.

The Key Literature

- [1] Dengji Zhao, Bin Li, Junping Xu, Dong Hao, Nick Jennings. **Selling Multiple Items via Social Networks**. AAMAS 2018.
- [2] Bin Li, Dong Hao, Dengji Zhao, and Tao Zhou. **Mechanism design in social networks**. AAAI 2017.
- [3] Bin Li, Dong Hao, Dengji Zhao, Tao Zhou. **Customer Sharing in Economic Networks with Costs**. IJCAI-ECAI 2018.
- [4] Galen Pickard, Wei Pan, Iyad Rahwan, Manuel Cebrian, Riley Crane, Anmol Madan, and Alex Pentland. Time-critical social mobilization. *Science*, 334(6055):509-512, 2011.
- [5] Roger B Myerson. 1981. Optimal auction design. *Mathematics of Operations Research* 6, 1 (1981), 58-73