CAP6671 Intelligent Systems

Lecture 6:

Trading Agent Competition (Part 1)

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Schedule: T & Th 9:00-10:15am

Location: HEC 302
Office Hours (in HEC 232):
T & Th 10:30am-12

Why have TAC?

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- Standardize research problem
- “Shopping agents” are a useful class of personal assistant agents
- Auctions are a good decentralized mechanism for maximizing group utility

What are the research problems?

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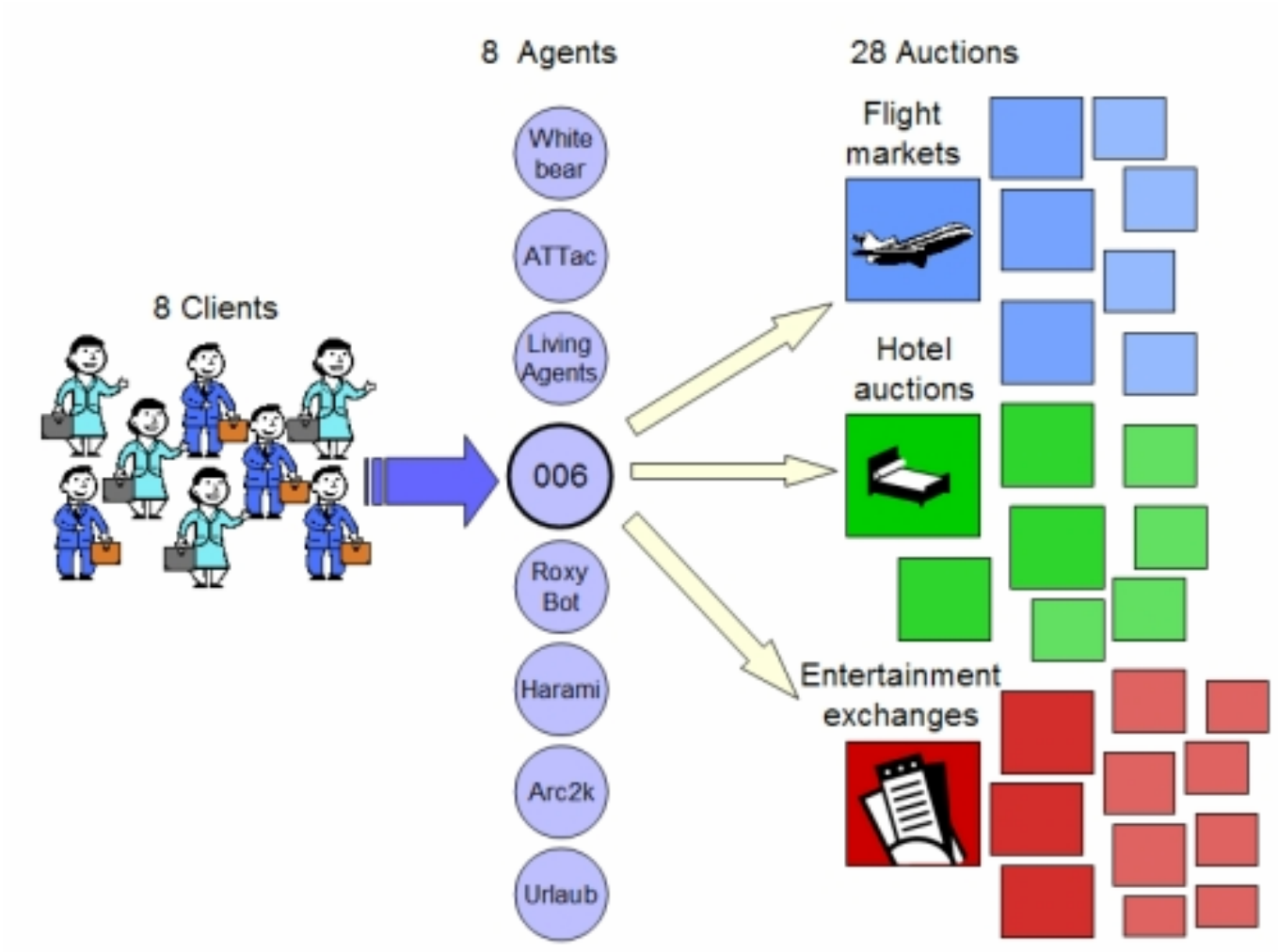
- Rapid optimization/search
- Auction bidding strategies
- Prediction
- Agent allocation
- Planning under uncertainty (see next paper)
- Learning models from past data
- Adversarial strategies

History of TAC

- First competition was in 2001, organized by Michael Wellman
- Competitions are often held at AAAI or AAMAS
- 3 types of competition
  - TAC Classic: agents act as personal travel agents for a group of clients and attempt to maximize their clients utilities
  - TAC Supply Chain Management: agents manufacture PCs, win customer orders, procure components
  - TAC Market Design: reverse problem in which the organizers provide the agents and the competitors design markets

Competition Rules



Game Design

- Game:
  - 8 agents competing in ~15 minute games
  - Agents are simulated travel agents with 8 clients
  - Client needs to travel from TACtown to Boston and home again in a 5 day period
- Auctions for flight, hotels, and entertainment ticket
  - Server maintains markets, sends prices to agents
  - Agents sends bids to server over network (must be able to cope with network issues)

28 Simultaneous Auctions

- Flights: Inflight days 1-4, Outflight days 2-5 (8)
  - Unlimited supply; immediate clear; no resale
- Hotels: 2 different hotels for days 1-4 (8)
  - 16 rooms per auction; 16th price ascending English auction; no resale
  - Due to delayed bidding, it reduces to m-price sealed bid auction
  - Random auction closes minutes 4-11
- Entertainment:
  - Continuous double auction (no trading phases, prices to buy and sell may be submitted at any time
  - Resale allowed

Client Preferences

- Preferences: randomly generated per client
  - Ideal arrival, departure days
  - Good hotel value
  - Entertainment values

Agent Design

- Bidding: offering payments for goods to gain utility
- Allocating: Constructing travel packages for each of the 8 clients
- After auctions close, agents have 4 minutes to report allocations of goods to clients.
- Score: difference between summed clients utilities and agents expenditure

Game Structure

1. Get market prices from server
2. Decide on what goods to bid
3. Decide at prices
4. Decide for how many to bid
5. Decide at what time to bid

UNTIL game over

Allocate goods to clients

Bidding Strategies

- Hotel auction
  - Hotel rooms are limited resource
  - Refrain from bidding early unless the auction seems near to closing
  - One strategy:
    - Treat current holdings as sunk costs and calculate the utility of an unsecured hotel room reservation as the utility of the package (marginal utility)
    - Bid this utility—due to the structure of the m-unit auction the agent will pay less than the closing price

Bidding Strategies

- Flight auction
  - Delay bidding on flights until end of game
  - In future versions of the competition the prices increased towards end of the game which made bidding earlier more advantageous
  - Account for unpredictable network and server delays to make sure bid is received before the game is over
  - Bid at maximum price to make sure that bids were not rejected because of information delays resulting from network asynchrony

Bidding Strategies

- Entertainment auction:
  - Focus on obtaining complete packages or
  - Separate the problem into calculating travel packages and entertainment packages separately and solving greedily
  - Greedy strategy has problems:
    - If client doesn't have ticket to event then better to extend client stay when utility gain exceeds cost of ticket plus hotel plus travel penalities
    - Similarly it can be better to shorten stay and sell off tickets.

Results from 2000 TAC Competition

1. ATTac (P. Stone)
2. Roxybot (J. Boyan and A. Greenwald)
3. Aster (InterTrust Research Lab)
4. UMBCTAC (UMBC)

How would you tackle the problem?

ATTac

- Bidding:
  - Calculate G* (most profitable allocation of goods to clients based on current holdings and predicted future prices) for use in bidding
  - Buy/sell bids for entertainment based on a sliding price strategy (dependent on time till end of game)
- Allocation:
  - Uses MILP to find optimal allocation
- Online adaptation to game conditions:
  - Passive/active bidding modes based on server latency
  - Allocation strategy based on time required for MILP
  - Hotel bidding based on closing prices in previous games

RoxyBot

- Allocation
  - Using an A* search with admissible heuristic or variable-width beam search
- Completer
  - Optimal quantity of resources to buy and sell using priceline structure to forecast future costs
  - Pricelines are learned using ML techniques (whereas ATTac uses heuristics to estimate future prices)

Aster

- Heuristic bidding and locally optimal search for final allocation
- Bidding:
  - Delay precommit phase
  - Bid for consecutive nights
  - Calculate utility of other agents when doing entertainment bids

UMBCTAC

- Allocation:
  - Consider agent itineraries individually rather than solving 8 client optimization problem
  - Switch itineraries often early on and then avoid switching itineraries late in game
- Bidding
  - Flights: bid maximum price
  - Hotels: bid current price plus a price increment based on past transactions
  - Entertainment:
    - Buy tickets if client is in town that night at market value
    - Sell tickets at average of preference values

Observations

- No incentive to buy airline tickets (early)
- Hotel auctions were effectively sealed-bid
- Only limited activity in entertainment auction
- Difficult to observe bidding pattern of individual agents

Research Problems in 2000 TAC

- How to estimate utility of current holdings
- How to calculate future prices
- How/when to bid
- Calculating final optimal allocation within time limits

Homework

- Reading: A. Greenwald and J. Boyan, Bidding under Uncertainty: Theory and Experiments, Proc of UAI