TAC Ad Exchange Game
The Case for Mediating Industry and Research Interplay

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Google

Disclaimer: The opinions expressed herein are my own and not necessarily those of my employer(s).
Agenda

TAC

AdX

Next?
Simulation Games and TAC

Classic
2002

SCM
2003

Ad Auctions
2009

PowerTAC
2011

Ad Exchange
2014

Travel Agents
Manufacturers
Merchants
Brokers
Ad Networks

Abstraction (Simulation) : Controlled, Repeatable, Transparent

What are the essential elements of a strategy, a setting?

How Good is an algorithm?
For Example... TAC AA
1. Applicability: Robustness [HSM’13]

2. Identify agents: behavioral attributes

3. Diminishing importance of modeling accuracy
Agenda

AdX
The evolution of the display-ad advertising industry

Return, Efficiency
Access
Targeting
Adaptability

Yield, Cost
Liquidity
Demand
Price
The AdX Setting

**Contract:** Reach Target Audience

**Win Advertising Campaign Contracts:** Budget, Quality

**Execute Campaigns By Bidding at AdX**

**Matched Targeted Audience And Requested Reach:** Quality Rating

**Audience Attributes:** Age, Gender, Income..
AdX Game Setting: The Ad Network Problem

Interest Mechanisms:
- Value of user classification service (cookie matching)
- Publisher’s reserve price
- Quality rating
- Campaign allocation
- RTB @ AdX

Target of competing Ad Network: Maximize total net earnings
Tradeoff: Short term vs. Long term
The Ad Network Decisions

Real Time

Advertiser Allocation Allocation Allocation

AdN

Impression Opportunity

Web site

AdX

Periodically

Advertiser

Reach Target

Contract Opportunity

AdN

Bid

Bid (budget)

UCS
The AdX Game

Based on SICS/TAC-Ad Auctions:
Similar “Look and Feel”: Server / Competing Agents, Simulated user population, 60 Days, Daily Reports and Decisions.
AdX Game Flow

Legend:
- Only day 0
- Starting day 2
- Starting day 1

1. Ad Network
2. Initial Campaign (1)
3. Campaign Report (n-1)
4. Daily Notification (n+1)
5. Campaign Opportunity (n+2)
6. AdNet Bids (n+2)
7. Bank, Publisher, AdNet Reports (n-1)
8. Strategy
9. Simulate (n)
10. Simulation Status
11. AdX Bid Bundle (n+1)

Game Server
Mechanisms

AdNet Quality Rating, Contract Auction
Max/Min Budget Quality Squash

User Classification Service
Value Discovery through Auction

AdX Real-Time Second-Price Auction
Bid Bundle Proxy

Publisher Reserve Price Optimization

User Population Simulation
Real Web sites Statistics
Users

Attributes

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Segments

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Contract

Target Audience:
Segments of level 1, 2, or 3:
Y   OL   YFH

Bid Bundle Entries

Web Site, Segment → Bid, Contract, Weight

Campaign Execution Quality

AdNet Revenue, Quality:
Contract Reach (Target Audience) Vs Actual
There Is (Much) More..

Relative Popularity

Reserve Price Optimization

Ad Types: Video, Text

Access Device: Desktop, Mobile

Repeated Visits

Unique Impressions

AdX
Bid Bundle

Daily Limits: Impressions, Budget

Contract Allocation:
Random, Bid Range Restrictions
The AdNet Problem

\[
\max_X \sum_{i=1}^{m} u_i(r_i) - \sum_{j=1}^{n} c(p_j)
\]

subject to

\[
\sum_{j=1}^{n} x_{ij} a_{ij} = r_i, \quad i \in \{1, \ldots, m\}
\]
\[
\sum_{i=1}^{m} x_{ij} = p_j, \quad j \in \{1, \ldots, n\}
\]
\[
p_j \leq 1, \quad j \in \{1, \ldots, n\}
\]
\[
x_{ij} \geq 0, \quad j \in \{1, \ldots, n\}, i \in \{1, \ldots, m\}
\]

Given cost and utility functions, and relevance of each impressions opportunity – Decide allocation

Related Models:
- Publishers Problem [BFMM’11]
- AdWords Problem [DH’09]
- Online Stochastic Packing [FKMS’10]

Related Decisions:
- Reserve price, contract allocation
- Allocation to budget-constrained bidders
AdX Game – In Practice

Yearly Workshops

- Undergrad teams
- Agents Repository - Top performers take part in TAC-AdX
- Concluding Competition
- Project reports

TAC-AdX

- 2014 – AAMAS Report by Champion
- 2015 – Technical University of Crete, Brown University, University of Edinburgh, and Tel-Aviv University

Insights

- Agent Strategies
- ’AdNet Problem’ – still open?!
AdX Game – In Practice..
Scores for finals2016 (game 132 - 171) at localhost

**Competition started at 2016-07-10 12:00:00 and ends at 2016-07-10 21:55:00.**

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AdX Game – In Practice..
Quality Rating is Crucial:
Phases: Opening/Mid/End-Game

UCS:
• Winner’s Curse.
• Fierce competition at ‘Must Win’ first days.
• Zero if no contracts.
• Learn (from logs) winning price for required level.
• Lower on last days.
• Adjusted to contract fulfillment levels
• Adjusted to targeted segment size (‘unknown’ risk)

AdX – Impressions prices:
• Estimate competition level
• Learn price as function of popularity and time-lapse [TWC’15]
• Adjust to contract fulfilment levels.
• Metric: Bid/price variance
AdX Insights - Contract Allocation

Rating:
Updated upon contract completion.
Used to squash bids and determines bids range.

Random allocation: Allow recovery

Related Agents’ Strategies:

• **Learn winning prices** (based on campaign attributes)
• **Regularized bid** – by outstanding won campaigns
• **Maintain ‘desperate’ levels** – Update upon non-random result [TWC’15]
• **Bid low if not-profitable** (rely on random).
• **Small reach campaigns** are easy opportunities to improve rating.
Insight [ANL’15] - Bidding high increases reserve prices

Research:
[CGM’13] Regret Minimization, Censored Info
[MM’16] Contextual (User Attributes), Full Info

Train/Learn:
\[ r(x) = Wx \quad \text{using } \{(x, b_1, b_2)\}: \quad W = \arg \min \ Revenue(r) \]

New in TAC-AdX 2016: One of Original/None/[MM’16]
Convergence !?
Publisher’s Revenue !?
A New Era

Trading Agent Competition

A New Era – (User) Agents

**TAC-AdAuctions**
Merchants

**PowerTAC**
Energy Brokers

**TAC-AdX**
Ad Networks

**New Challenges**
- Scale of Strategic Entities
- Distributed Presence

**New/Relevant Applications**
- Shopping
- Negotiation
- Choice/Elections
- Navigation
- Health Care
- Trust/Security
- Financials/Banking
- *Personal Assistant*

**Simulated**

**Strategic**

**TAC-???”**
Avatar/Bot/’Thing’
A New Era - Trading

Valuable, Tradeable Assets (What we.. Sense/Are/Know)
• Sensors
• Identity, Habits
• Information, Knowledge

Multiple Objectives!

New Challenge(s)
• Heterogeneous Marketplace

New/Relevant Applications
• Shopping
• Negotiation
• Choice/Elections
• Navigation
• Health Care
• Trust/Security
• Financials/Banking
• Personal Assistant

Implicit ➔ Explicit

Tradeable Training Data!

ML:
Truly Democratized
Coopetition

Infinitesimal value of a data point vs value of aggregated data
• Pooling as alternative to mediators/platforms

Collaboration models
• IoT/Bots
Summary

TAC As a Test-bed/Platform
- Insights from AdAuctions
- AdX Game

Next Gen TAC
- Enter the **Strategic User**-agent
- Data **Explicitly** Traded
- **Coopetition**
- Myriad relevant applications

AdX Insights
- AdNet Problem still open
- Reserve Price Optimization
- Winning strategies
References

• A Model-Free Approach for a TAC-AA Trading Agent. [Schain, Hertz, Mansour 2013]
• An Empirical Study of Trading Agent Robustness [Hertz, Schain, Mansour 2013]
• Ad Exchange - Proposal for a New Trading Agent Competition Game [Schain, Mansour 2013].
• Internet Advertising and the Generalized Second Price Auction [Edelman, Ostrovsky, Schwarz, 2007]
• Ad Exchange: Research Issues [Muthukrishnan, 2009]
• The Design of Advertising Exchanges [McAfee, 2011]
• Yield Optimization of Display Advertising with Ad Exchange [Balseito, Feldman, Mirrokni, Muthukrishnan, 2011]
• Improving the Effectiveness of Time-Based Display Advertising [Goldstein, McAfee, Suri 2012]
• To match or not to match: Economics of cookie matching in online advertising [Ghosh, Mahdian, McAfee, Vassilvitskii, 2012]
• TAC AdX’14: Autonomous Agents for Realtime Ad Exchange [Tao, Wu, Chen 2015]
• Learning Algorithms for Second-Price Auctions with Reserve [Munos Medina, Mohri 2016]
• Regret minimization for reserve prices in second-price auctions [Cesa-Bianchi, Gentile, Mansour 2013]
• Online Stochastic Packing Applied to Display Ad Allocation [Feldman, Henzinger, Korula, Mirrokni, Stein 2010]
• The adwords problem: online keyword matching with budgeted bidders under random permutations [Devanur, Hayes 2009]