Discussion: AI and Market Design

Matt Taddy – UChicago and Microsoft

Milgrom: ML Auction Optimization

Market/ Auction structure is given, but impractical to solve.

You can replace VCG with a heuristic clock auction, but this requires checking feasibility of solutions during the auction. This is hard!

Use ML to tune a suite of fast algorithms for checking feasibility

e.g., Bayesian Optimization

- Define the loss to minimize (time required for feasibility check)
- Use ML regression (RFs) to predict loss surface from tuning inputs
- Choose new inputs *x* to maximize 'expected improvement'

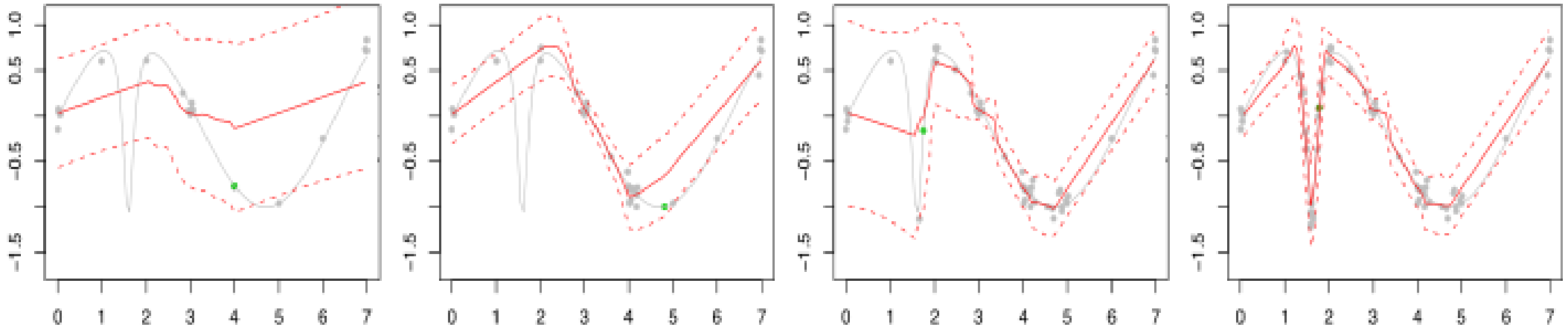
Then run your auction with the super tuned feasibility checker and grin

Bayesian Optimization

You want to minimize $f(x)$, with current 'best' f_{min}

Choose x_{new} to maximize *expected improvement*:

$$I(x) = \max \{f_0 - f(x), 0\}$$



What is AI?

Domain Structure + Data Generation + Fast ML

Domain Structure	Data Generation	Fast ML
Economic Theory	Reinforcement Learning	Deep Neural Nets
Structural Econometrics	Sensor Networks	Fast/Cheap/OOTB
Relaxations and Heuristics	Simulation/GANs	Video/Audio/Text

Self-training structures of ML predictors that automate and accelerate human tasks

Optimal Auctions through Deep Learning*

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$$u_i(v_i, b) = v_i(g_i(b)) - p_i(b)$$

$$u(v) = \sum_{j=1}^{m} g_j(v)\, v_j - p(v).$$

$$rgt_i(g,p) = \mathbf{E}_{v\sim F}\big[\max_{v_i' \in V_i} u_i(v_i', v_{-i}) - u_i(v_i, v_{-i})\big]$$

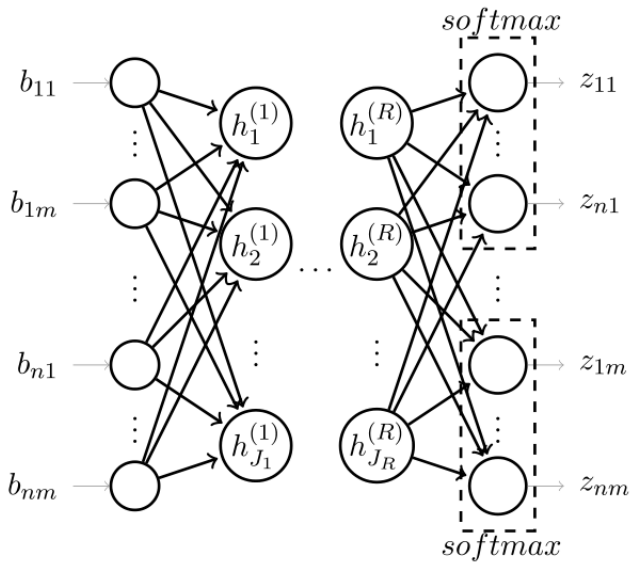
$$irp_i(g,p) = \mathbf{E}_{v\sim F}\big[\max\{0, -u_i(v)\}\big]$$

$$\mathcal{L}(g,p) = -\mathbf{E}_{v\sim F}\left[\sum_{i=1}^{n} p_i(v)\right]$$

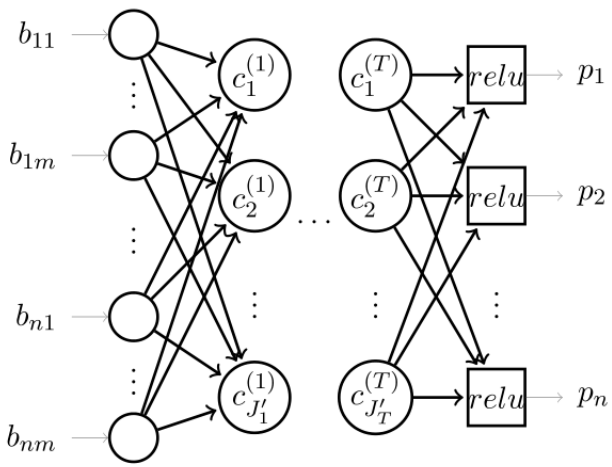
$$\min_{(g,p)\in\mathcal{M}} \mathcal{L}(g,p)$$

$$\text{s.t.}[\text{IC}] \quad rgt_i(g,p) = 0, \quad \forall i \in N,$$

$$[\text{IR}] \quad irp_i(g,p) = 0, \quad \forall i \in N.$$



(a) Allocation network g



(b) Payment network p

Tadelis: pricing, personalization, visibility

It's all about increased information

- How do ML learned signals influence markets? (Zestimate suit)
- How do people view or trust ML signals? (algorithm aversion)
- What is fair in personalization? (Bias, pricing)
- How can AI foster markets for information? (RL or advice)

AI will also increase our information about what did or did not work…

Markets for AI

AI needs constant experimentation and collection of `outcomes' (RL) and the outcomes you train against *must* drive actual rewards ($$)

This incentivizes performance tracking on massive scale and has the potential to allow us to write contracts that didn't previously exist

Plenty of open problems

- Mapping from observable short-term signals to long term rewards
- Contracts around ML model (= Data) component ownership
- Compliant transparency