Bundling, Pricing and Learning in a Multi-Agent Information Goods Economy

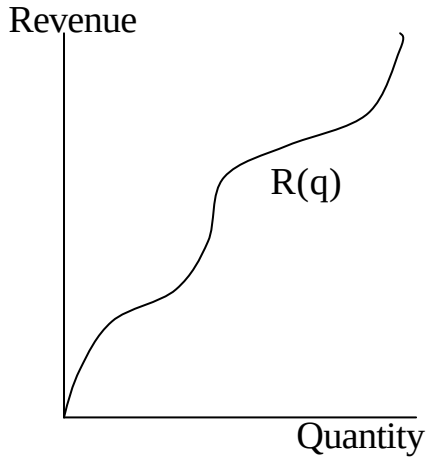
Principal Investigators:
Ed Durfee, U of Michigan
Jeff MacKie-Mason, U of Michigan
Jeff Kephart, IBM Watson

The Problem: Product Space

- Information goods:
  - Bundles of components (articles, tables, figures, issues, volumes, &c.)
  - Once digitized, nearly limitless possibilities for un-bundling and re-bundling
- Examples:
  - subscriptions (seller chooses)
  - generalized subscriptions (buyer chooses)
  - sub-bundles (multiple “journals”)
  - per item

The Problem: Price Space

- Also, nearly limitless possibilities for pricing structures
  - e.g., in quantity of “infochunks”, any monotonic curve is possible
  - examples:
    - subscription
    - “per drink”
    - quantity discount
    - selective discounts (senior citizens, students)



Size of the Problem Space

- If goods have A attributes, each with V ✍ 2 values
  - Goods space: V^A
- But, customers interested in more than one good: could buy in different bundles
  - Information bundles space:

$$2^{V^A} \text{ possibilities}$$

Multi-Agent Info Economies

- Setting: Agents representing multiple publishers and info brokers, multiple buyers
- Seller goal: Find set of bundles and prices that maximizes profit
- Buyer goal: Find bundle/price offering that maximizes utility

Agent Problems

- Sellers don’t know distribution of buyer tastes
- Sellers must incur search cost to learn what other sellers are offering
- Buyers must incur search costs to find out which sellers offer best price/bundle match
- Seller strategies and buyer tastes are changing
- Exponentially enormous space to search for the above!

Our research strategy

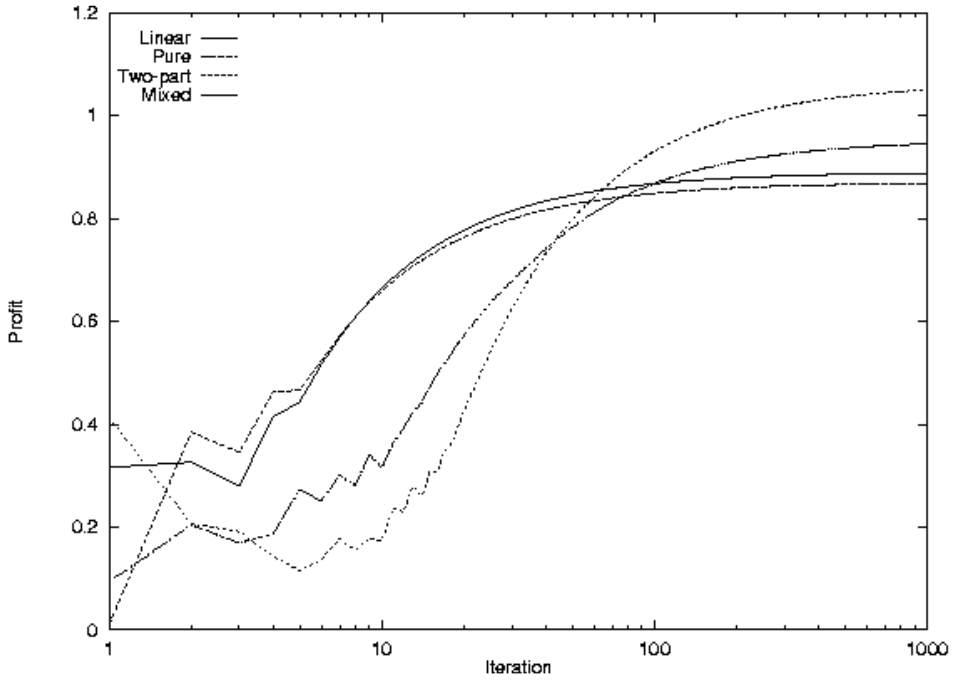
- Use artificial agents to search the space and transact for info goods
- Explore strategies that trade off exploitation (based on current information) and exploration (learning more)
- Study statics and dynamics both analytically and through agent-based simulations

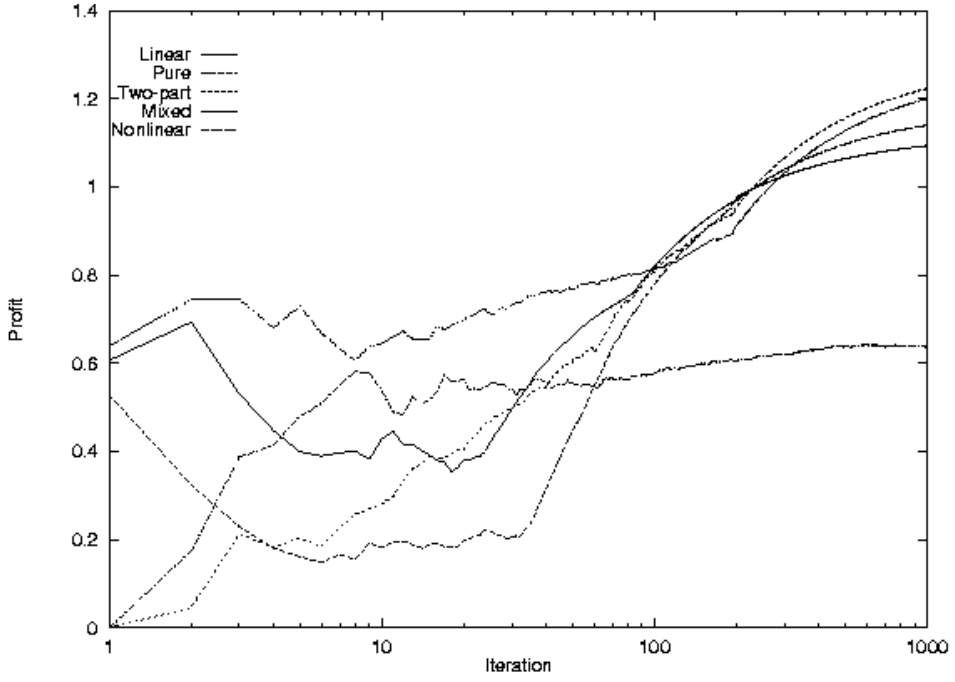
Some research questions

- What learning strategies converge? How quickly, at what cost?
- How well do strategies perform when learning incomplete (or environment non-stationary)? Slower "learners" might earn higher cumulative profits (more robust)
- How much is gained by more complex pricing, at what cost? Are simpler pricing schemes (e.g., constant unit price) more robust?

Some results:

- Different price/bundle schemes, different learning methods:
  - Different learning speed
  - Slow learners can have higher intermediate profits
  - Simple schemes (lower profit potential) can have higher realized profits





Project commencement: Jan 1999

Team: UM/IBM, Computer Science & Economics

- UM PIs:
  - Ed Durfee, CS
  - Jeff MacKie-Mason, Econ
- UM Grad Students:
  - Chris Brooks, CS
  - Scott Fay, Econ
- IBM PI:
  - Jeff Kephart
- IBM Staff:
  - Rajarshi Das

Papers since Jan ‘99:

“Two-sided Learning in an Agent Economy for Information Bundles,” *Agent-Mediated Electronic Commerce ‘99.*

“Automated Strategy Searches in an Electronic Goods Market: Learning and Complex Price Schedules,” submitted to *ACM Conference on Electronic Commerce (EC-99).*