

## 15.564 Information Technology

Business Intelligence II

Software Agents

### Frictionless commerce???

- Low search costs
- Strong price competition
- Low margins

## Frictionless commerce???

- Empirical data suggests that it is still an elusive dream...
  - Amazon charges 20-30% higher prices than its online competitors but still manages to maintain a 85% market share
    - [Brynjolfsson and Smith 2000]
  - “Predictions that lower search costs would increase competition, forcing prices to fall to cost [...] have not been realized. Average prices are well above cost and are flat or rising over the sample period.”
    - [Clay et. al. 2000]

What is going on???

Amount of information is increasing

Getting the right information is daunting

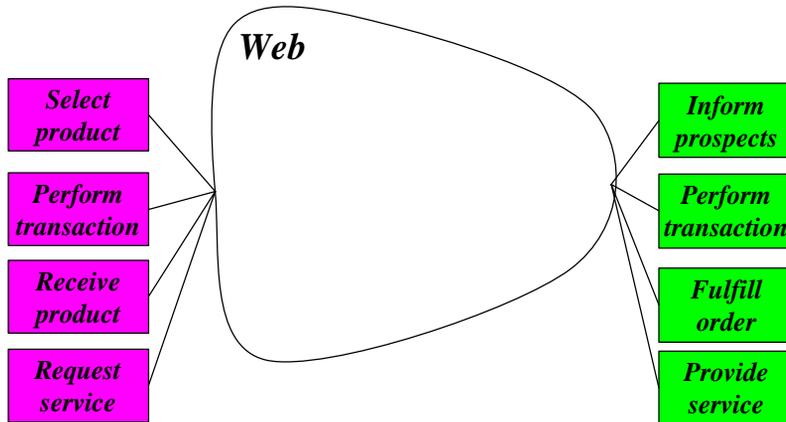
Electronic commerce is still primarily a human-centered activity



Buyer



Seller



Example: Use the Web to organize a trip

- Where to go?
- Where to stay?
- How to fly?
- What to see?
- Where to eat?
- Etc. etc. etc.

**Wouldn't you rather use a travel agent???**

## Enter software agents

- A software agent is an autonomous (software) actor which can take actions towards its goals
- Software agents can help their human masters find information, make better decisions and obtain better transaction outcomes

## What can software agents do

- Select one or more actions based on "rules"
- Select actions based on knowledge about their users
- Have dialog/negotiation with other software agents
- Autonomously learn over time

## An early example: Intelligent email filtering agents

## Agents in the buy/sell process

- What to buy?
  - Recommendation agents
- Where to buy?
  - Price/merchant comparison agents
- How to buy?
  - Automatic negotiation agents

What to buy:

Recommendation agents

Example: Amazon

Screenshot of recommendations page from  
[www.amazon.com](http://www.amazon.com):

"Welcome to Recommendations.  
Here are our recommendations for you."

## Collaborative filtering vs. personal agent approach

- Collaborative filtering
  - Is based on forming clusters of “similar” customers who visit a *given* site
  - Personalization engine and data are “owned” by retailer/intermediary
- Personal agents
  - Learn individual consumer’s preferences by trial and error by observing the consumer’s interactions with *all* sites
  - Are owned by the consumer

## How do agents learn?

- Several approaches
  - Adaptive neural networks
  - Reinforcement learning
  - Genetic algorithms

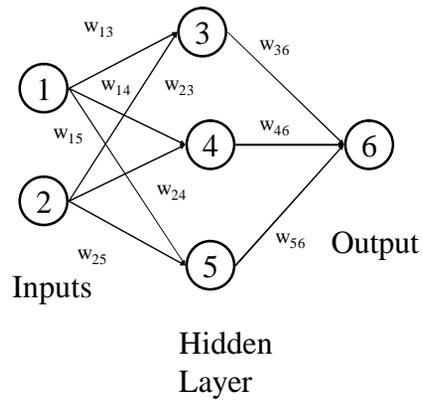
## Adaptive Neural Networks

Inputs:

- Product attributes

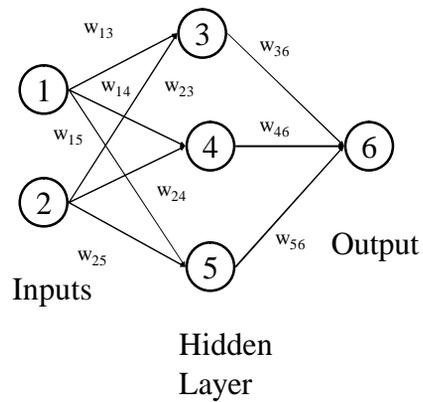
Output:

- Probability of purchase

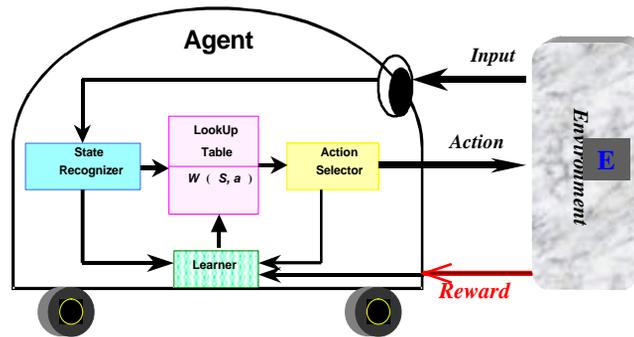


## Adaptive Neural Networks

- Start with rough guess
- Each time, observe consumer's response and use transaction as the next "training" example



## Reinforcement learning

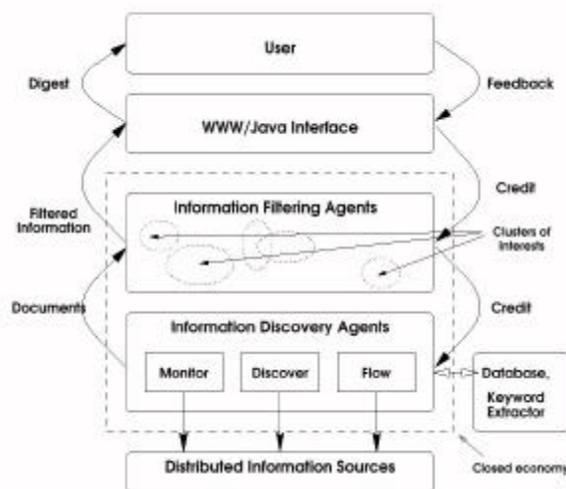


## Genetic Algorithm Case Study:

Amalthea:  
A Personalized Information Discovery Agent  
Ecosystem

(Screenshot of Amalthea: A Personalized Information Discovery Agent Ecosystem.)

## Amalthea architecture



Source: Moukas, Alexandros. *Amalthea: Information Discovery and Filtering Using a Multiagent Evolving Ecosystem*. *Proceedings of the Conference on Practical Application of Intelligent Agents & Multi-Agent Technology*, London, 1996.

## Genetic algorithm example

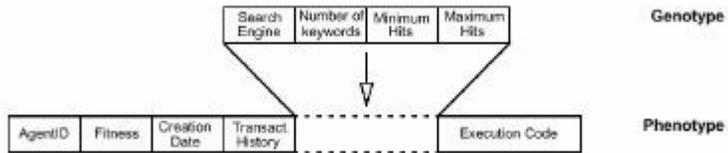
- <http://ai.bpa.arizona.edu/~mramsey/ga.html>

## Amalthea functionality

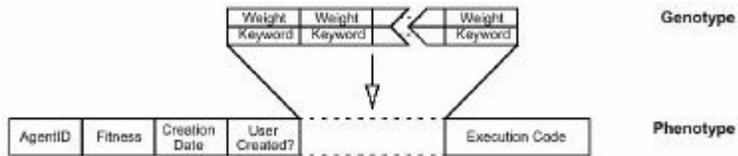
- Amalthea creates an ecosystem of agents, which search the web for “interesting” sites
- Each agent searches for sites which contain a given set of keywords
- Amalthea users rate the returned documents
- Based on user ratings, agents evolve
  - “Worthless” agents get killed
  - “Useful” agents are allowed to “mate” (I.e. combine the keywords they are looking for) and form the next generation
- Over time, this evolution process results in increasingly good fit with the user’s interests

## Amalthea genetic evolution

### Information Discovery Agents

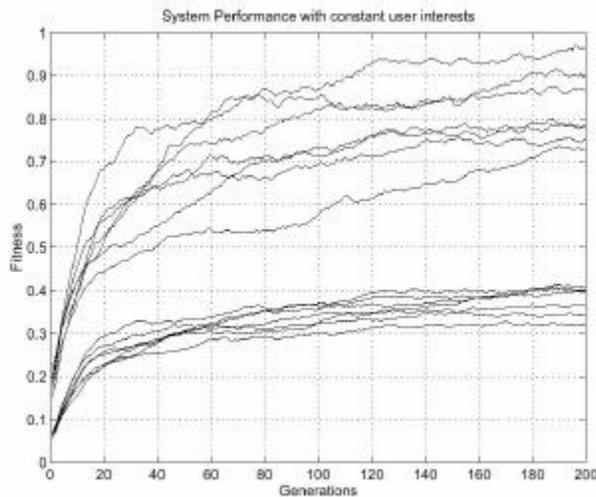


### Information Filtering Agents



Source: Moukas, Alexandros. *Amalthea: Information Discovery and Filtering Using a Multiagent Evolving Ecosystem*. Proceedings of the Conference on Practical Application of Intelligent Agents & Multi-Agent Technology, London, 1996.

## Amalthea performance



Source: Moukas, Alexandros. *Amalthea: Information Discovery and Filtering Using a Multiagent Evolving Ecosystem*. Proceedings of the Conference on Practical Application of Intelligent Agents & Multi-Agent Technology, London, 1996.

## Benefits for customers

- Reduce search time/effort
- Make better recommendations
- Improve over time
- Tailored content and advertising
- One-to-one marketing
- Etc ...

## Benefits for providers

- Higher customer satisfaction
- Higher loyalty
  - ... because benefits increase over time
- Accumulate useful data for “market research”
  - ... but must be very careful with privacy laws!!!

Where to buy:

Price comparison "shopbots"

Screenshot of search for Guinness World Records 2000 book at price comparison "shopbot" and the results from different online vendors.

## Limitations of current shopbots

- Do not necessarily display the information the consumer really cares about
- Do not capture the consumer's relative weighing of price/quality attributes
- Do not capture information from consumers past experiences
- ... No wonder they are not very successful (less than 5% of Internet users use shopbots)

## Opportunities for software agents

- Personalized shopbots who adaptively infer individual consumers utility function
  - What factors matter most
  - Relative weighing of factors
- Similar in spirit to recommendation agents

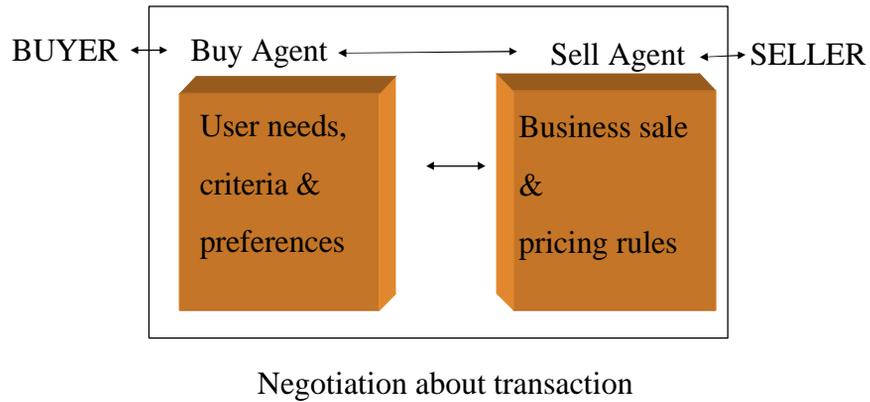
## Implications of “shopbots”

- Benefits for customers
  - Better prices, service terms
- Challenge for vendors
  - ... but also helps vendors learn more about their competitors
  - Most vendors have responded with complex, rapidly changing price structures
- Business opportunity for the mediating entity (the agent “operator”)
  - E.g. frictionless commerce. Com

How to buy:

Negotiation agents

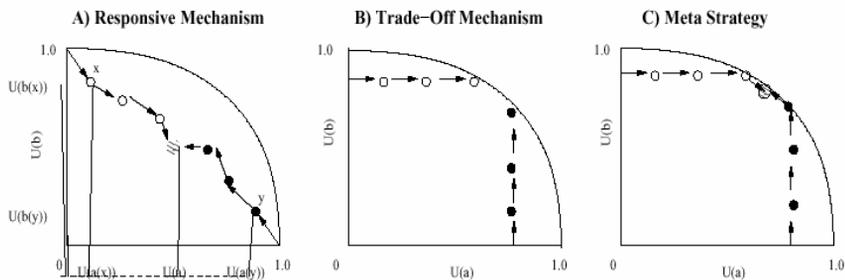
## Intelligent Negotiating Agents



Screenshot of Kasbah project by Keith D. Smith, Robert H. Guttman, Pattie Maes, Alexandros G. Moukas, and Giorgos Zacharia

Screenshot of Kasbah project by Keith D. Smith, Robert H. Guttman, Pattie Maes, Alexandros G. Moukas, and Giorgos Zacharia

## How do agents negotiate?



## Implications of negotiating agents

- Dynamic pricing becomes a reality
  - Everything is on auction
- New, complex categories of auctions that were not practical before become possible
  - Combinatorial auctions where multiple “bundles” of goods are auctioned simultaneously
  - E.g. complete travel packages including airfares, hotels, tours, etc.

## Challenges

- Standardizing the meaning of information
- Trust building
- Dispute resolution
- Security
- ...

## When will all this happen???

- Historically, there has been a time-lag of about 15 years between the time that a major new technology has been proposed in the lab and the time it entered the mainstream of business
- Agents were proposed in the late 80's-early 90's
- Therefore, they are about to enter the mainstream by 2005!!!
- (Historically, technological predictions involving time have been most unreliable)