Security & Economics — Part 1:
Introduction

Dusko Pavlovic

Spring 2014

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Course on the web

- slides and notes: asecolab.org
- homeworks and solutions: moodle

Books

- L. A. Gordon and M.P. Loeb, *Managing Cyber-Security Resources*, Mc-Graw Hill 2006
- L.J. Camp and S. Lewis (eds.), *Economics of Information Security*, Kluwer 2004
- T. Moore et al (eds.), *Economics of Information Security and Privacy*, Springer 2010
- D. Easley and J. Kleinberg, *Networks, Crowds and Markets*, Cambridge University Press 2010

What do you expect from the course?

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Question

Why study Security and Economics together?

Question

Is this a security problem
or an economic problem?

Question

Whose problem is harder?

The troubles

- It is a trouble to not have.
- It is a trouble to have.

Security is the problem of having

J.K. Gallbraith:

- The poor man has always a precise view of his problem: he hasn't enough and he needs more.
- The rich man [has] a much greater variety of ills and he [is] correspondingly less certain of their remedy.

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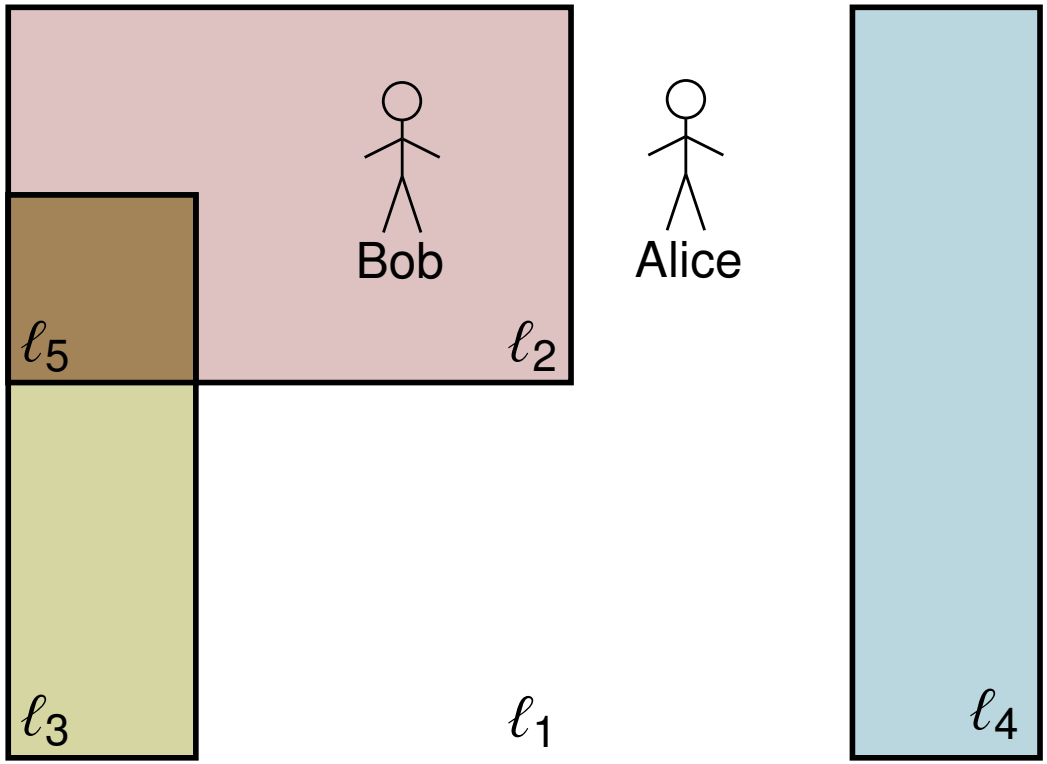
- Early security protocol
- Security in E-commerce
- Digital Rights Management
- Tragedy of the Commons
- Securing free market
- Monetizing information

Example 1: Early security protocol

About 6000 years ago, Kain's son Bob built a secure vault



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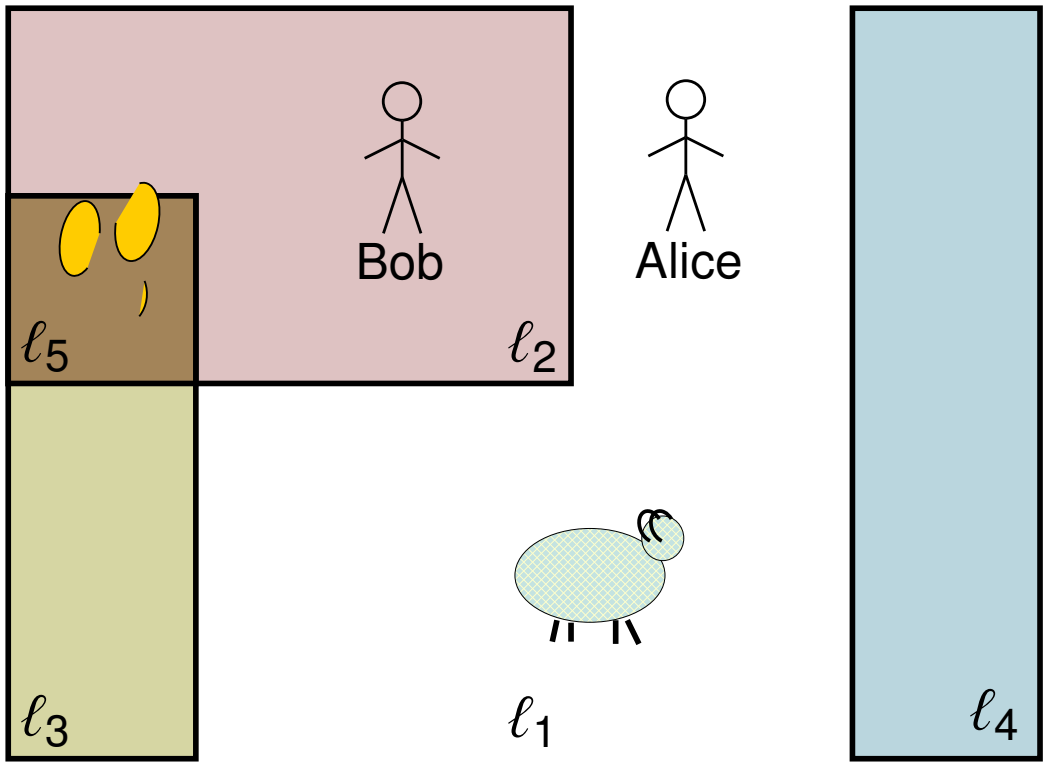
Example 1: Early security protocol

and stored his goods in it.



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Example 1: Early security protocol

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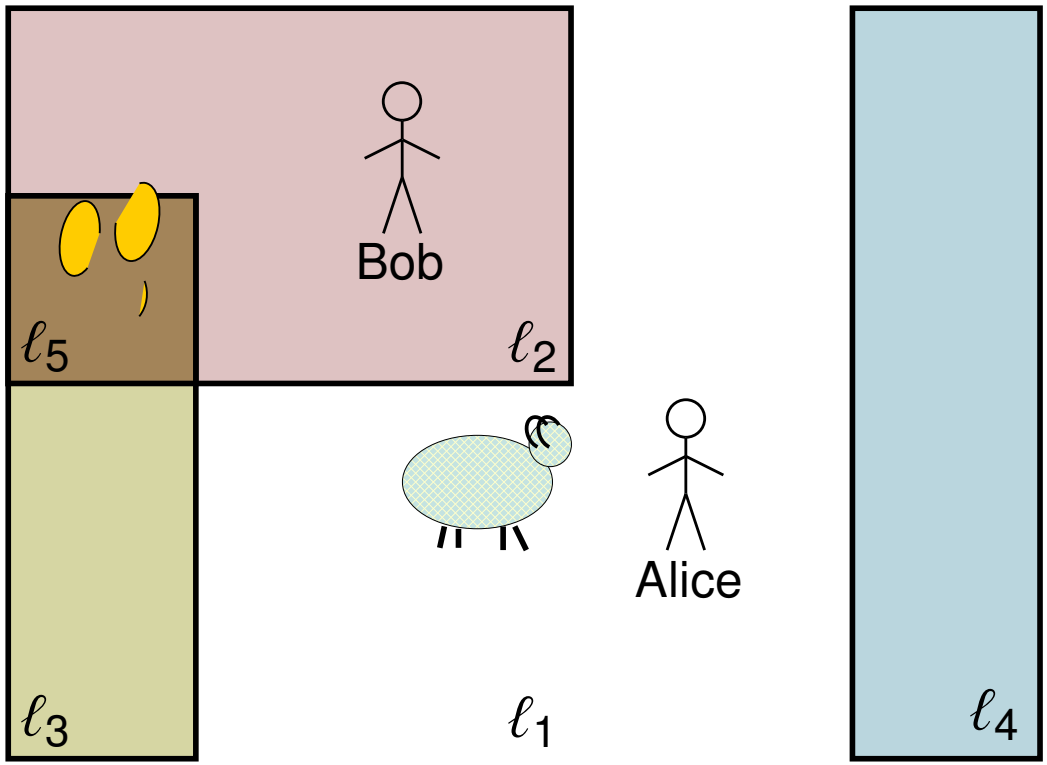

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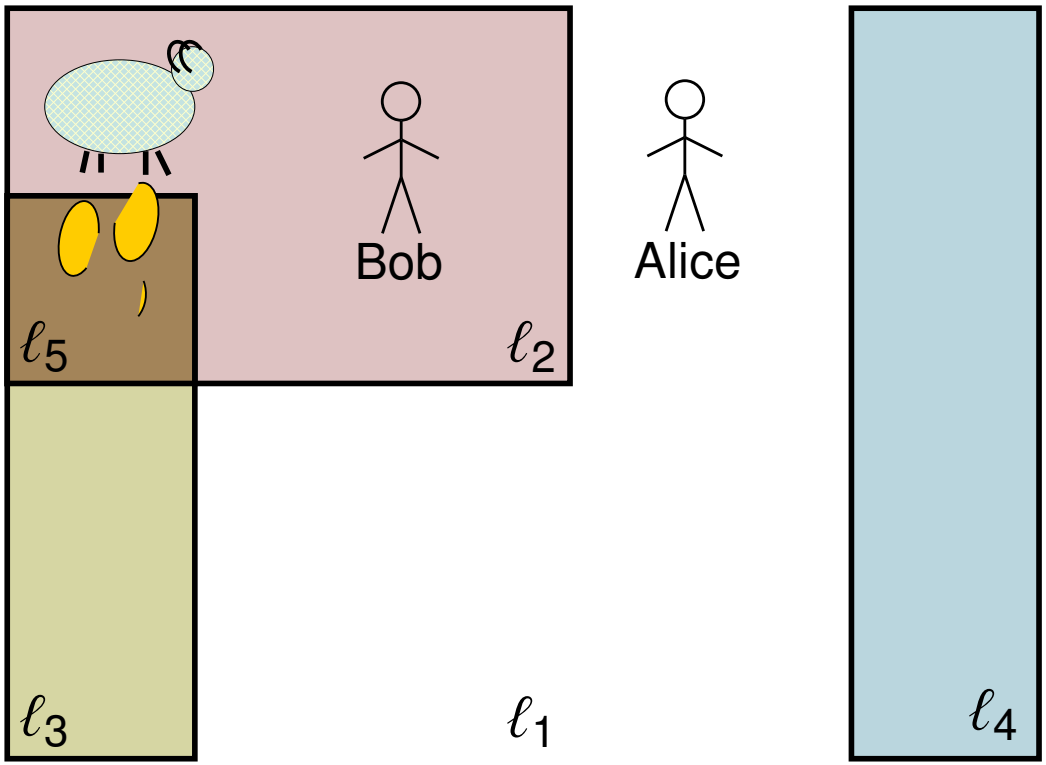
Example 1: Early security protocol

and stored his goods in it. When Alice wanted to go for a vacation, she stored her goods there too.



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Example 1: Early security protocol

As a receipt for her deposit in Bob's vault, Alice got a *secure token in a clay envelope*.

Figure : Louvre, Paris

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Example 1: Early security protocol

As a receipt for her deposit in Bob's vault, Alice got a *secure token in a clay envelope*.

Figure : Louvre, Paris

- To take the sheep, Alice must give the token.

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Example 1: Early security protocol

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Figure : Louvre, Paris

- To take the sheep, Alice must give the token.
- To give the sheep, Bob must take the token.

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Example 1: Early security protocol

As a receipt for her deposit in Bob's vault, Alice got a *secure token in a clay envelope*.

Figure : Louvre, Paris

- To take the sheep, Alice must give the token.
- To give the sheep, Bob must take the token.
- Anyone who gives the token can take the sheep.

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Example 1: Early security protocol

- This protocol goes back to Uruk (Irak), 4000 B.C.

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Example 1: Early security protocol

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- *Money* developed from *security* tokens.

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Example 1: Early security protocol

- This protocol goes back to Uruk (Irak), 4000 B.C.
- *Money* developed from *security* tokens.
- Numbers developed from security annotations.
- Writing developed later.

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Example 2: Security in E-commerce

Security seals convey trust

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Example 2: Security in E-commerce

Adverse selection

	TRUSTE-certified	uncertified
honest	94.6%	97.5%
malicious	5.4%	2.5 %

Table : Trustworthyness of TRUSTE [Edelman 2007]

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Example 2: Security in E-commerce

Adverse selection

Google		
	sponsored	organic
top	4.44%	2.73%
top 3	5.33%	2.93 %
top 10	5.89%	2.74 %
top 50	5.93%	3.04 %

Table : Malicious search engine placements [Edelman 2007]

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Example 2: Security in E-commerce

Adverse selection

Yahoo!		
	sponsored	organic
top	6.35%	0.00%
top 3	5.72%	0.35 %
top 10	5.14%	1.47 %
top 50	5.40%	1.55 %

Table : Malicious search engine placements [Edelman 2007]

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Example 2: Security in E-commerce

Adverse selection

	Ask	
	sponsored	organic
top	7.99%	3.23%
top 3	7.99%	3.24 %
top 10	8.31%	2.94 %
top 50	8.20%	3.12 %

Table : Malicious search engine placements [Edelman 2007]

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Example 2: Security in E-commerce

Questions

- Why does adverse selection happen?
- How can it be avoided?

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Example 2: Security in E-commerce

Questions

- Why does adverse selection happen?
- How can it be avoided?

Answers

- Reputation
- Trust

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Example 3: Digital rights management (DRM)

Economic art history

- art used to be bound to the artist
  - music was available only from a musician
  - a story from a storyteller
  - a painting could only be seen in the cave, church. . .

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Example 3: Digital rights management (DRM)

Economic art history

- mass reproduction bound art to copiable media
  - copying technologies led to *copyright*-based markets
  - artists could sell lots of books and records
  - **Copyright Management**: branding, celebrities

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Example 3: Digital rights management (DRM)

Economic art history

- digital networks freed art (science, religion. . .) from physical tokens (books, CDs. . .)
  - copying of digital content is essentially costless
  - Copyright Management becomes unviable
  - **Digital Rights Management**: seeks to
    - prevent (sandboxing. . .)
    - detect (watermarking . . .)
    - deter (lawyers . . .)

    unauthorized copying of digital content

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Example 3: Digital rights management (DRM)

Art economy as a security problem

In DRM, economics and security cannot be separated

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Example 3: Digital rights management (DRM)

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- unauthorized copying of digital content cannot be prevented

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Example 3: Digital rights management (DRM)

Art economy as a security problem

In DRM, economics and security cannot be separated:

- unauthorized copying of digital content cannot be prevented
- the cost and the risk of copying needs to be made greater than the price of the downloads

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Example 3: Digital rights management (DRM)

OR should art be a common resource, like air, or the Internet?

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Example 4: Tragedy of the Commons

Commons: publicly shared resources

For centuries, Alice, Bob and Charlie have been sharing an **open field system**.

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Example 4: Tragedy of the Commons

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Example 4: Tragedy of the Commons

Commons: publicly shared resources

In England, such open fields were called *Commons*.

Alice, Bob and Charlie alternated different crops with grazing, and maintained the land together.

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Example 4: Tragedy of the Commons

Commons: publicly shared resources

In England, such open fields were called *Commons*.

Alice, Bob and Charlie alternated different crops with grazing, and maintained the land together.

Two remarkable social processes ensued:

- Tragedy of the Commons, and
- Enclosure Movement

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Example 4: Tragedy of the Commons

- Charlie realized that it was *rational* for him to invest
  - all effort into exploiting the public resource, and
  - no effort into maintaining it.

Charlie became a *free rider*.

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  Charlie became a *free rider*.

- Alice and Bob realized that it was *rational* for them
  - to stop maintaining the resource for Charlie, and
  - to hurry to exploit the resource too.

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- A **race to the bottom** ensued.

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- A **race to the bottom** ensued.

- The resource got depleted.

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Example 4: Tragedy of the Commons

Common resources cause the **race to the bottom**.

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Example 4: Tragedy of the Commons

Fair sharing of public resources is a security problem.

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Example 4: Tragedy of the Commons

- the Internet is a common resource
- spam is an instance of the Tragedy of the Commons
- it is an economic & security problem

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Example 4: Tragedy of the Commons

Solution: The Enclosure Movement

- Charlie *enclosed* the Commons from Alice and Bob.
- In England, this happened in XV–XVII centuries.

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Example 4: Tragedy of the Commons

Market economy: private vice → public benefit

"It is not from the benevolence of the butcher, the brewer, or the baker that we expect our dinner, but from their regard to their own self-interest. We address ourselves not to their humanity but to their self-love, and never talk to them of our own necessities, but of their advantages"

Adam Smith

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Example 4: Tragedy of the Commons

Second Enclosure

Verizon: net neutrality violates our free speech rights

Company argues FCC regulations run afoul of Fifth Amendment property rights too.

by **Timothy B. Lee** - July 3 2012, 8:15pm CEST

GOVERNMENT 310

"Can you hear me now?"

Aurich Lawson

Verizon pressed its argument against the Federal Communications Commission's new network

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Example 5: Free market protocol

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Example 5: Free market protocol

Based on trust

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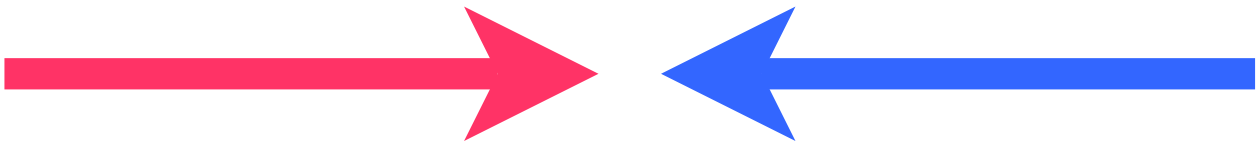
Example 5: Free market protocol



supply demand

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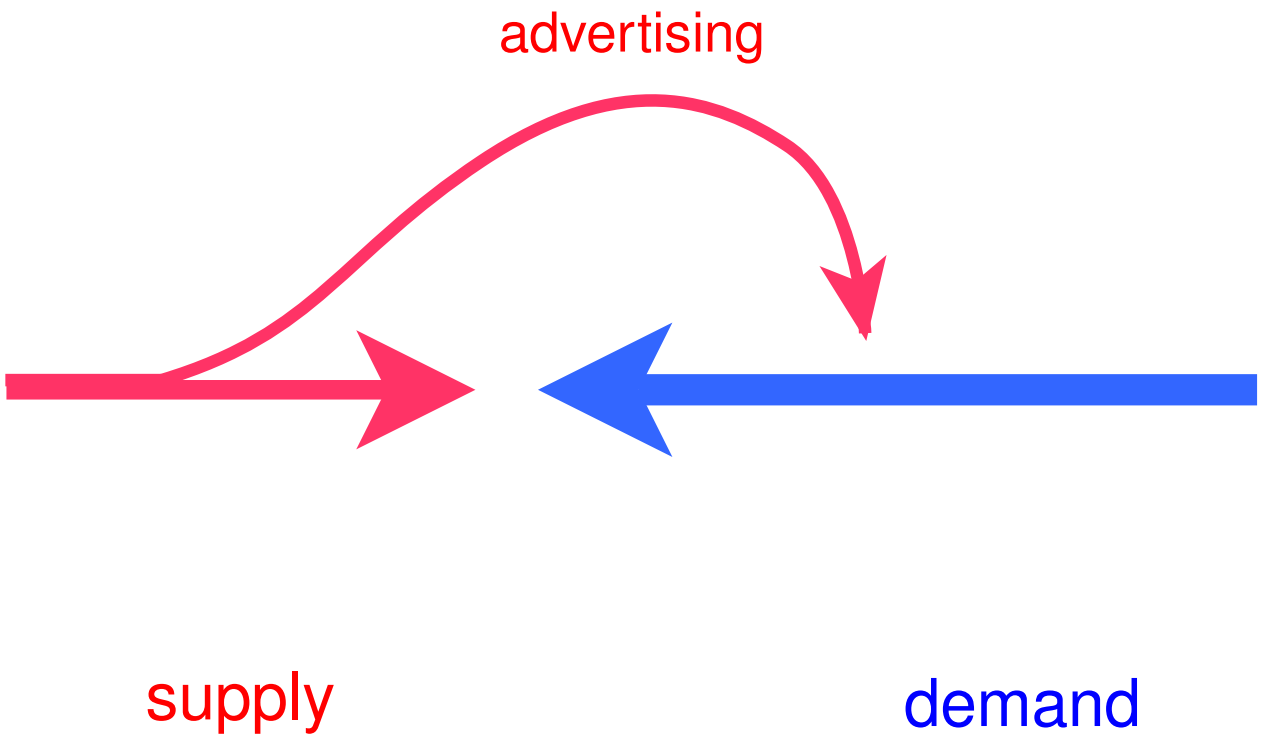
Example 5: Free market protocol



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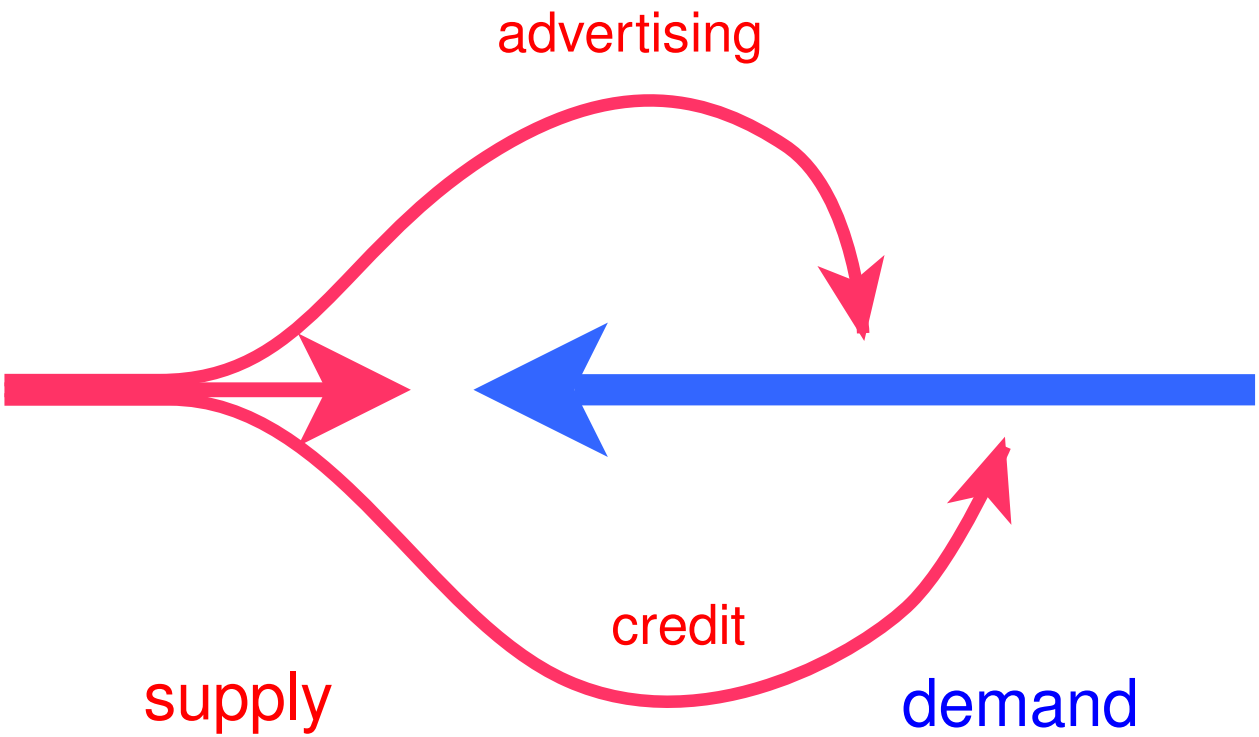

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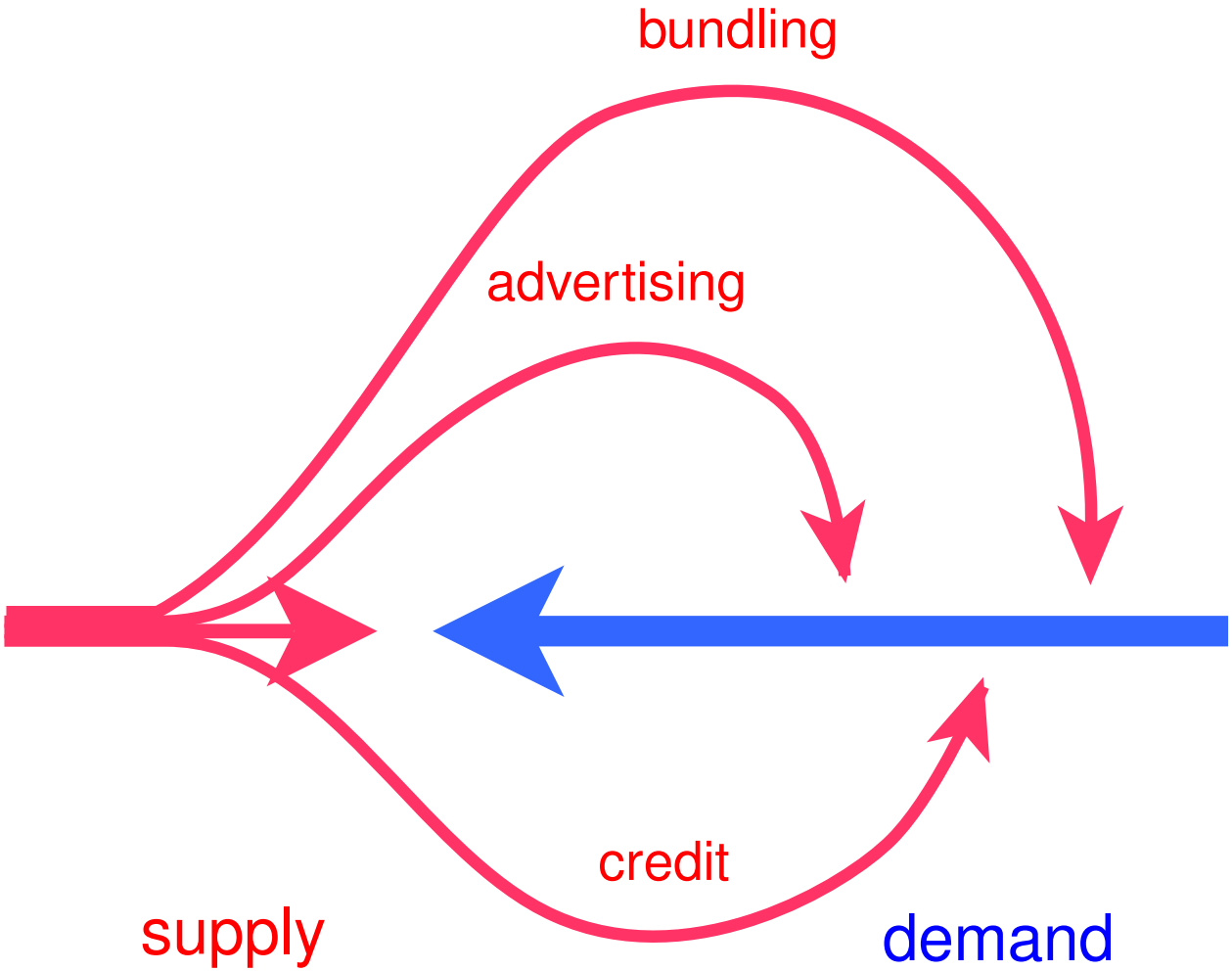

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Example 5: Free market protocol

Based on influence

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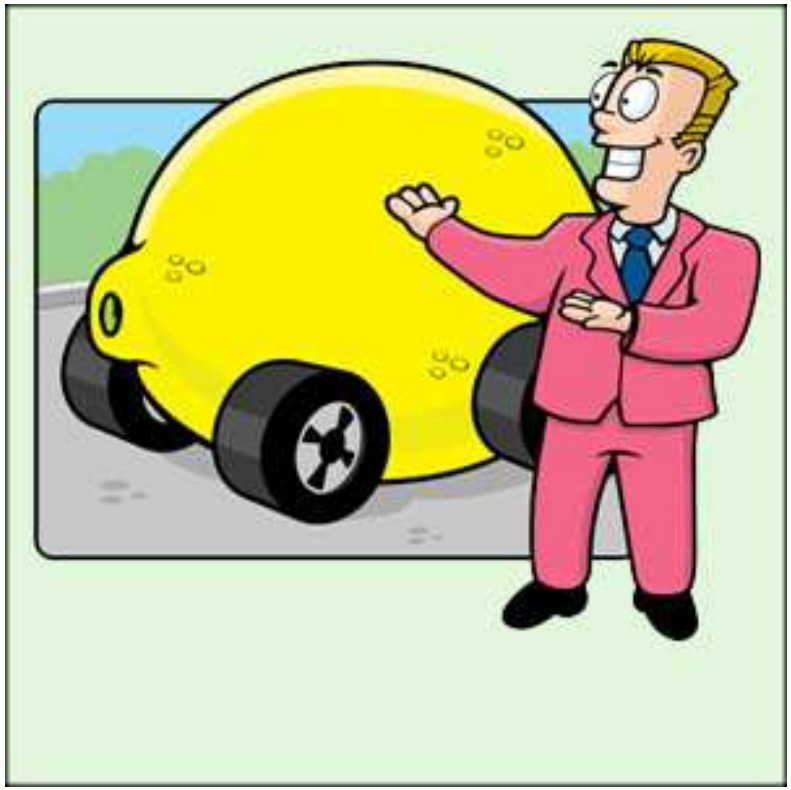
Example 5: Free market protocol



Information asymmetry: "Market of lemons"

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Example 5: Free market protocol

Information asymmetry: "Financial derivative"

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Example 5: Free market protocol

Upshot

- *security goal:* equilibrium of supply and demand
- *security protocol:* free exchange
- *"attacks above":* advertising, information asymmetry
  - security protocol correctly executed
  - security goal shifted

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Example 6: Monetizing information

Problem of the Web: Semistructured data

- no global declarations
- semantics vary from node to node

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Example 6: Monetizing information

Problem of the Web: Semistructured data

- no global declarations
- semantics vary from node to node

Proposed solutions

- *Semantic Web:*
  - standardize formats for global declarations (ontologies)
- *search:*
  - do not standardize
  - extract the meaning from the documents

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Example 6: Monetizing information

Demise of Web 1.0

- keyword search
  - crawling and indexing
- stealing the meaning is easy and blatant
  - keyword stuffing, keyword spam, spamdexing
- race to the bottom
  - costless advertising overruns all information

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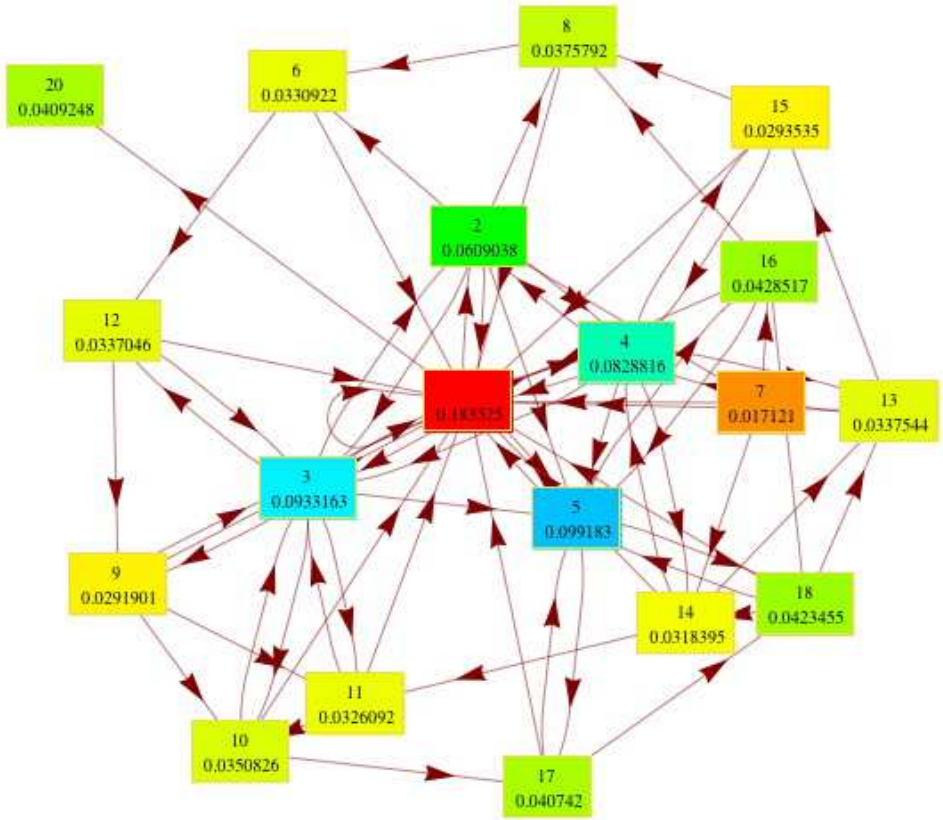
Web 2.0 solution: Reputation ranking



Reputation as a fixed point (PageRank, HITS)

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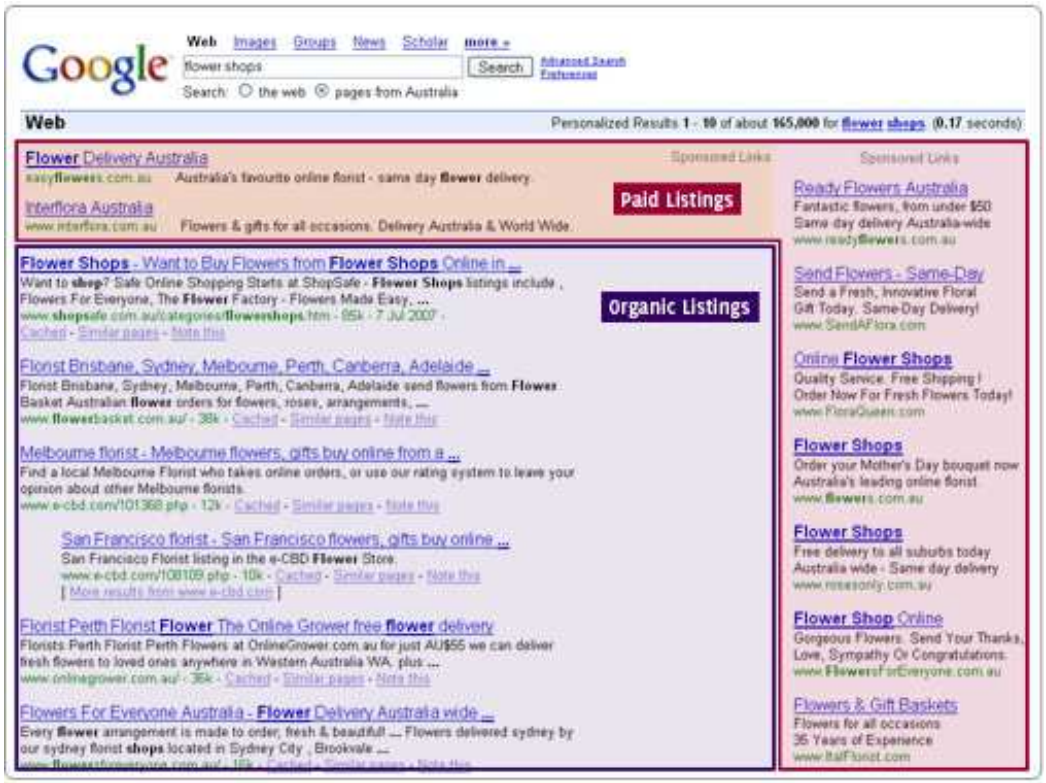
Monetizing search: Ad Words



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Monetizing semantics: Ad Sense

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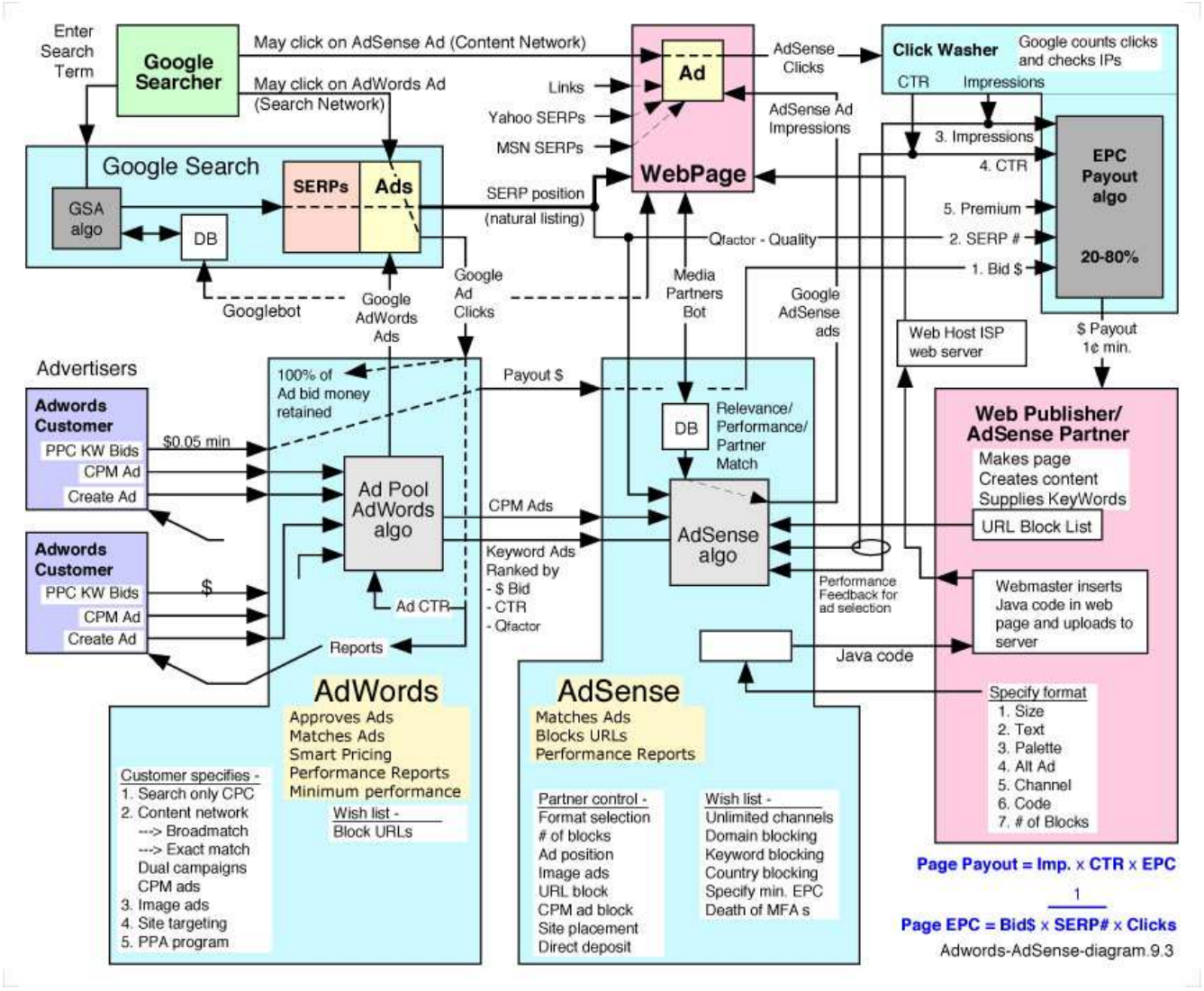
Google protocol



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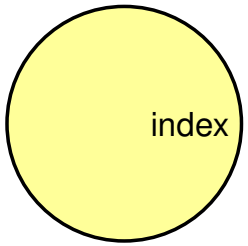
Search engine protocol

SE



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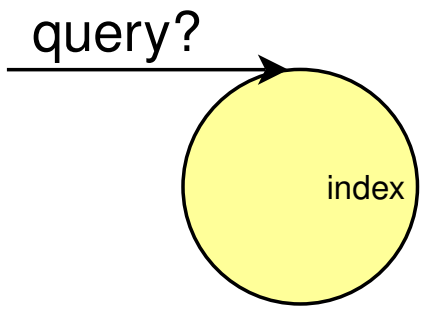
Search engine protocol

User **SE**



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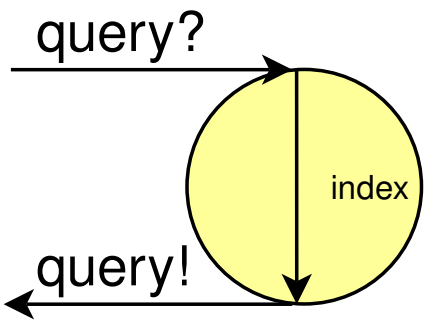
User **SE**



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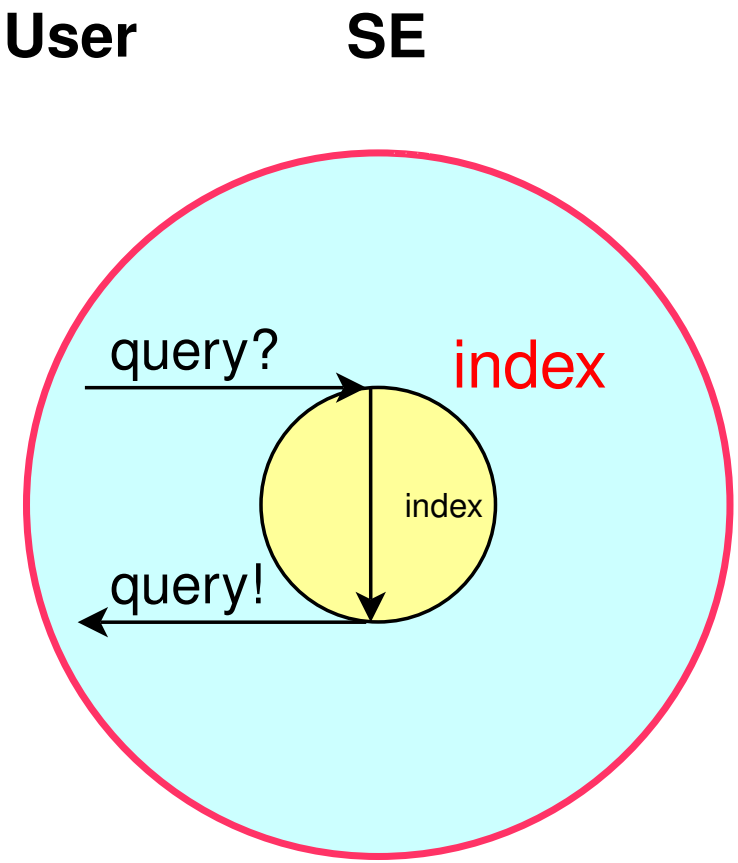

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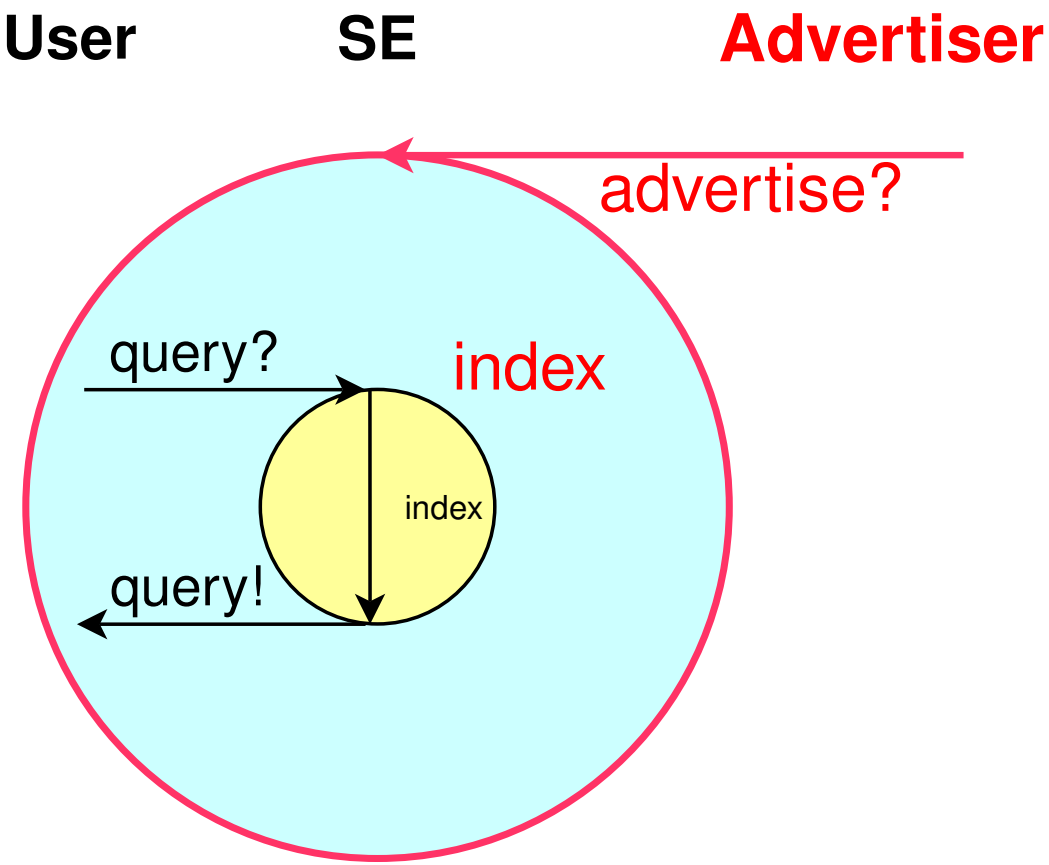

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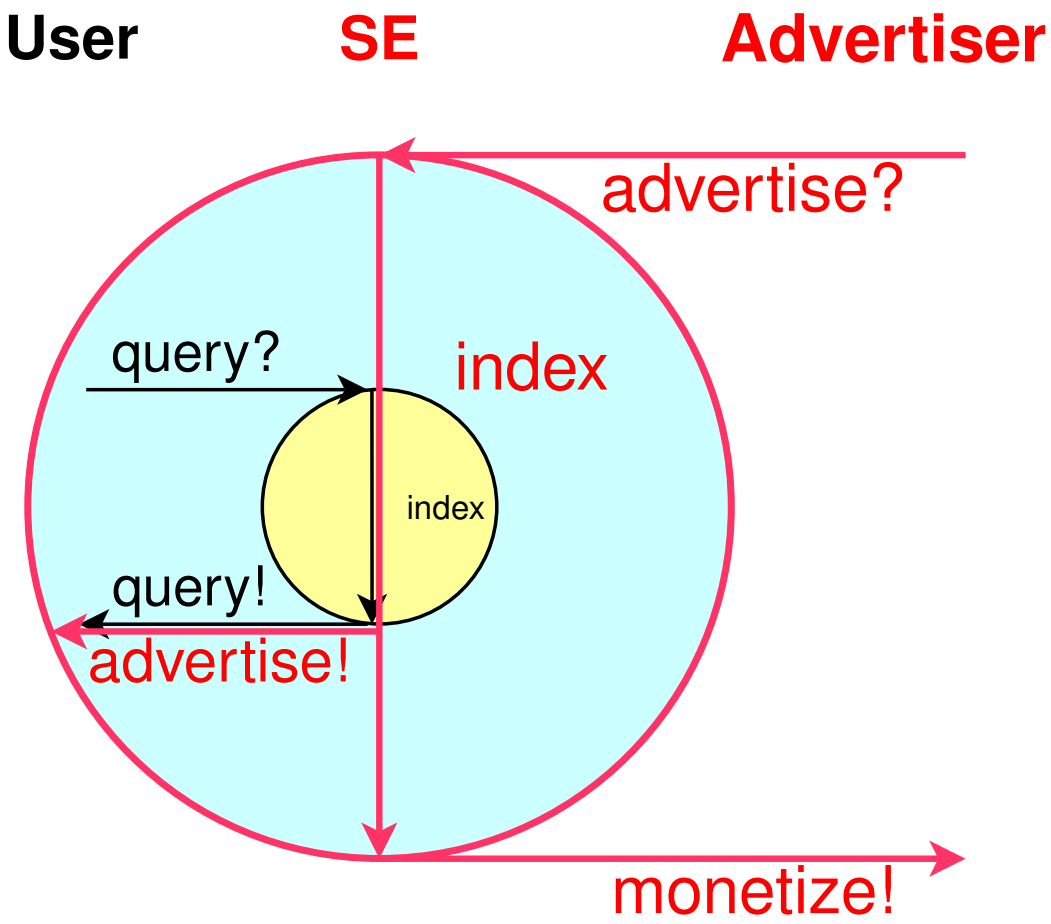

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Upshot

Search protocol participants have **different security goals**:

- *surfer:* acquire information
- *search engine:* monetize information
- *sponsors:* influence information

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Upshot

Search protocol has **different executions**:

- *surfer:* information retrieval
- *search engine:* man-in-the-middle
- *sponsors:* user tracking and profiling

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Upshot

. . . And these security problems arise before fraud. . .

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Claim 1

Networks open up **social problems** like

1. trust and reputation
2. digital property rights
3. commons and the environment
4. free market
5. information economy

...

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Claim 2

Such social problems open up to **technical solutions** that combine

- security methodologies and
- economic modeling

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Why Economics & Security?

Conceptual roots of network economy

Structure of the course

What are Economics & Security?

- What is economics?
- What is security?

What are Economics & Security?

- Economics is concerned with production of wealth.
- Security is concerned with protection of assets.

What links Economics & Security?

- Economics $\subseteq$ Security
  - economics studies the market
  - the market is a security protocol
  - market economy is a security process

What links Economics & Security?

- Security $\subseteq$ Economics
  - security protects assets
  - security costs $\leq$ asset value
  - security is an economic process

Dark side of the economic force

"The efforts of men are utilized in two different ways:

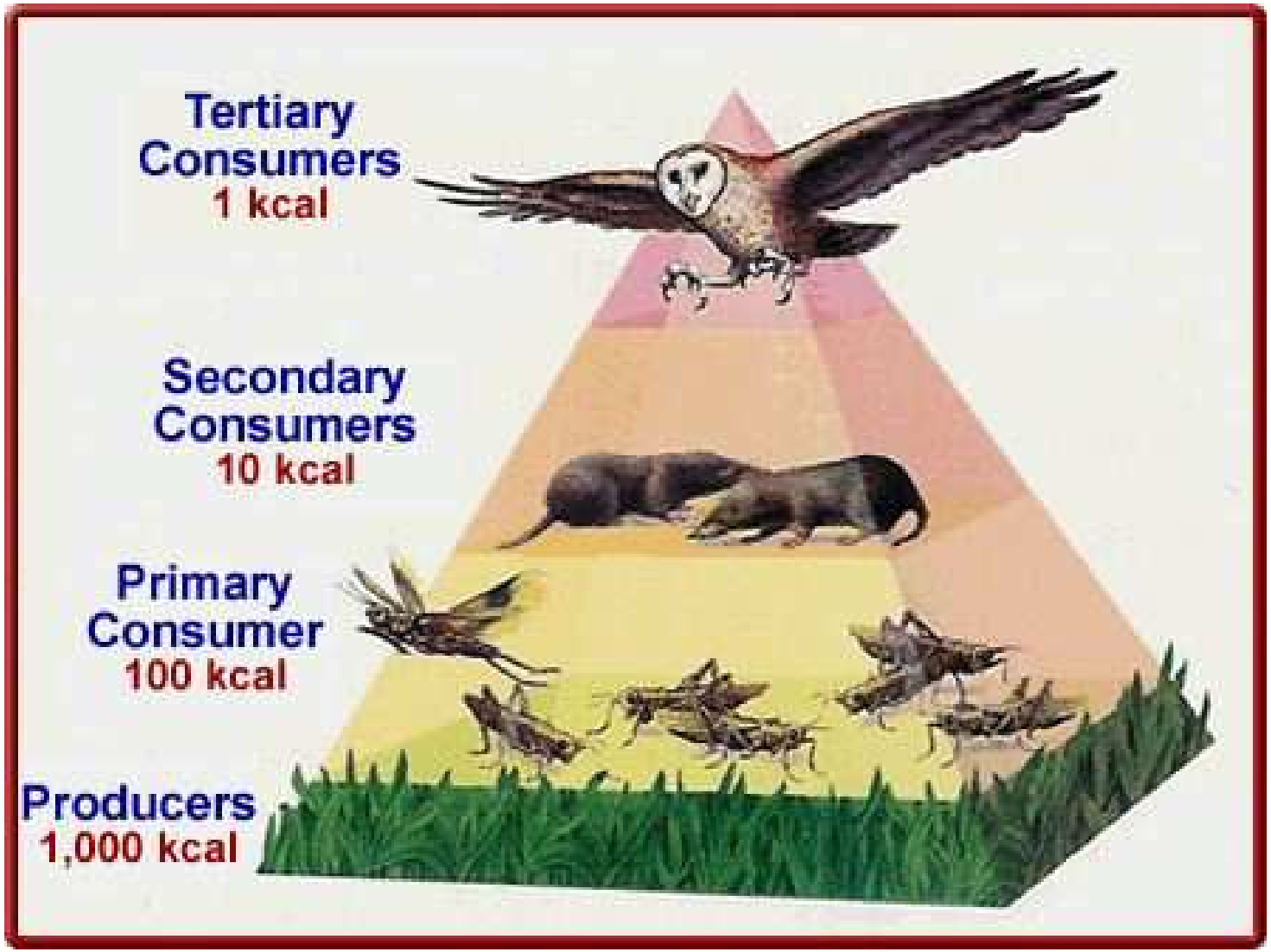
- they are directed to the production or transformation of economic goods,
- or else to the appropriation of goods produced by others.

Vilfrido Pareto

A race is won by moving fast

. . . or by tripping up the opponent

Economy of production and predation



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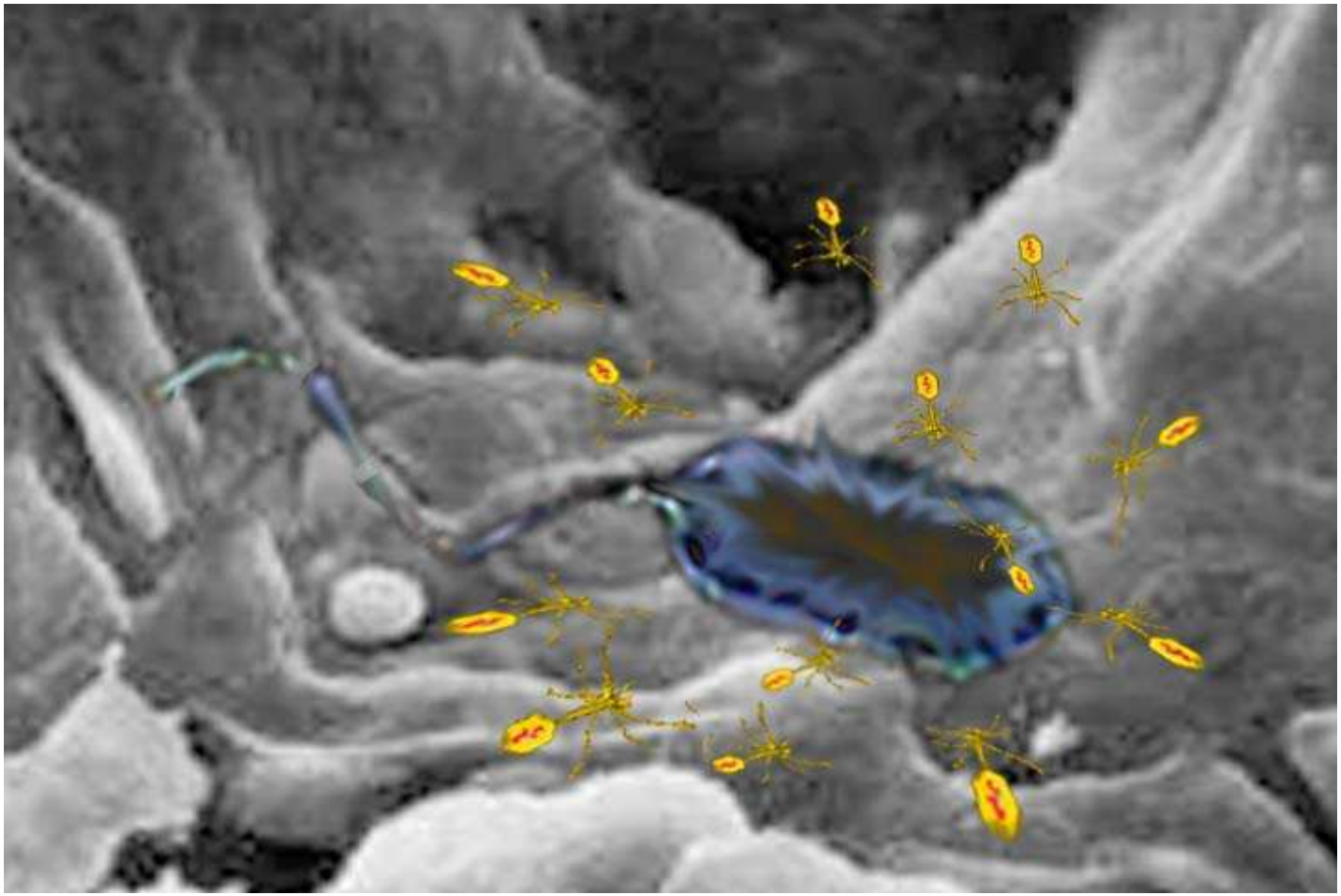
Economy of production and predation



Bacteria have a security problem to protect their assets.

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Economy of production and predation

- Production increases wealth.
- Predation redistributes it.
- Redistribution leads to new forms of production.
  - network servers: banks, real estate agents...

Dynamics of production and predation

The rich get richer.

Vilfrido Pareto

Structure of the course

Part I: Methods of economics in security

Lecture 2: Security Investment Analysis

Lecture 3: Interdependency and Gaming

Part II: Methods of security in economics

Lecture 4: Information economy

Lecture 5: Trust and reputation

Teaching outcomes of the course

Part I: Market aspects of security

Lecture 2: Tools for CIO

Lecture 3: Security and competition

Part II: Security aspects of market

Lecture 4: Pricing and market mechanisms

Lecture 5: Monetizing information

Employment outcomes the course

Part I: Chief Information Ofiicer

Lecture 2: "How much is this firewall worth to me?"

Lecture 3: "Can I secure this transaction?"

Part II: Monetizing guru

Lecture 4: "Where is the revenue on this network?"

Lecture 5: "How can I monetize this free transaction?"