Why Do We Need "Money" in *Mechanism Design*?

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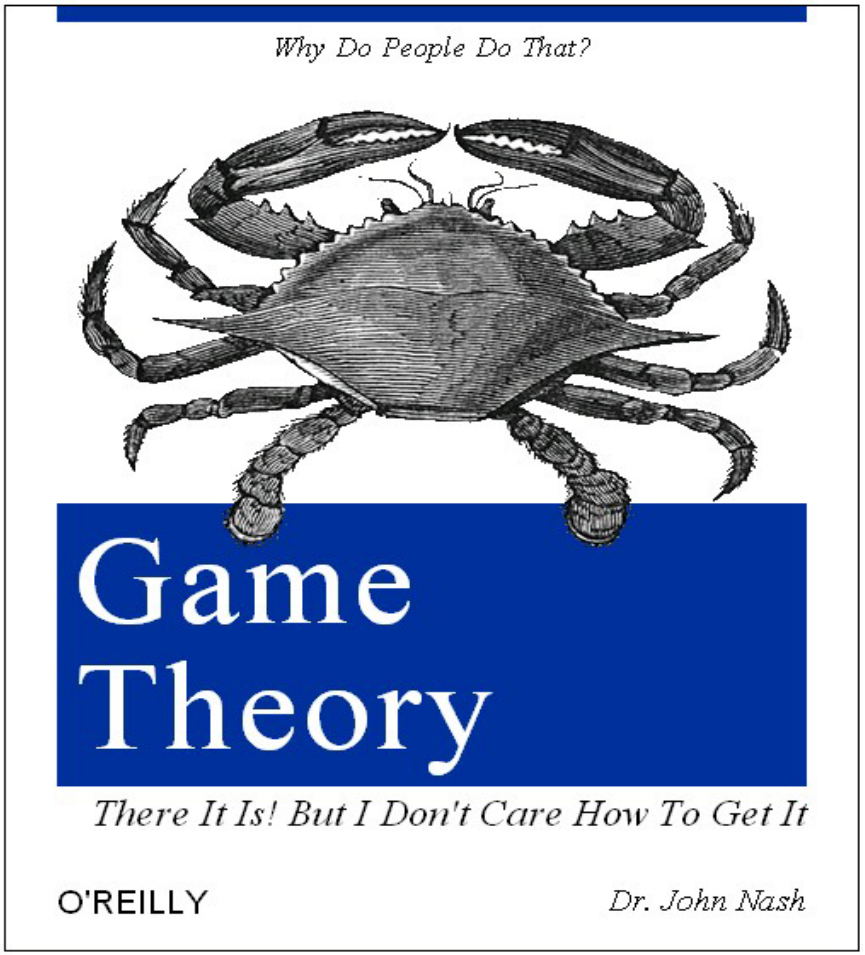
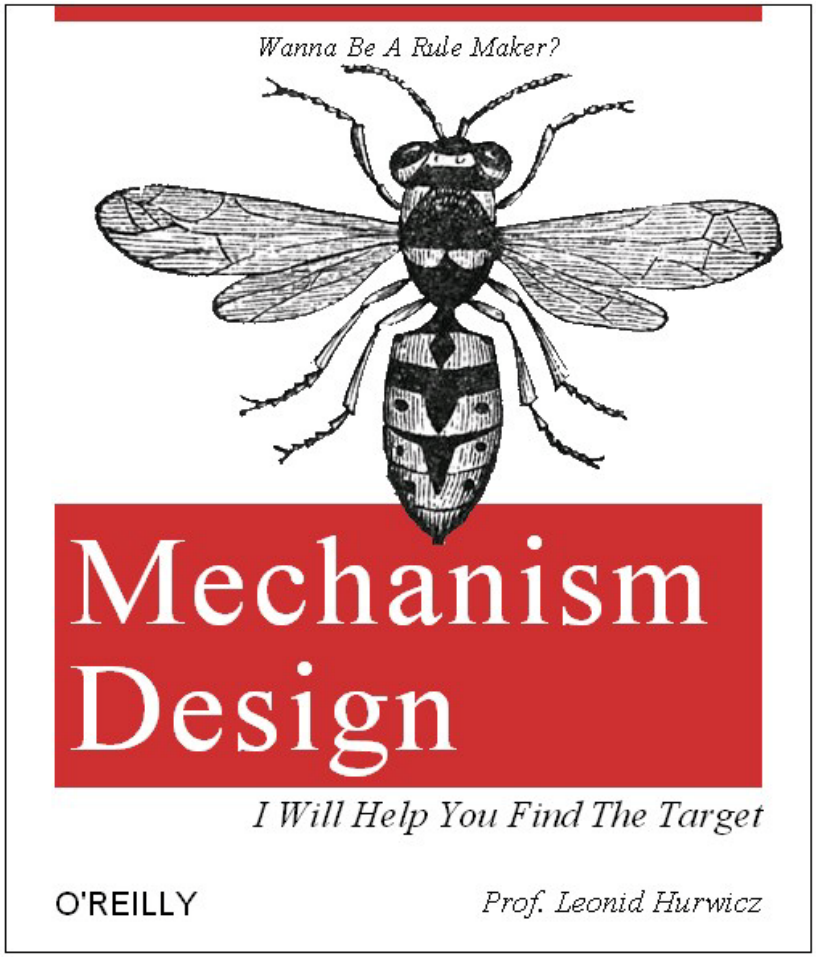
Why Mechanism Design ?

- MD: Algorithmic Game Theory
- Having an Engineering Perspective





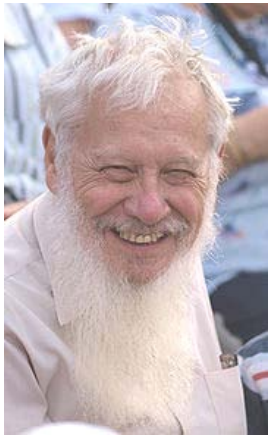
Where is MD from? (1)

- **Utility**
  - **Utility Theory (*Expected Utility Maximization Theorem*)**

John von Neumann

Where is MD from? (2)

- **Intelligence and Common Knowledge**
  - **CK: An Important Implication of *Intelligence:***
  - ***"Everyone knows it"***
  - ***"Everyone knows that everyone knows it"***
  - ***…***
  - ***"Everyone knows that … that every one knows it"***



Robert Aumann
(Nobel Prize 2005)

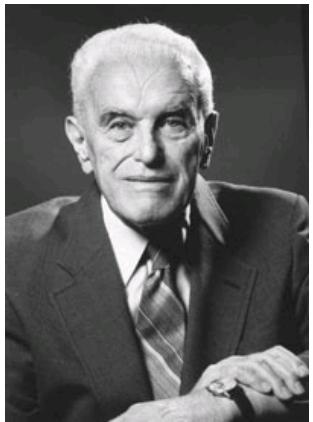
Roger Myerson
(Nobel Prize 2007)

What is MD?

- Concerns:
  - HOW to implement system-wide solutions
  - Multiple self-interested agents
- Socially Desirable Outcome
- Without the Mechanism?

Social Choices

- A Term from Political Sciences
- Formal Definition:
  - Given a set of agents N={1,2,...,n}, and their preferences sets: Θ1, Θ2, ..., Θn and a set of outcomes X, a social choice function (SCF) is a mapping: $F: \Theta 1 \times \Theta 2 \times \ldots \times \Theta n \rightarrow X$ that assigns each possible preference profile (θ1, θ2, ... θn) a collective choice from the set of alternatives.



John C. Harsanyi
Nobel Prize 1994

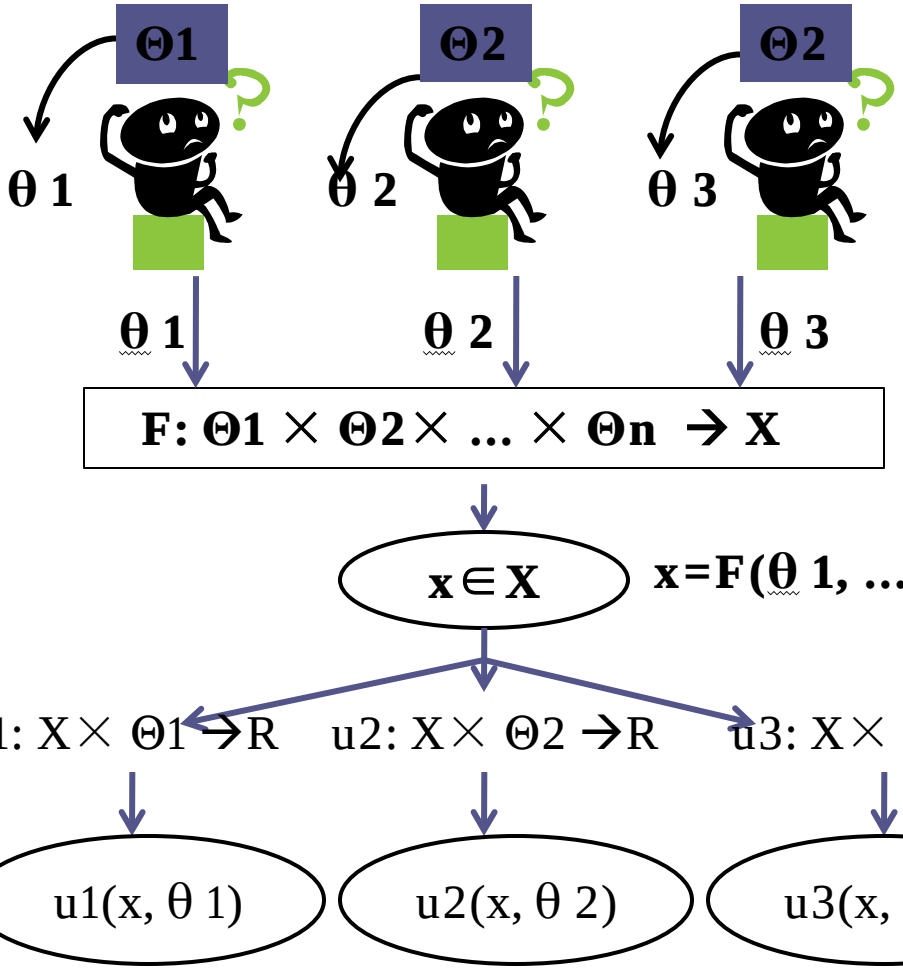
Majority?

- Paradox of Voting
  - A social choice cannot be taken simply by the natural system of taking a majority vote.

Marquis de Condorcet

- Then, How to Design a Voting Mechanism?

Mechanism Design Environment



Individual Preference Sets

Individual Preferences

Reported Preferences

Social Choice Function

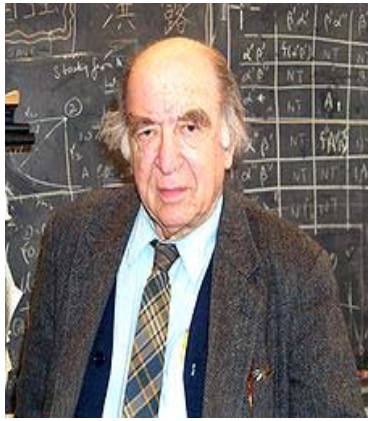
Outcome

Utility Functions

Utility Values

Incentive Compatible Mechanism

- Incentive Compatibility (IC)
  - Individual Preferences == Reported Preferences
- Strategic Manipulation



Leonid Hurwicz
Nobel Prize 2007

Dictatorship

- Dictator:
  - who assumes sole and absolute control over all people

- Voter ***i*** is a *dictator* if, $\theta i \equiv x$, (*or defined by utility*)
  - One person can ignore all other voters,
    and make the outcome exactly
    as he himself expects!

Gibbard-Satterthwaite Theorem

- Suppose that:
  - 1. |x| >= 3
  - 2. Rational Preference Relation on X, (eg. ordinal)
    - Completeness: for agent ***i***, either x1>x2 or x2>x1
    - Transitivity: for agent ***i***, if x1>x2, x2>x3, then x1>x3
  - 3. SCF (function F) is an "onto" function
- Then: the mechanism is **IC** *iff*. is a **Dictatorship**

Allan Gibbard

No Hope?

- G-S Theorem: Procrustean's bed
- How to be Theseus :
  - From the conditions of G-S Theorem :
    - 1. Let $|x|<3$
    - 2. Let preference not be linear
    - 3. Let SCF not be surjective
- Example:
  - Use Money
    - Linear Preferences → Quasilinear Preferences

Possible Ways

- To Design No-Money Involved Mechanisms