Bureaucracy in Quest for Feasibility

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Motivating Example

- A president of a university finds out that a new program was not launched
- It is said that the scheduling and staffing of courses “didn’t work out”
- She doesn’t know whether a solution could have been found
- The general questions:
- How do organizations make decisions
- How do we formally model these decisions?

Rational Choice Approaches

- The organization as a decision maker
- Insightful, but limited
- The decision as an equilibrium among agents
- Again... (observability; equilibrium selection)

Vast Literature in Organization Theory

- Efficient production: Smith, 1776, Marx, 1867, and Durkheim, 1893
- Well-tuned machine: Taylor, 1911, Follett, 1918, Fayol, 1919
- Bureaus as production units: Niskanen, 1971, 1975
- Decomposing the organization: Weber, 1921, 1924 (on authority and bureaucracy)
- For the state: Buchanan and Tullock, 1962
- Decision making: March and Simon, 1958 (satisficing)
- Other metaphors: organisms, brains, cultures, political systems...

Goal

- To suggest formal models of decisions made by organizations that will capture some of the insights of the organization literature
- Yet be amenable to incorporation in economic models
- Highlighting the notions of consistency
- – with past decisions and with regulations
- – and the power of bureaucracy

Bureaucracies Cope with Complex Problems

- Example: t tasks, s employees
- $L_{ij} \in \{0, 1\}$ denotes whether task $i \leq t$ can be performed by employee $j \leq s$
- If $L_{ij} = 1$, task i would require $e_i \geq 0$ hours of employee j
- Employee $j \leq s$ has a budget of $B_j \geq 0$ hours
- An allocation: $(a_{ij})_{i \leq t, j \leq s}$ with $a_{ij} \in \{0, 1\}$. The allocation is *consistent* with $(e_i)_{i \leq t}$, $(B_j)_{j \leq s}$, and $(L_{ij})_{i \leq t, j \leq s}$ if

$$a_{ij} \leq L_{ij} \qquad \forall i, j$$

$$\sum_{j \leq s} a_{ij} = 1 \qquad \forall i$$

and

$$\sum_{i \leq t} a_{ij} e_i \leq B_j \qquad \forall j$$

Theorem

Given expenses $(e_i)_{i \leq t}$, $(B_j)_{j \leq s}$, and $(L_{ij})_{i \leq t, j \leq s}$ finding whether there exists a consistent allocation $(A_{ij})_{i \leq t, j \leq s}$ is NP-Complete.

Bureaucracies Cope with Complex Problems II

- Bureaucracies cope with problems that are NP-Hard
- Scheduling, assignment... – can't be solved by the best algorithms and fastest computers
- Implication: when a director makes a decision, and it's not implemented, she will not know why.

Bureaucracies in Quest of Feasibility

- The director faces a constrained optimization problem
- The bureaucracy – only constraints
- But even this is NP-Hard
- The bureaucracy attempts to use past cases in which feasibility was obtained.

A Condorcet-Style Problem

- A single constraint

$$x_1 + x_2 + x_3 = 2$$

- Past cases:

$x_{i\tau}$	$\tau = 0$	$\tau = 1$	$\tau = 2$
$i = 1$	1	1	0
$i = 2$	1	0	1
$i = 3$	0	1	1

- Doing “what we usually do” will not lead to a consistent decision.

An Arrow-Style Theorem

- The main message: the only way to obtain feasibility is by mimicking the single most-similar case
- In case different offices have different similarity functions, even this won't help
- As a result, the bureaucracy will tend to make incoherent decisions.

Model

- Bureaucracy faces constraints

$$Ax \leq b$$

- $x = (x_1, ..., x_n)^T$ is a vector of non-negative integer-valued decision variables
- A is a $m \times n$ matrix of real numbers
- b is a vector of m extended real numbers, $b_j \in \mathbb{R} \cup \{\infty\}$
- At period t

$$A_t x \leq b_t$$

- W.l.o.g. $A_t = A$

Past Cases

- A *problem* – a pair $(p, b) \in P \times B$
- where p denotes various circumstances
- A *case* $c = (p, b, x)$ – (p, b) is a problem, and $x \in \mathbb{Z}_{+}^{n}$
- A *history*

$$h_t = ((p_0, b_0, x_0), ..., (p_{t-1}, b_{t-1}, x_{t-1}), (p_t, b_t)).$$

How is History Used?

- A *similarity* function

$$s : (P \times B) \times (P \times B) \to \mathbb{R}_+$$

- *Kernel*: choose a maximizer of

$$S(h_t, x) = \sum_{\tau=0}^{t-1} s((p_\tau, b_\tau), (p_t, b_t))1_{\{x_{i,\tau}=x\}}. \quad (1)$$

(for each i, each t, given any h_t)

- *Nearest-Neighbor*: choose τ such that

$$s((p_\tau, b_\tau), (p_t, b_t)) \geq s((p_r, b_r), (p_t, b_t))$$

for all $r < t$, and set $x_i = x_{i,\tau}$.

Most-Similar-Case

- Assume a function

$$f : \mathbb{Z}_+^t \to \mathbb{Z}_+$$

such that, for each i,

$$x_{it} = f\left(x_{i0}, x_{i1}, ..., x_{i(t-1)}\right)$$

- f is a *most-similar-case function* if there exists $\tau < t$ such that

$$f\left(x_0, x_1, ..., x_{t-1}\right) = x_\tau$$

for all $\left(x_0, x_1, ..., x_{t-1}\right) \in \mathbb{Z}_+^t$.

Consistency

- A history

$$h_t = ((p_0, b_0, x_0), \ldots, (p_{t-1}, b_{t-1}, x_{t-1}), (p_t, b_t))$$

  is *regular* if

(i) $b_\tau = b$ for all $\tau \leq t$;
(ii) x_τ is feasible for all $\tau < t$ (that is, $Ax_\tau \leq b$).

- A function $f : \mathbb{Z}_+^t \rightarrow \mathbb{Z}_+$ is *consistent* if it generates a feasible decision for each regular history.

Main Result

- A $(m \times n)$ matrix A contains *potentially conflicting rows* if (i) there exist two rows $i_1, i_2 \leq m$ and three columns $j_1, j_2, j_3 \leq n$ such that $a_{i_1 j} > 0$ and $a_{i_2 j} < 0$ for $j = j_1, j_2, j_3$ and (ii) there exists a row i such that $\sum_j a_{ij} > 0$.

Theorem

Assume that A contains potentially conflicting rows. Then f is consistent if and only if it is a most-similar-case function.

Comments

- The most similar case may often be the most recent
- The result points out that it is difficult to retain consistency because of decentralization
- The assumption that f determines the value of each variable based on its *own* history is equivalent to “independence” in Arrow’s model
- However, in our set-up it doesn’t have a normative flavor; rather, it is a matter of organizational constraints.