# Data and Privacy: Tools from Information Design

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# Economics of Data



Personal data has become key input of the modern economy

**Economics of Data**:

- Implications of collecting, trading, using personal data on economics outcomes, e.g., consumer welfare, market power, etc.
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**Today ⇒ A Methodological Point**

How/why tools from **information design** constitute a building block to study questions concerning the **economics data** (plus some future directions)

# model

# Model

The typical **Information Design** setting:

- A finite set $\Omega$ of payoff states (e.g., demand condition)
- A common prior belief of about $\omega$, denoted $q \in \Delta(\Omega)$
- One "designer," $N$ agents (e.g., e-com platform and merchants)
- Finite action sets $A_0 \times A_1 \times \ldots \times A_N =: A$ (e.g., price, feature, quality)
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- Base Game: $G = (\Omega, q, N, (A_i, u_i)_{i \in N})$
- An information structure is a pair $(S, \pi)$ s.t. $S = S_1 \times \ldots \times S_N$ (finite) and $\pi : \Omega \to \Delta(S)$

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The **information-design** problem:

$$V(q) = \max_{(S,\pi)} \max_{\sigma \in \mathsf{BNE}(G,(S,\pi))} \sum_{\omega,s,a} v(a,\omega)\sigma(a|s)\pi(s|\omega)q(\omega)$$

# Applications

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Limiting assumptions of the standard model:

Commitment power, equilibrium selection, inherently static

# Obedient Recommendation Mechanisms

The ID problem can be equivalently formulated as choosing an obedient direct **recommendation mechanism** $x : \Omega \to \Delta(A)$: Bergemann and Morris '16, *TE*

$$V(q) = \max_{x:\Omega\to\Delta(A)} \sum_{\omega,a} v(a,\omega)x(a|\omega)q(\omega)$$

such that, for all $i \in N, a_i, a_i' \in A_i$

$$\sum_{\omega,a_{-i}} \Big(\pi_i(a_i, a_{-i}, \omega) - \pi_i(a_i', a_{-i}, \omega)\Big)x(a_i, a_{-i}|\omega)q(\omega) \geq 0$$

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A finite-dimensional linear program $\Rightarrow$ Quite tractable

The typical object of interest in the ID literature: Characterize the optimal $x$

# a different perspective

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A **database** of data records: $q = \big(q(\omega)\big)_{\omega \in \Omega} \in \mathbb{R}_+^{\Omega}$

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   A benchmark for compensating individuals for their data

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   – What are the properties of the "demand function" for data

   Law of demand — as $q(\omega) \nearrow$, value of $\omega$-records $\searrow$

   Indifference curves — When are records complement/substitute?

   Merging databases: When is $V(q + q') > V(q) + V(q')$?

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Intermediaries pay consumers for their data records

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Galperti, Liu, Perego '24 (For more details on this, come to my talk!)

Sunday @8am, Session title: *Competitive Implications of Data Sharing*

# conclusions

# Conclusions

- A large literature in **information design** provides natural framework and powerful tools to study questions concerning the **economics of data**
- Information design as a production problem:

  *Input:* Personal Data $\rightarrow$ *Output:* Optimal Information

- A new perspective: How does changing inputs affects economic outcomes (through changes in optimal information)?
- This is key for studying: The value of data; The effects of privacy protection policies; The role of data unions; etc.
- In my view, this is a natural direction for this literature: lots of open questions and high demand for better theory

# an example

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- $\omega_L$ reveals consumer has valuation $1$
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Merchant chooses price $a \in A$ given information received. He maximizes profits:

$$\pi(a, \omega) = a\mathbb{1}(\omega \geq a)$$

Suppose platform choose information to maximizes consumer's surplus

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**Question:** How much **value** does platform derive from each record in $q$?

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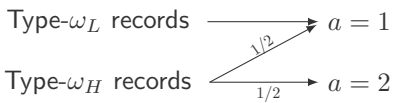
The (unique) optimal recommendation mechanism $(x_q : \Omega \to \Delta(A))$ is:



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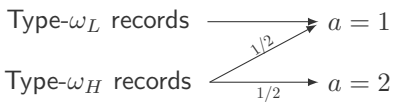


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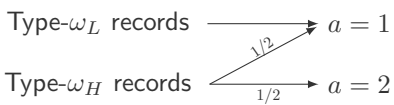


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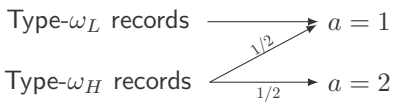


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Are $\omega_L$-records worthless? No, **value of data records** is $\psi_q^*(\omega) = \begin{cases} 1 & \text{if } \omega_L \\ 0 & \text{if } \omega_H \end{cases}$

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- **Approach.** Platform uses inputs (data records) to produce outputs (recommendations). GLP '23 use LP duality to **characterize** the **values** of these inputs, namely $\psi_q^*(\omega)$ – platform's willingnes to pay for an additional $\omega$-record