Pretention as a Means of Privacy: A Population Game with Signaling

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Workshop on Privacy and Economics
Short Talks

Caltech, Pasadena, CA
“Easily accessible digital records of behavior, Facebook Likes, can be used to automatically and accurately predict a range of highly sensitive personal attributes including: sexual orientation, ethnicity, religious and political views, personality traits, intelligence, happiness, use of addictive substances, parental separation, age, and gender [...] The model correctly discriminates between homosexual and heterosexual men in 88% of cases, [...] and between Democrat and Republican in 85% of cases.”

Modeling: Simple Pretention with Externality

- type, action, population action

\[ u(\theta, a, x_{\mathcal{A}}) = -C(\theta, a) - K(a, x_{\mathcal{A}}) \]

- Pretention Cost, Privacy (stigma) Cost

Example:

- \( \theta \in \Theta = \{\text{Roman, Barbarian}\} \), \( a \in \mathcal{A} = \{R, B\} \), \( x_{\mathcal{A}} \in \Delta\{R, B\} \)
- \( C(\theta, a) = c_{\theta,a} \) s.t. \( c_{BB} = c_{RR} = 0 \), \( c_{RB}, c_{BR} > 0 \)
- \( K(a, x_{\mathcal{A}}) = 1_{a=B}/x_B + 1_{a=R}/x_R \), where \( x_R = 1 - x_B \)

- Distribution of the true types (not known to individuals necessarily): \( P \in \Delta(\Theta) \), i.e., \( 0 \leq P_R, P_B \leq 1 \), \( P_R + P_B = 1 \)
- no conversions or birth-death imbalance
Modeling: Simple Pretention with Externality

\[ x_B = x_{BB} + x_{RB} \]

\[ u_{BB}(x_B) \]

\[ u_{BR}(x_B) \]
Modeling: Simple Pretention with Externality

\[ x_B = x_{BB} + x_{RB} \]

Utilities:
- \( u_{BR}(x_B) \)
- \( u_{BB}(x_B) \)
- \( u_{RB}(x_B) \)
- \( u_{RR}(x_B) \)
Modeling: Simple Pretention with Externality
Modeling: Simple Pretention with Externality

\[
\frac{dx_{BB}}{dt} = \gamma \left( (P_B - x_{BB}) \cdot (u_{BR}(x_B) < u_{BR}(x_B)) - x_{BB} \cdot (u_{BR}(x_B) > u_{BR}(x_B)) \right)
\]

\[
\frac{dx_{RR}}{dt} = \gamma \left( (P_R - x_{RR}) \cdot (u_{RB}(x_B) < u_{RR}(x_B)) - x_{RR} \cdot (u_{RB}(x_B) > u_{RR}(x_B)) \right)
\]
Modeling: Simple Pretention with Externality

\[ x_{BB} \]

Monolithically Declared Barbarian

Monolithically Declared Roman

Truthful Eq.

Arman Khouzani (EE, USC)
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Pretention with Signaling and Non-B. beliefs

- type, action, population action

\[ u(\theta, a, x_{\mathcal{A}}) = -C(\theta, a) - K(a, x_{\mathcal{A}}) \]

- Pretention Cost, Privacy (stigma) Cost

Example:

- \( \theta \in \Theta = \{R, B\} \), \( a \in \mathcal{A} = \{\text{pants, toga}\} \), \( x_{\mathcal{A}} \in \Delta\{p, t\} \)
- \( C(\theta, a) = c_{\theta,a} \) s.t. \( c_{Bt} \geq c_{Rt}, c_{Bp} \leq c_{Rp} \)
- \( K(a, x_{\mathcal{A}}) = \frac{P\{B|a\}}{P\{B|t\}x_t + P\{B|p\}x_p} + \frac{P\{R|a\}}{P\{B|t\}x_t + P\{B|p\}x_p} \)
- Non-Bayesian posterior updates: assume \( P\{\theta|a\} \) is fixed!
Pretention with Signaling and Non-Beliefs

\[
dx_{Bp}/dt = \gamma \left( (P_B - x_{Bp}) \cdot (u_{Bt}(x_p) < u_{Bt}(x_p)) - x_{Bp} \cdot (u_{Bt}(x_p) > u_{Bp}(x_p)) \right)
\]

\[
dx_{Rt}/dt = \gamma \left( (P_R - x_{Rt}) \cdot (u_{Rp}(x_p) < u_{Rt}(x_p)) - x_{Rt} \cdot (u_{Rp}(x_p) > u_{Rt}(x_p)) \right)
\]
Pretention with Sig. and Bayesian beliefs

- type, message, population message, reaction

\[ u(\theta, m, x_M, r) = -C(\theta, m) - K(m, x_M, r) \]

- Pretention Cost, Privacy (stigma) Cost

where here \( r \in \Delta \Theta: P(\Theta|m) \) (The Big-Eye player). Example:

- \( \theta \in \Theta = \{ R, B \}, m \in M = \{ \text{pants}, \text{toga} \}, x_M \in \Delta \{ p, t \} \)

- \[ K(m, x_M, r) = \frac{P\{ B|m \}}{P\{ B|t \}x_t + P\{ B|p \}x_p} + \frac{P\{ R|m \}}{P\{ B|t \}x_t + P\{ B|p \}x_p} \]

- The distribution of the true types is known: \( P \in \Delta(\Theta) \)

- Bayesian posterior updates: \( r \) should satisfy incentive compatibility and Bayesian update rule.
Pretention with Sig. and Bayesian beliefs

Semi-Pooling Equilibria?

Pooling Equilibria

Separating Equilibria

Dynamics?

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Gens: social graph, more types, conversions, birth-deaths, per ind. priors, etc.

Figure: source:wikimedia