Eliciting Informative Feedback: The Peer-Prediction Method

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The Setting

Camera Quality:
dist D over $\{L, H\}$

$s^1 \sim S$

$s^2 \sim S$

S: dist over $\{l, h\}$ jointly w/ D

Rater

Rater

Report r^1

Report r^2

Center:
- Ebay
- NetFlix
- Amazon

Example:

$$\Pr[S = h | D = H] = 0.85$$
$$\Pr[S = l | D = H] = 0.15$$

$$\Pr[S = h | D = L] = 0.45$$
$$\Pr[S = l | D = L] = 0.55$$

$$\Pr[D = H] = 0.5$$
$$\Pr[D = L] = 0.5$$

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Task:

How to make rational raters report honestly ($r^i = s^i$)

Naive Attempt: reward $\tau = \$1$ if $r^1 = r^2$, $\tau = \$0$ otherwise

Problem: rater 1 will report "more likely signal" of rater 2

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Task (formulation):
Reporting $r^i = s^i$ is a Nash Equilibrium

$\Updownarrow$

$\forall$ rater i, signal m, $x \neq m$

$$\mathbb{E}_{s^2}[\tau_1(s^1, s^2) | s^1 = m] \geq \mathbb{E}_{s^2}[\tau_1(x, s^2) | s^1 = m]$$

$$\mathbb{E}_{s^1}[\tau_2(s^2, s^1) | s^2 = m] \geq \mathbb{E}_{s^1}[\tau_2(x, s^1) | s^2 = m]$$

Solution using Proper Scoring Rule

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Task:

choose payoff τ_1 such that

$$\mathbb{E}_{s^2}[\tau_1(x, s^2) | s^1 = m]$$

is maximized at $x = m$

$$\Updownarrow$$

Equivalently,

$$\mathbb{E}_{z \sim Z}[\tau_1(x, z)]$$

where $Z = s_2|_{s_1 = m}$

Recall: f is **Proper Scoring Rule** if $\mathbb{E}_{z \sim Z}[f(P, z)]$ is maximized at $P = Z$

So let $\tau_1(x, z) = f(s_2|_{s_1 = x}, z)$

Issue: costs to the rater

In reality,

- Evaluating and reporting honestly incur a relative cost $c > 0$
  (e.g. testing is time consuming, opportunity cost, ...)
- Can be offset by scaling up the payoffs
- Problems:
  - Paying too much for truthful information?
  - What if c is unknown? [PRGJ08]

Issue: costs to the center

To reduce center's cost:

- Budget balancing:
  - pair up raters, make each pair a zero-sum game

- Use linear optimization to find cost-optimal payoff function [JF06]

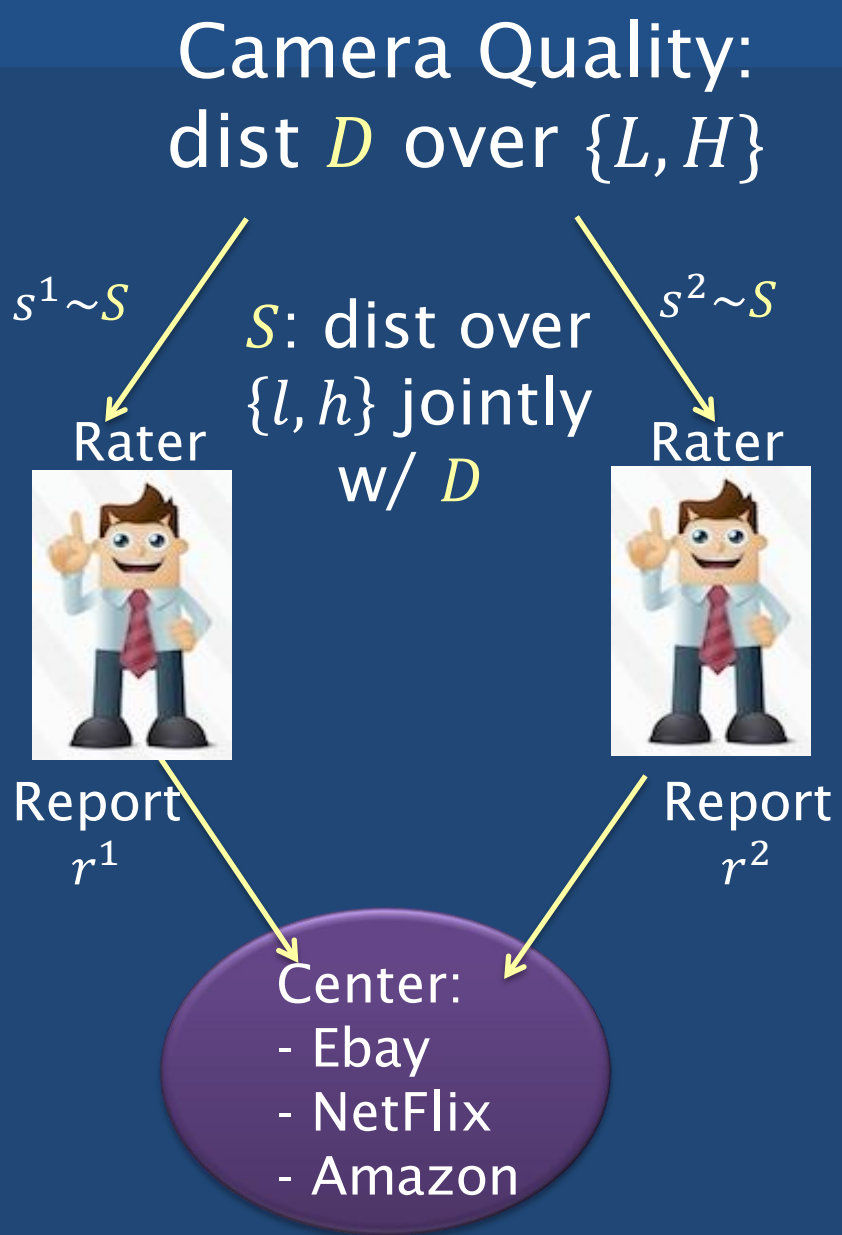
Issue: risk aversion

- When the center knows the raters' utility function(s)
- When the center does not know the utility function(s)
- Using multiple reference raters reduces risk

Issue: collusion

- Using an honest reference rater
- Randomized reference rater
- Outside experts...

Issue: Unknown/diff. priors



- In reality, raters have diff. beliefs about (D, S), unknown to the center
- Addressed in [WP12] for binary signals S