Persuasion with Coarse Communication

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Motivation

- **Expert advice** is vital for decision making in many settings
- Misaligned preferences complicates giving and receiving of this advice
- Kamenica and Gentzkow (2012): **Bayesian Persuasion** for Expert-Decision Maker communication

Motivation

- A key assumption in **Bayesian Persuasion** is **rich communication**
    - There are enough messages to describe **every state** or recommend **every action**
- In practice, we often see communication that is **coarse**
    - **e.g.** Letter grades, Hygiene Ratings, Credit Ratings
- We study **how limited availability of signals** effect communication

Preview of Result - Sender & Receiver

- **Sender** does worse off
    - ***Marginal value of a signal*** is bounded above
- **Receiver:** might benefit from the coarse communication
    - **Receiver** may limit **Sender's** persuasive ability
        - e.g. Judge v. Prosecutor

Preview of Result - Equilibrium

- We characterize **geometric properties** of the equilibrium
    - Locate the **optimal posteriors** in terms of **extremene beliefs**
- Using this, we describe a finite **algorithm** for finding equilibrium
- We describe the **set of attainable payoffs**

The Model

- Canonical Bayesian Persuasion model
- **States:** $\omega \in \Omega$ and **Actions:** $a \in A$
- **Signals:** $s \in S$ **with** $|S| = k \leq \min\{|A|, |\Omega|\}$
- **Belief-based Approach:** Choose μ_s and $\tau \in \Delta^2(\Omega)$ with $\mathbb{E}_{\mu \sim \tau}\mu = \mu_0$

Example: Targeted Advertisement

- **Receiver:** Customers who arrive to a platform
- **Sender:** Platform recommending goods/houses
  - Observes the state and picks which ads to show to a customer
- **State:** match between ideologies — similiar to Rayo & Segal (2010)

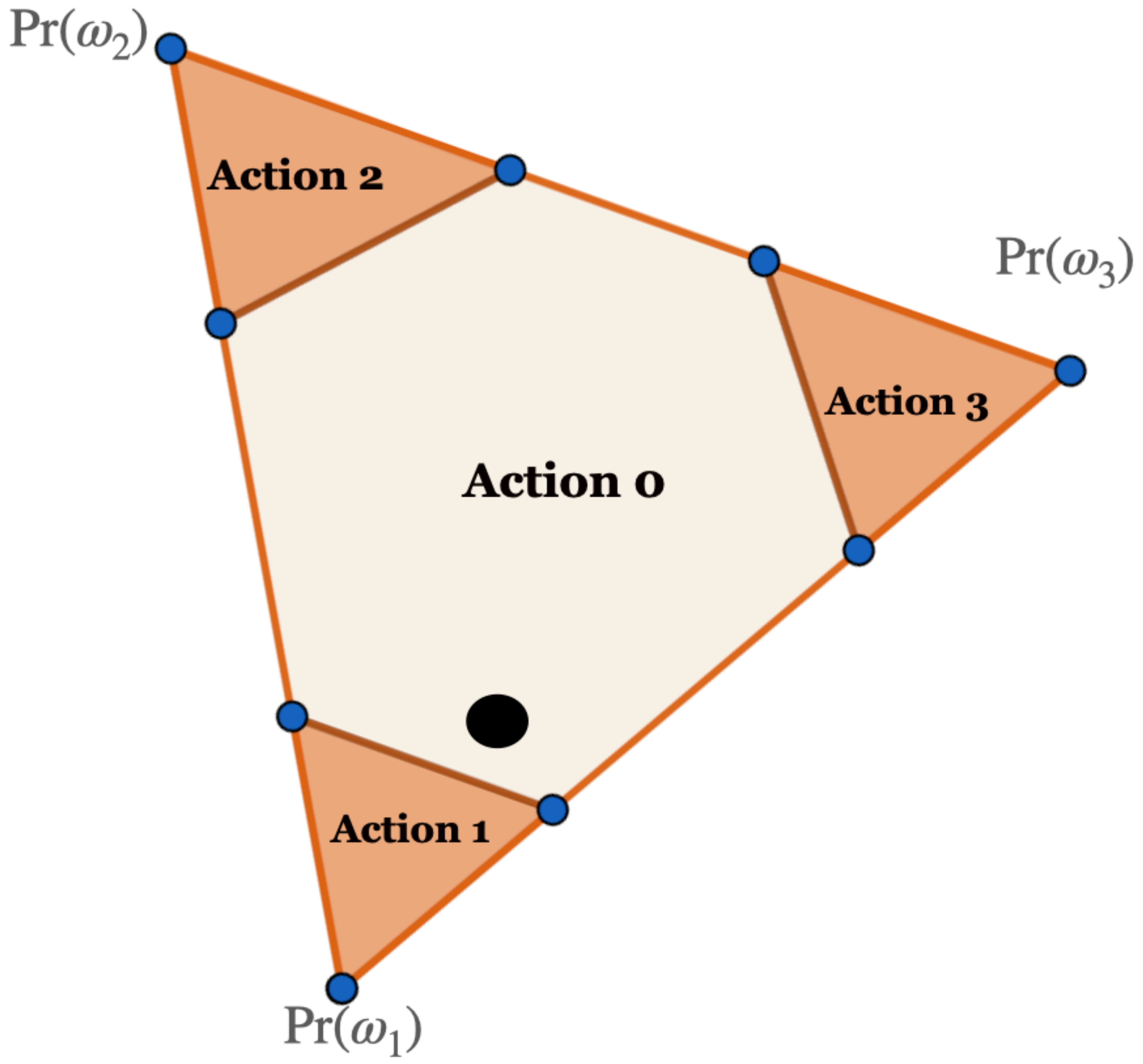
Receiver Strategy

States:

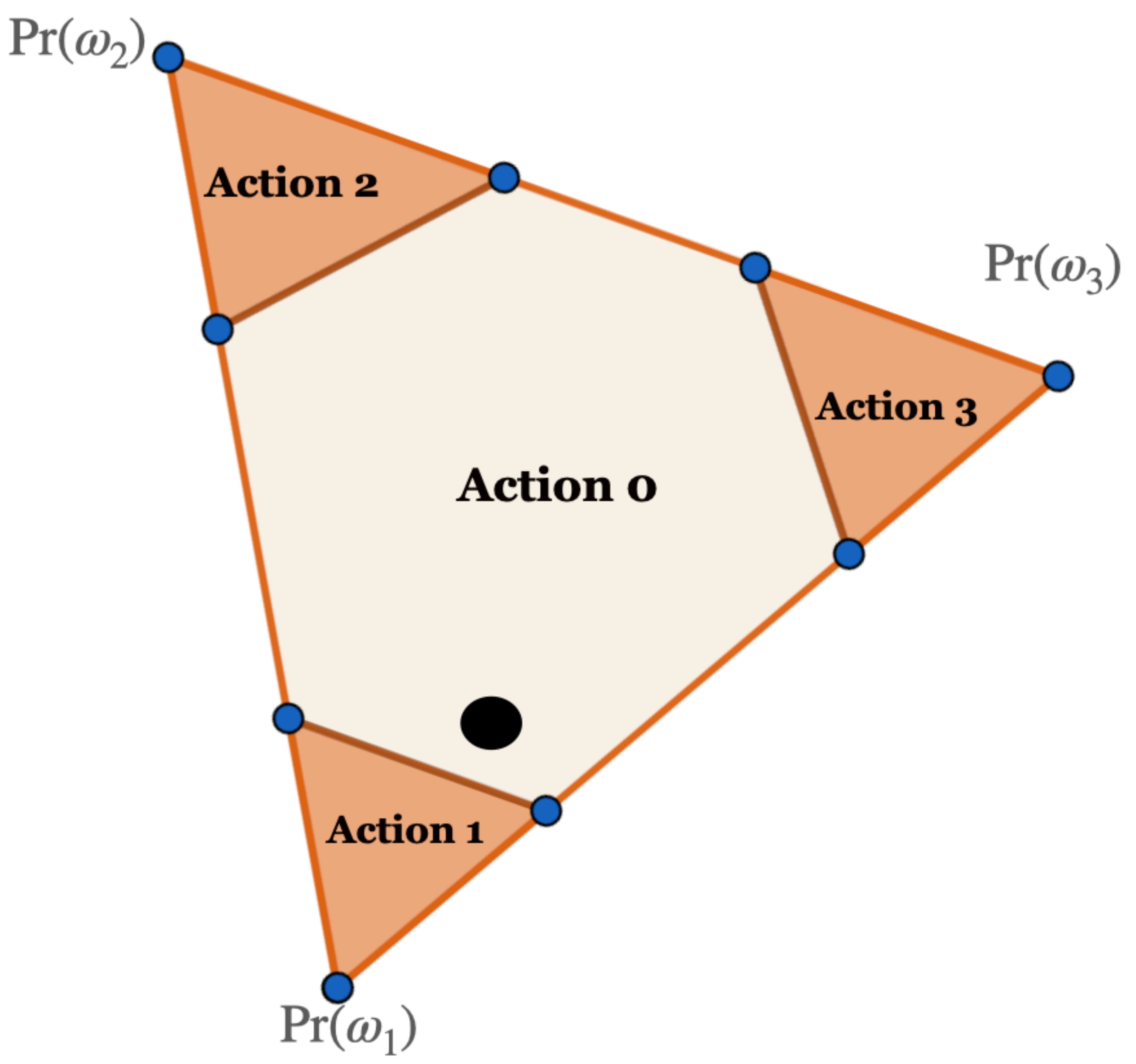
- ω_1 bad match
- ω_2 weak match
- ω_3 good match

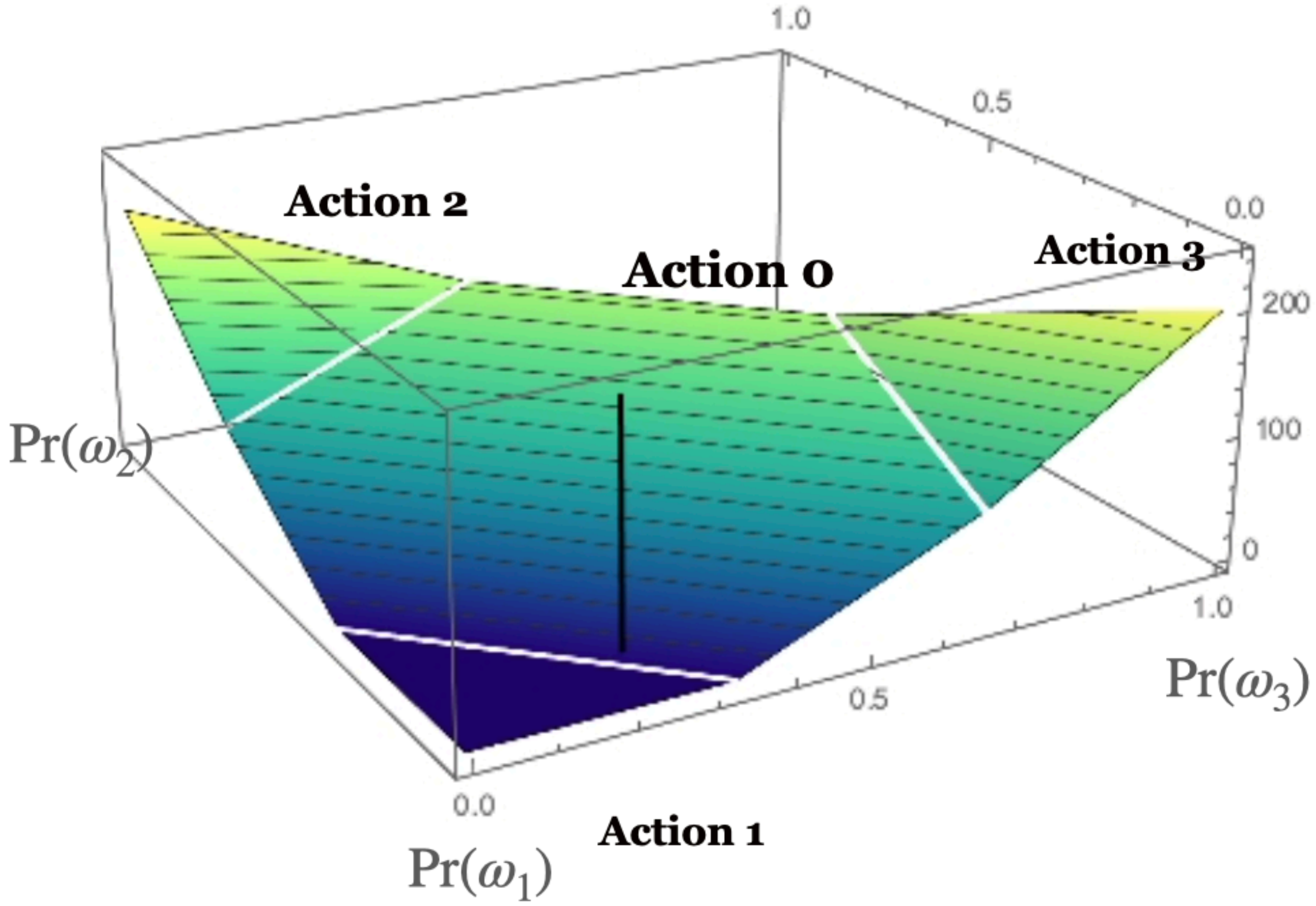
Actions:

- a_1 hide
- a_2 wishlist/tour
- a_3 buy/apply
- a_0 click/impression

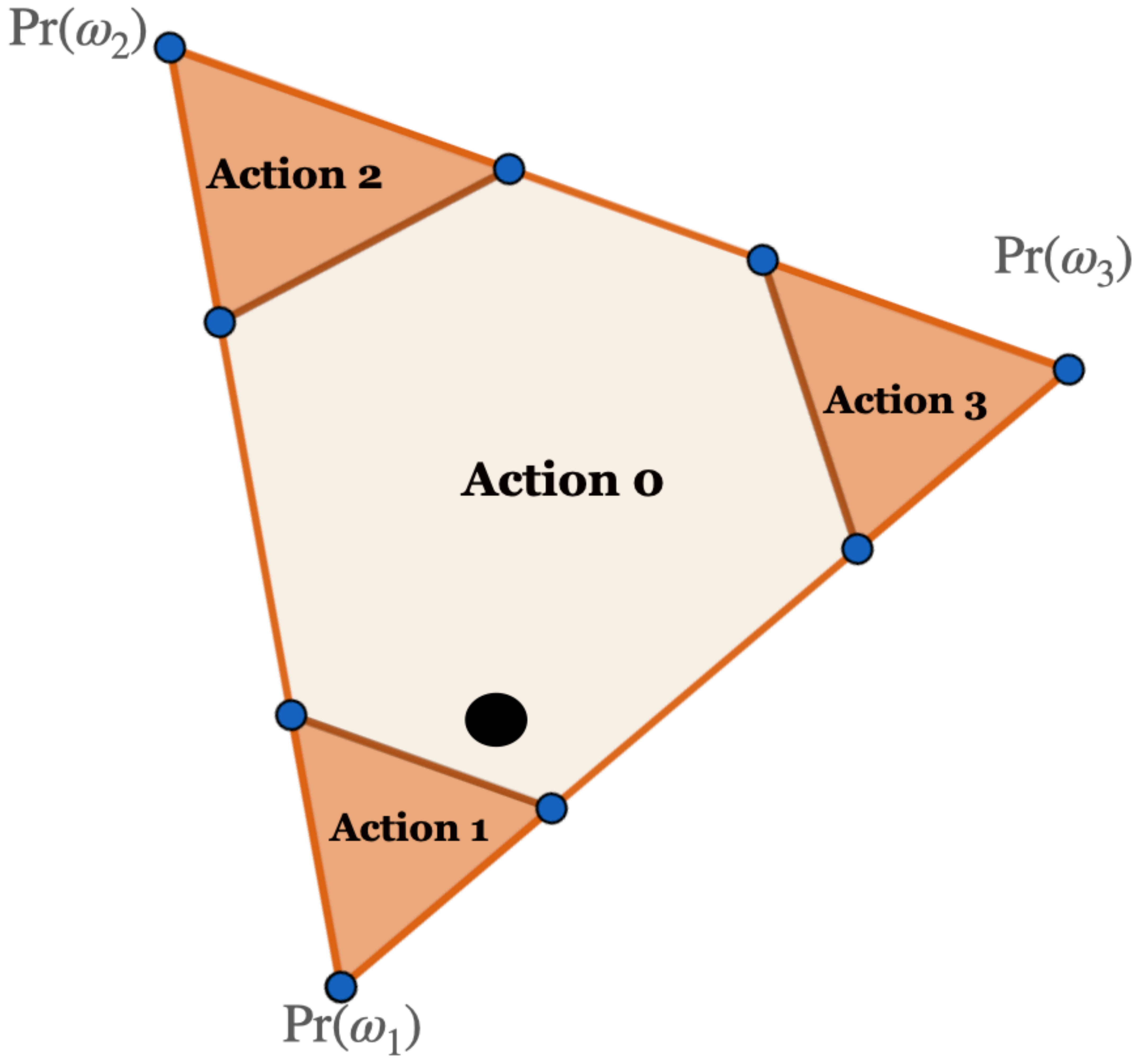


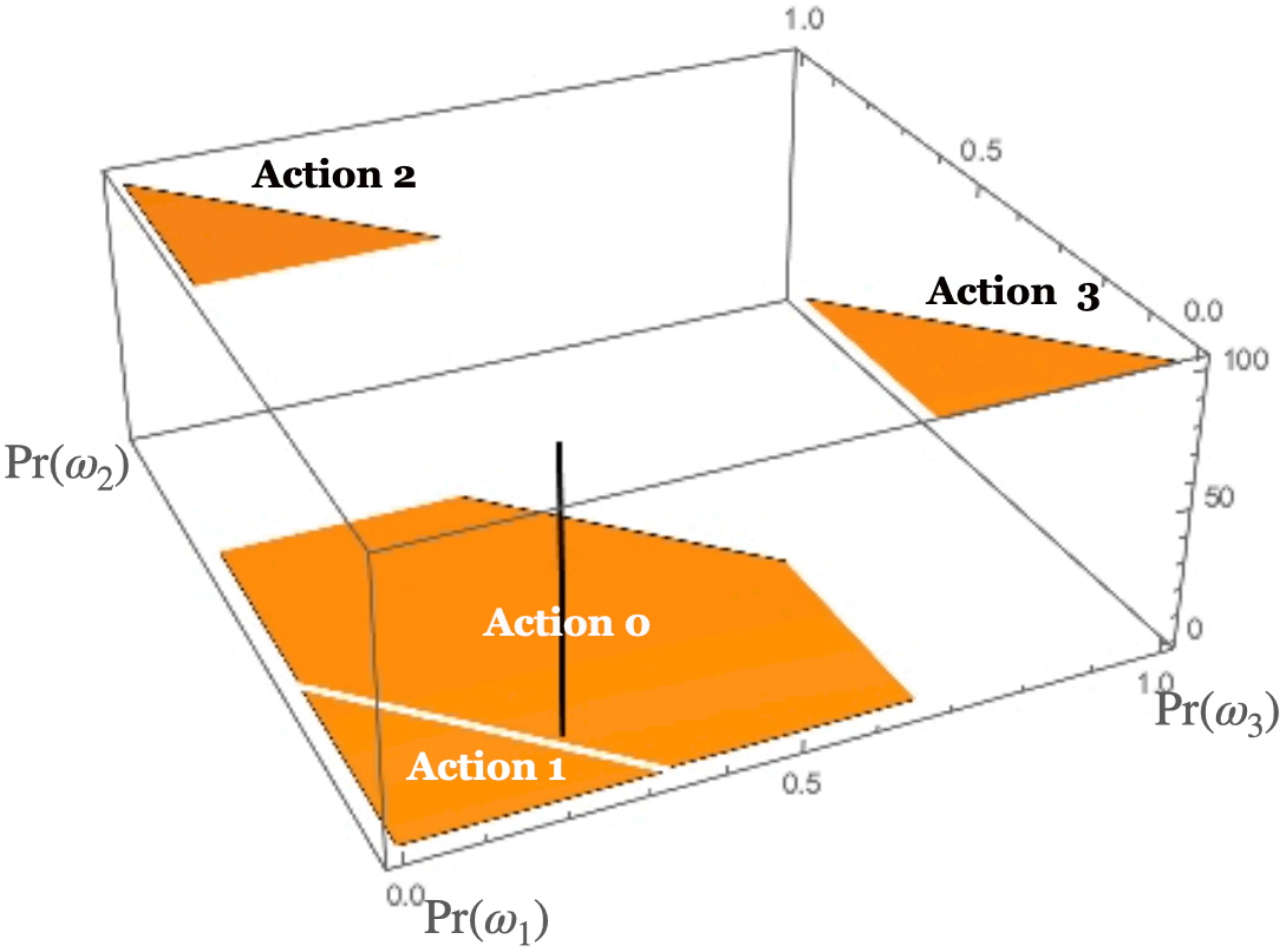
Receiver Utility



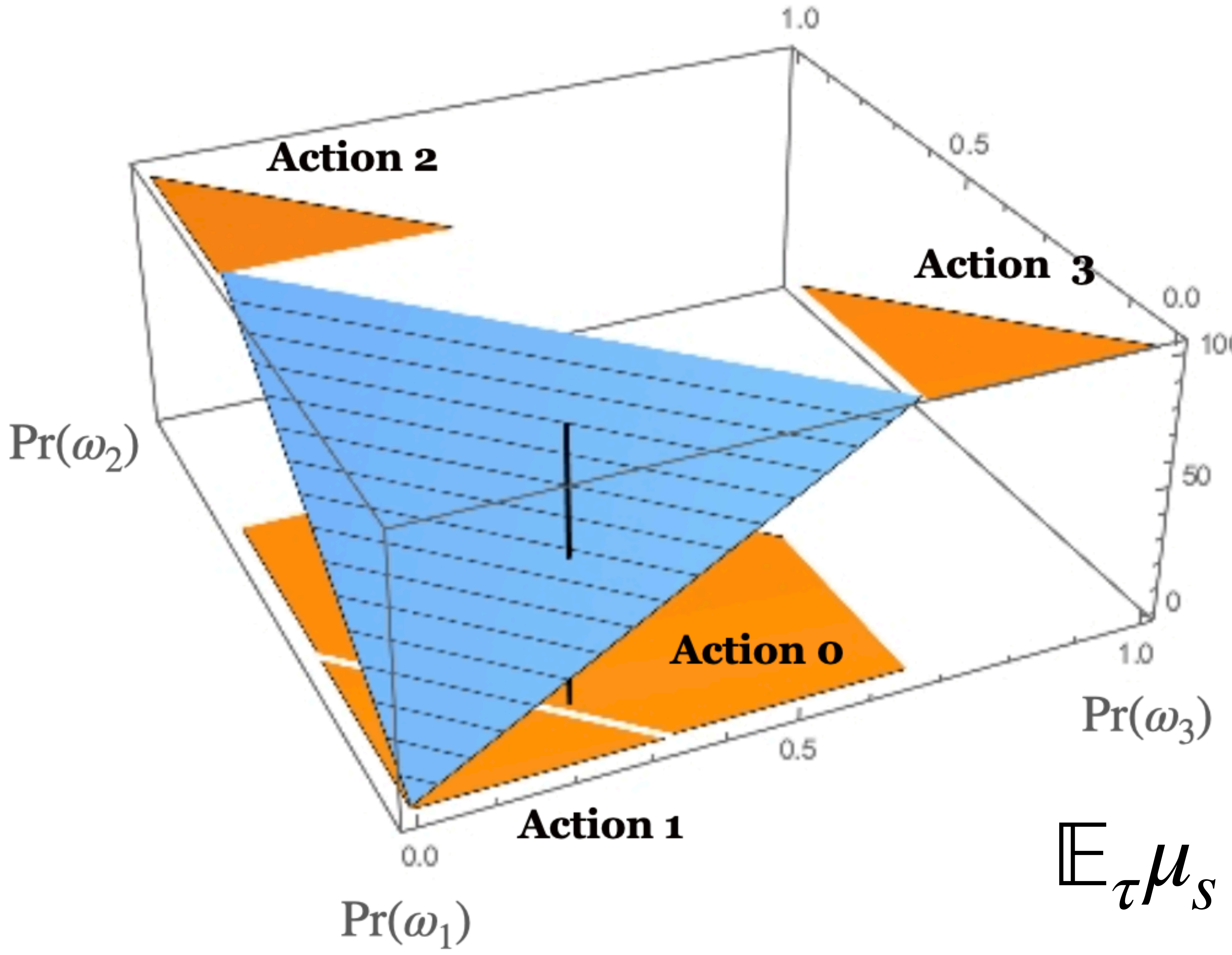


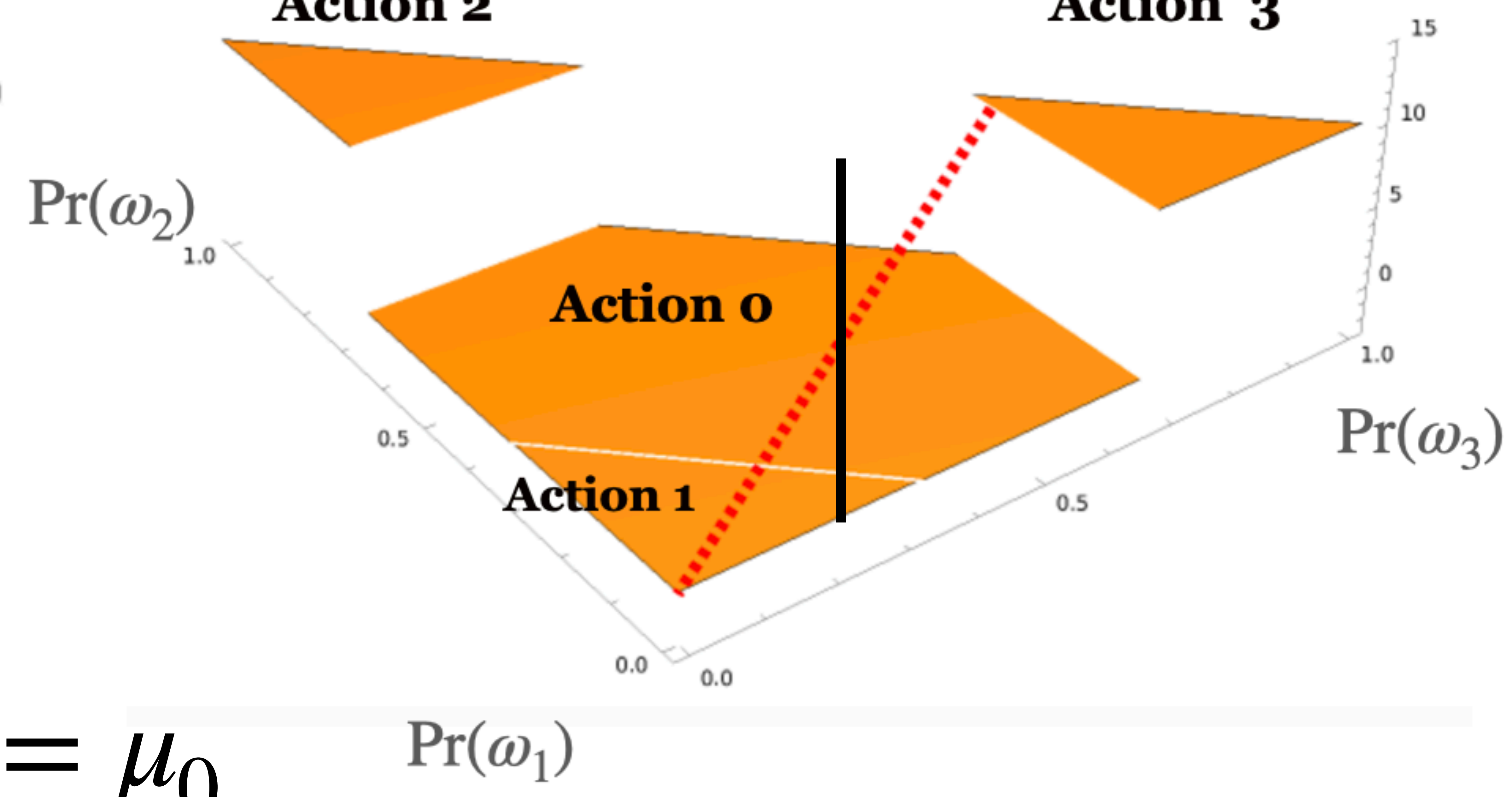
Sender Utility





Full v. Coarse Communication





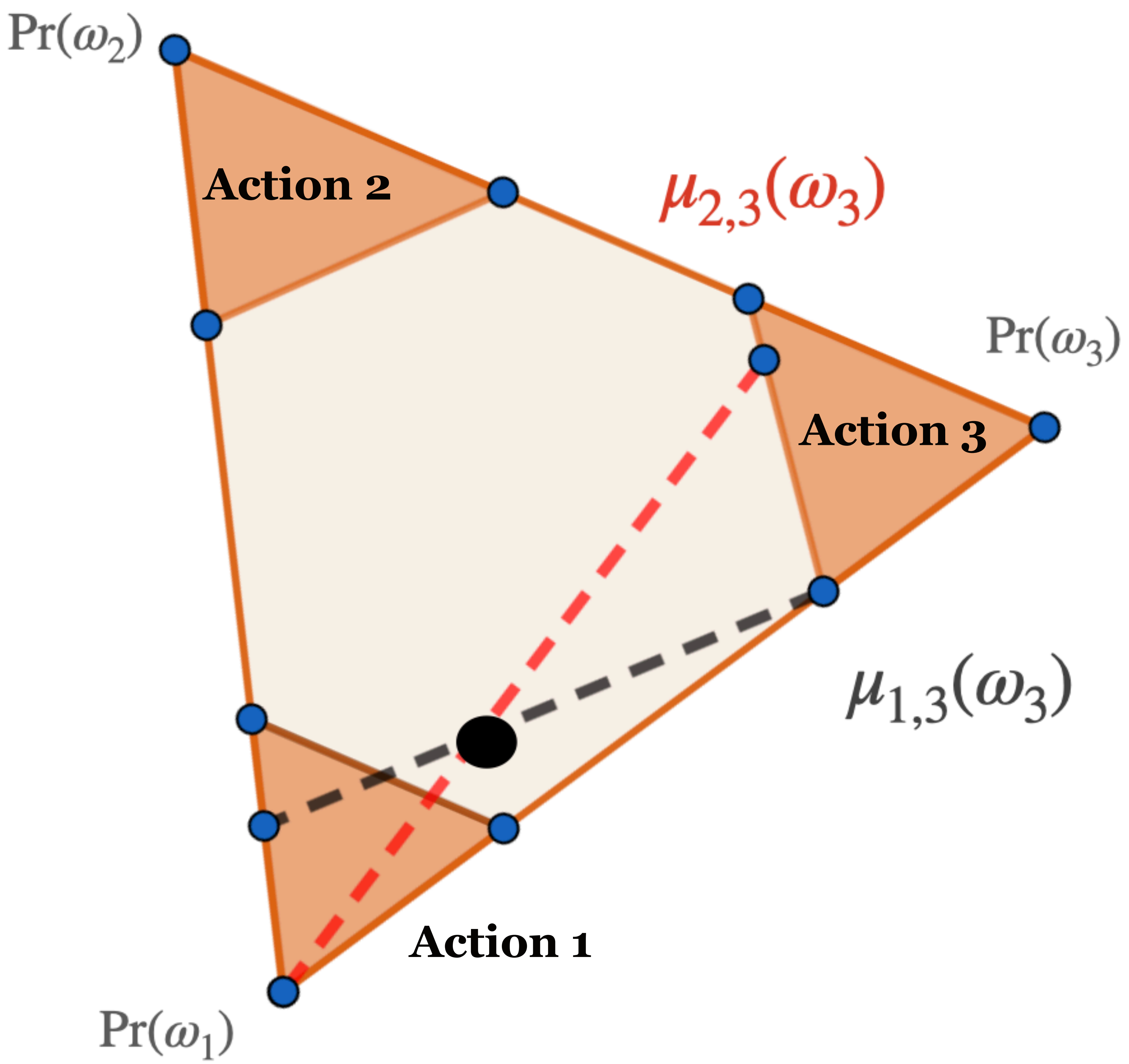
$$\mathbb{E}_\tau \mu_s = \mu_0$$

Full Communication
3 signals - Triangle

Coarse Communication
2 signals - Line

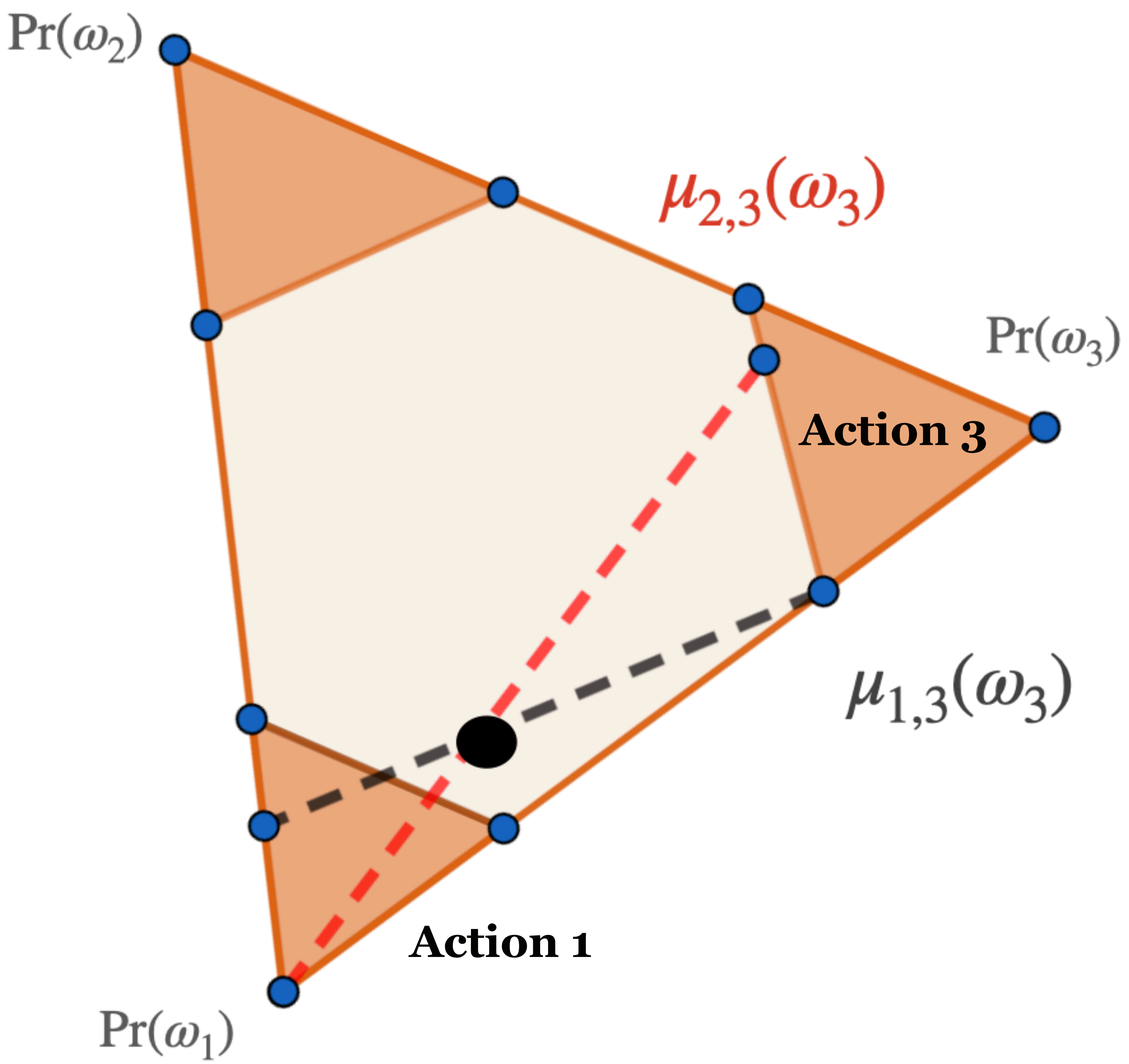
Searching for Optimal

- **Lemma:** Optimal information structure with k-signal exists
- How can we search for the optimal information structure?



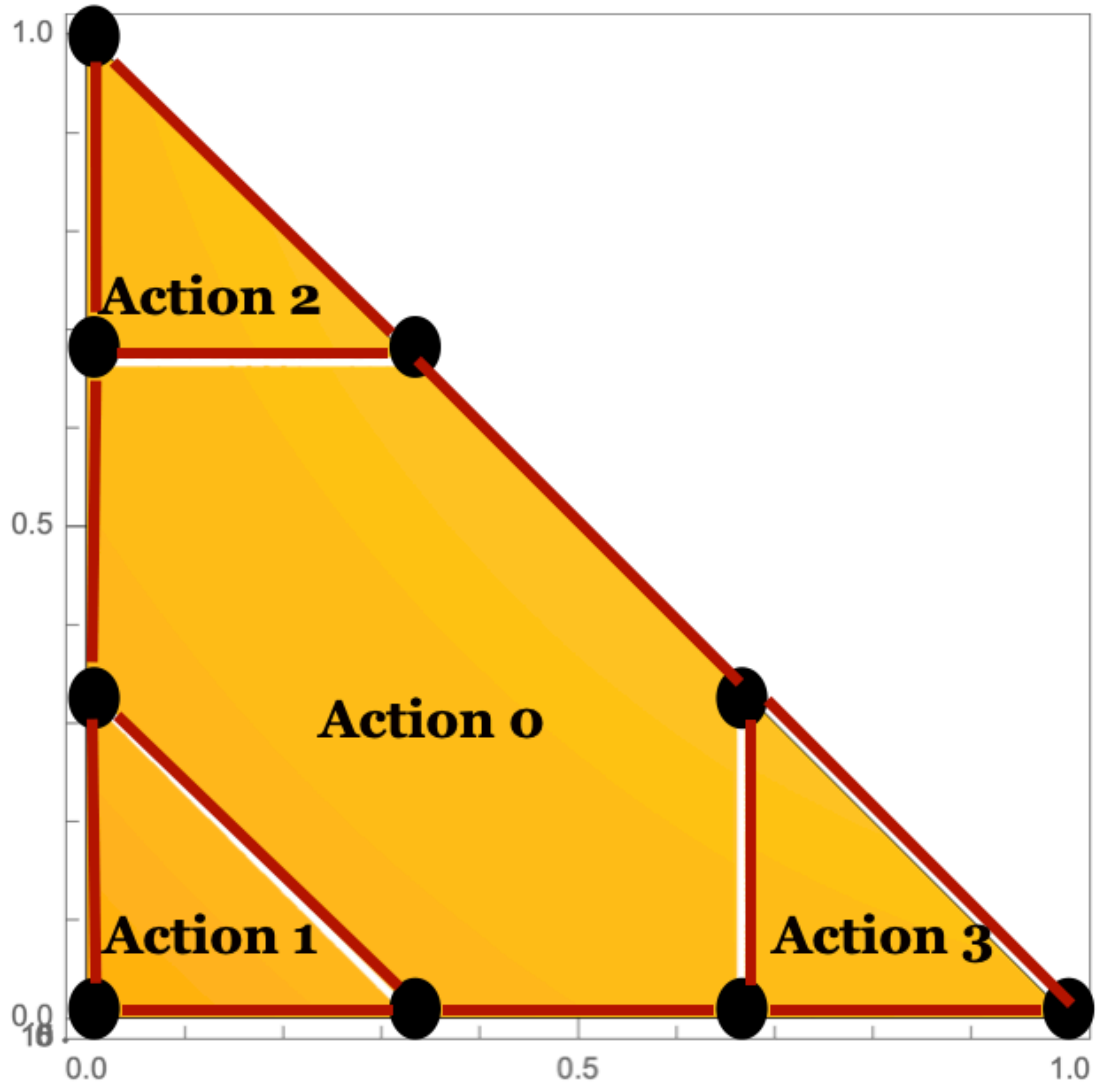
Searching for Optimal

- Optimality: **Corner** and **Edge**
- Feasibility: Passes through prior
- Only a **finite set** of alternatives



Searching for Optimal - Generalization

- Extreme points ⇒ **Extreme beliefs**
- q-extreme points are averages of (q-1)-extreme points, but not vice versa
- Similiar to Lipnowski & Mathevet (2017)



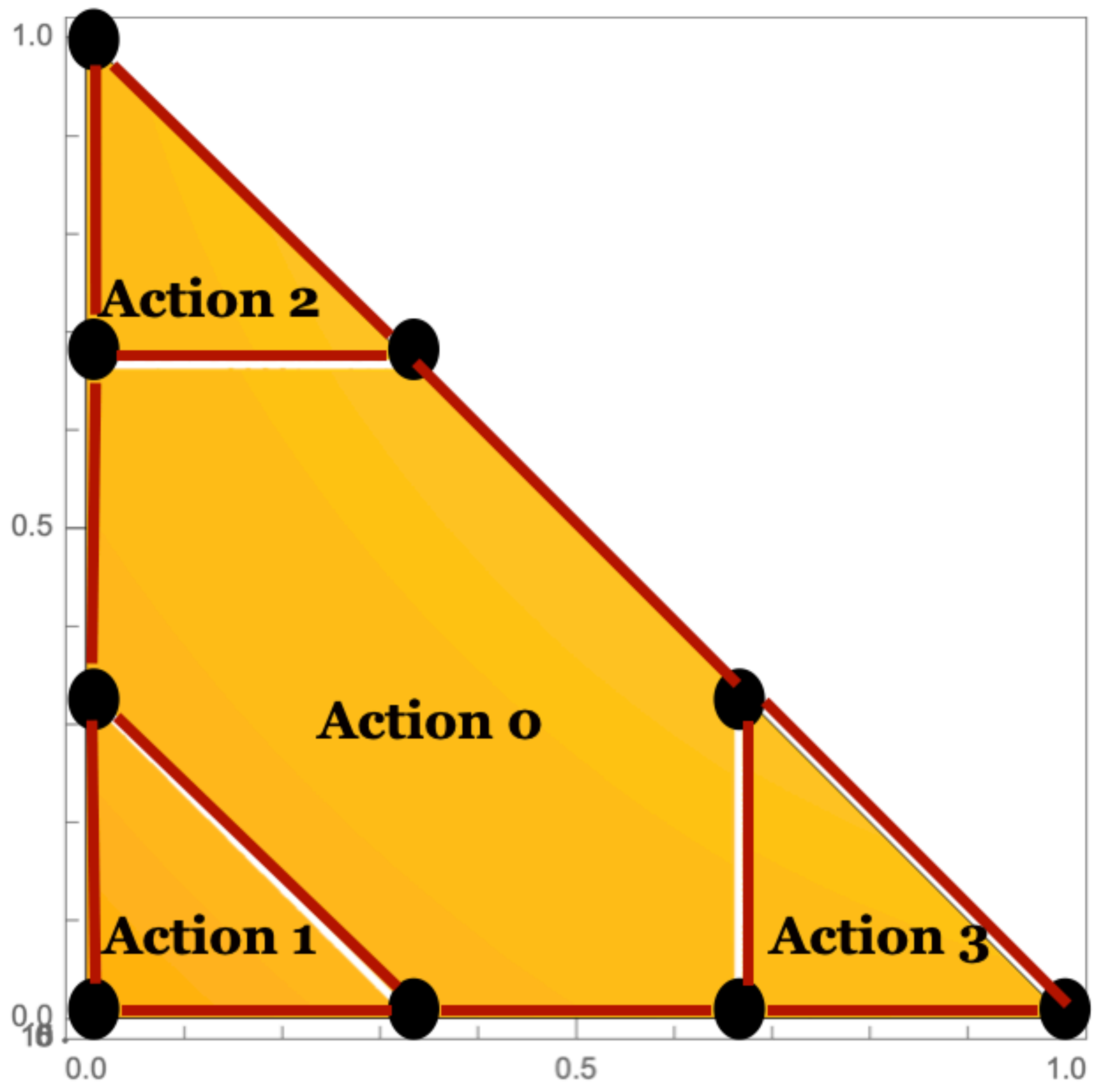
Black Points: 0-extreme points
Red Lines: 1-extreme points
Orange Regions: 2-extreme points

Searching for Optimal

Optimal information structure has:

- **k-1 posteriors** that are **0-extreme**
- k^{th} is at least $(n - k)$ **extreme**

Corollary: We describe a finite search algorithm for finding the optimal information structure



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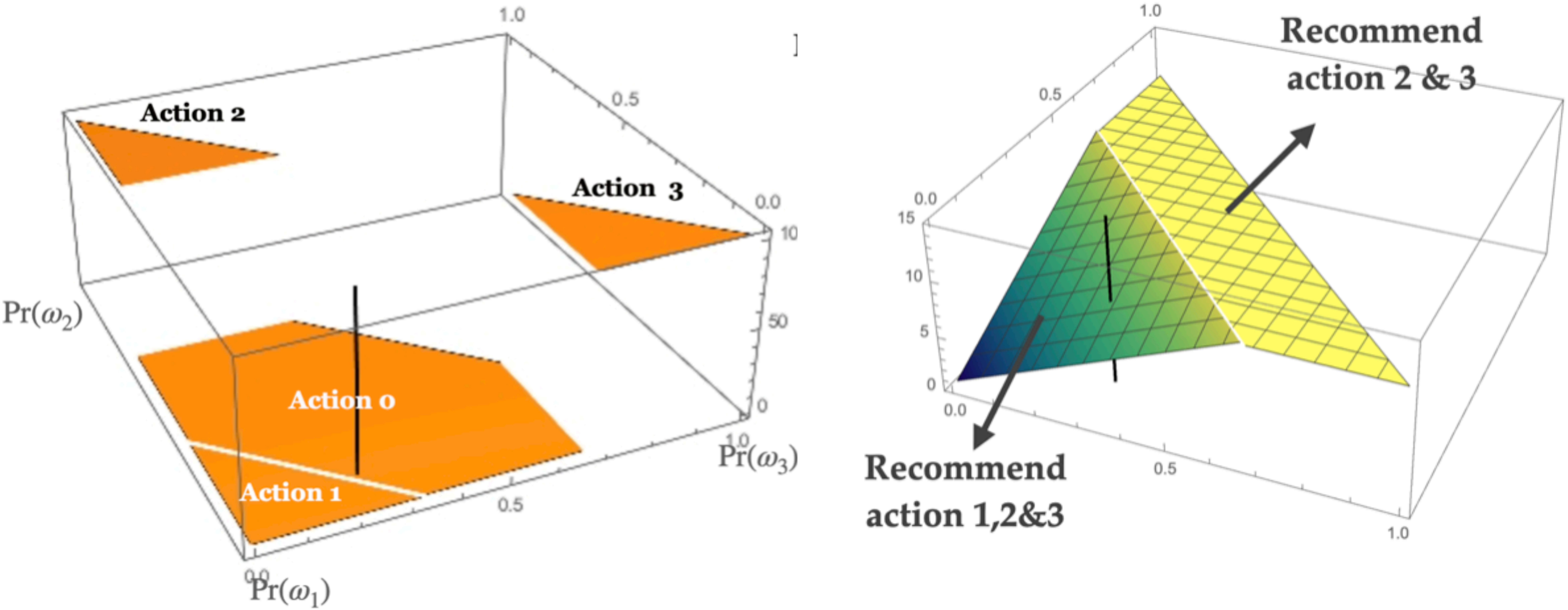
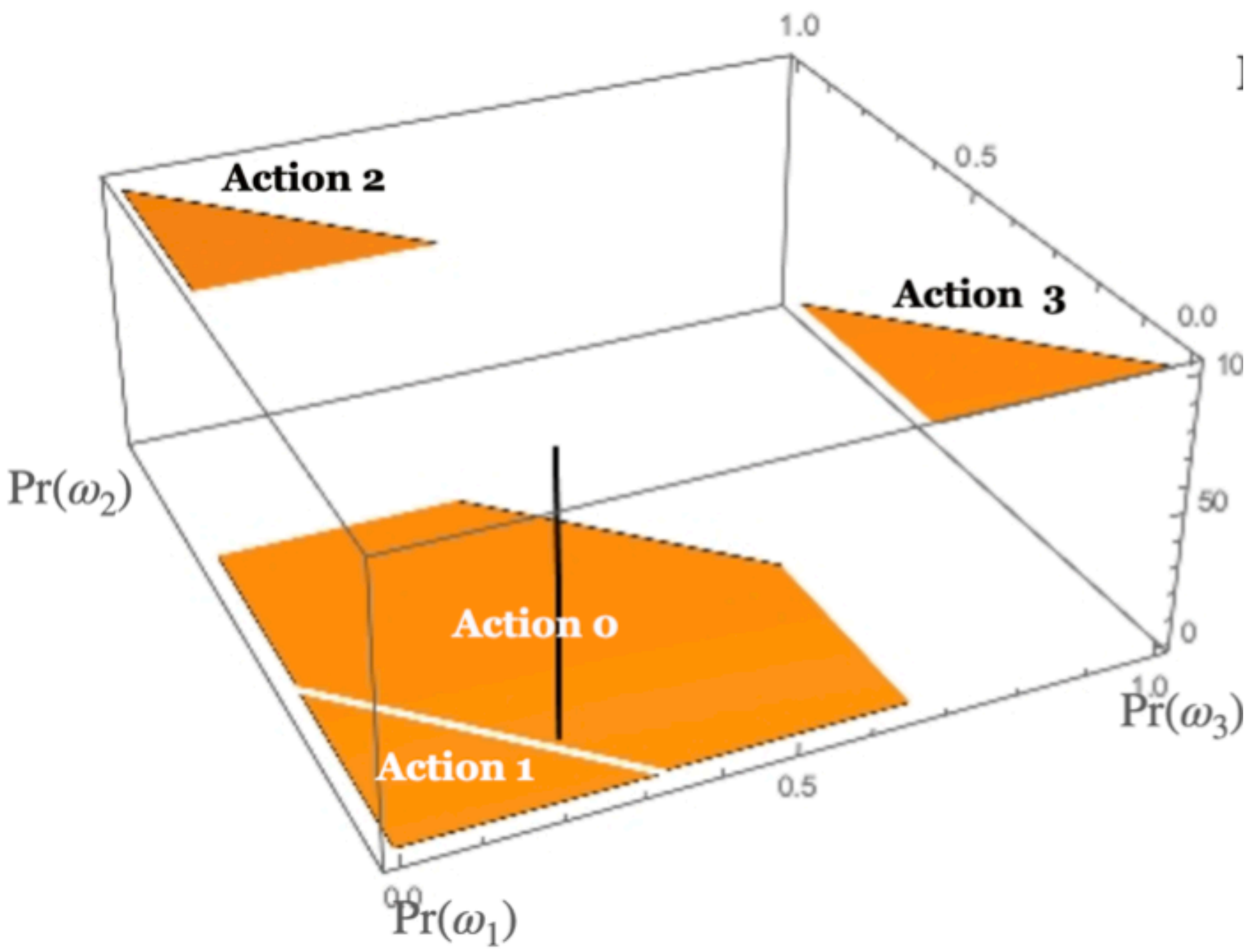
Set of Attainable Payoffs

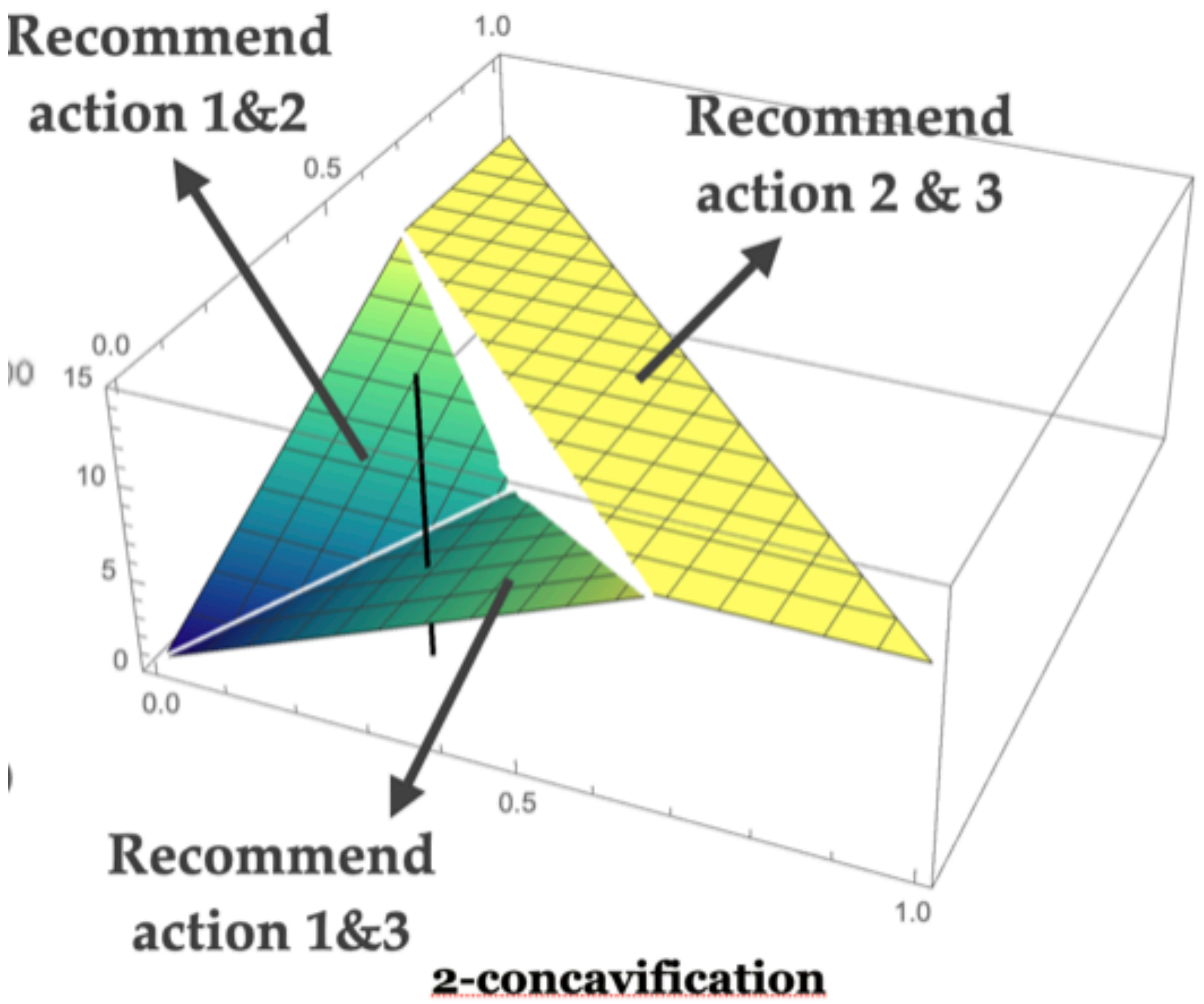
$$V(\mu_0) = \left\{ z \mid (\mu_0, z) \in \text{co}\left(\mathbb{E}_{\omega \sim \mu} u^s(a^*(\mu), \omega) \right) \right\}$$



k-Concavification

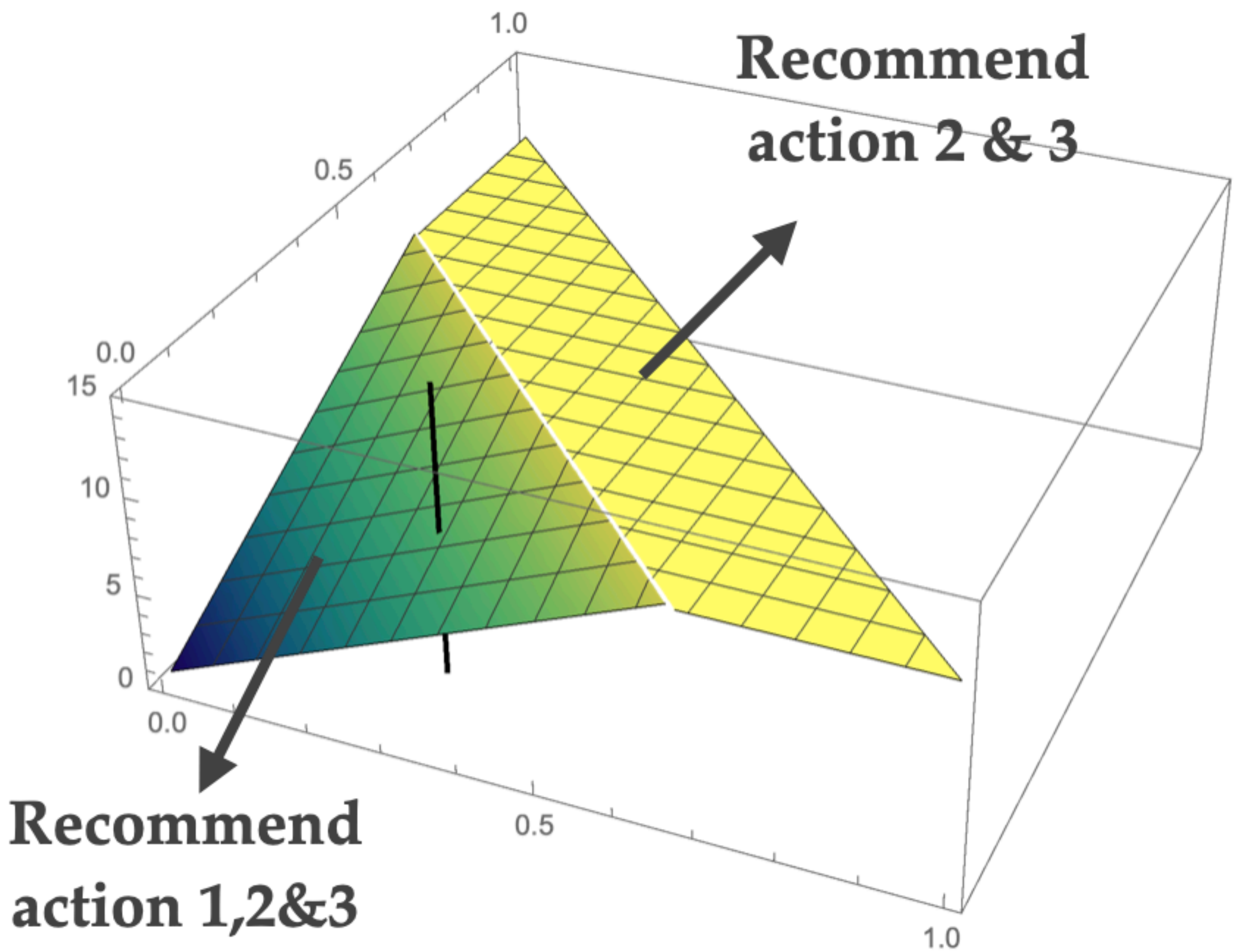
$$V_k(\mu_0) = \left\{ z \mid (\mu_0, z) \in \mathrm{co}_k \left(\mathbb{E}_{\omega \sim \mu} u^s(a^*(\mu), \omega) \right) \right\}$$

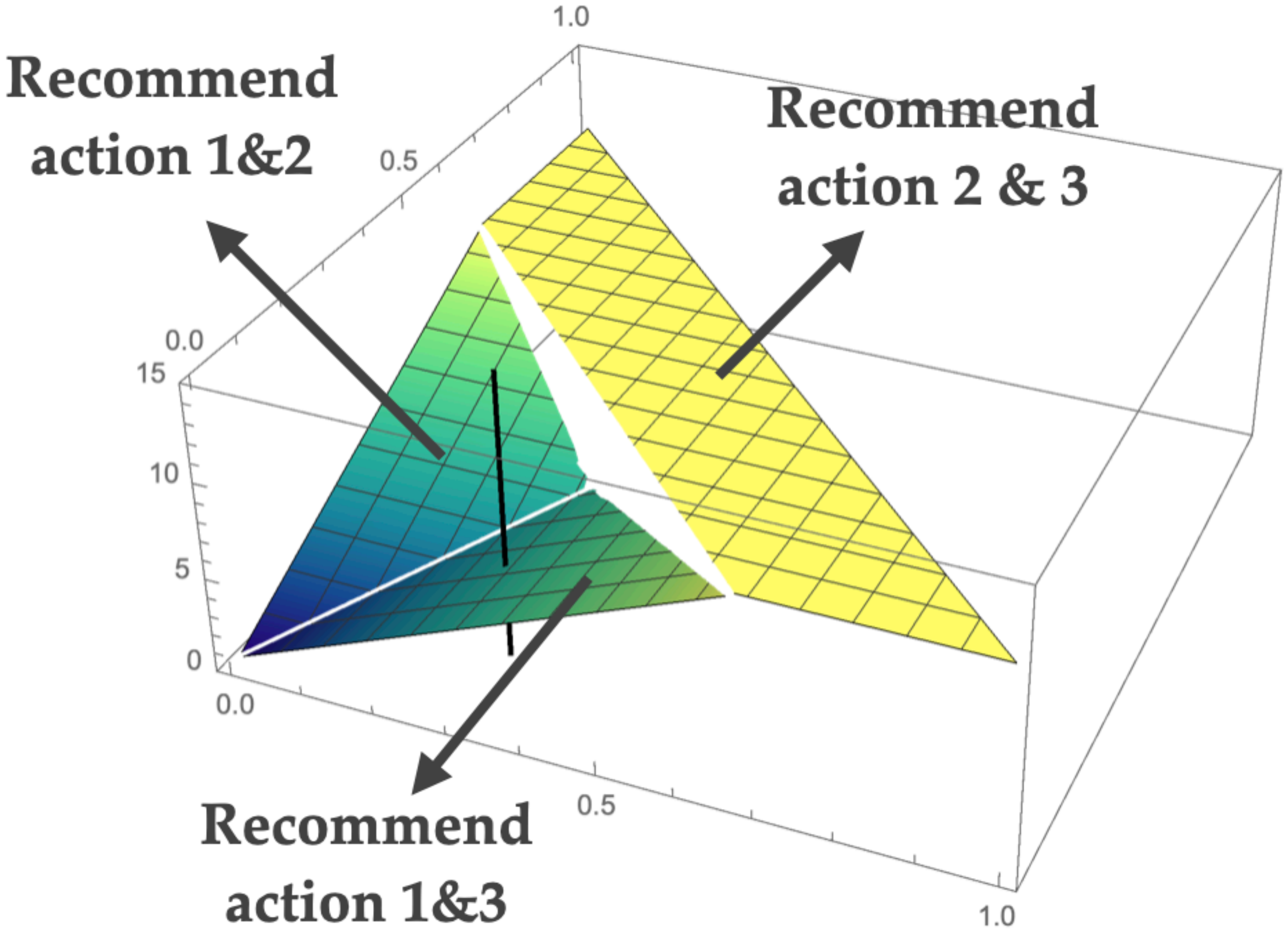




Concavification v. k-Concavification

- What can we say about this "gap"?





Marginal Value of a Signal

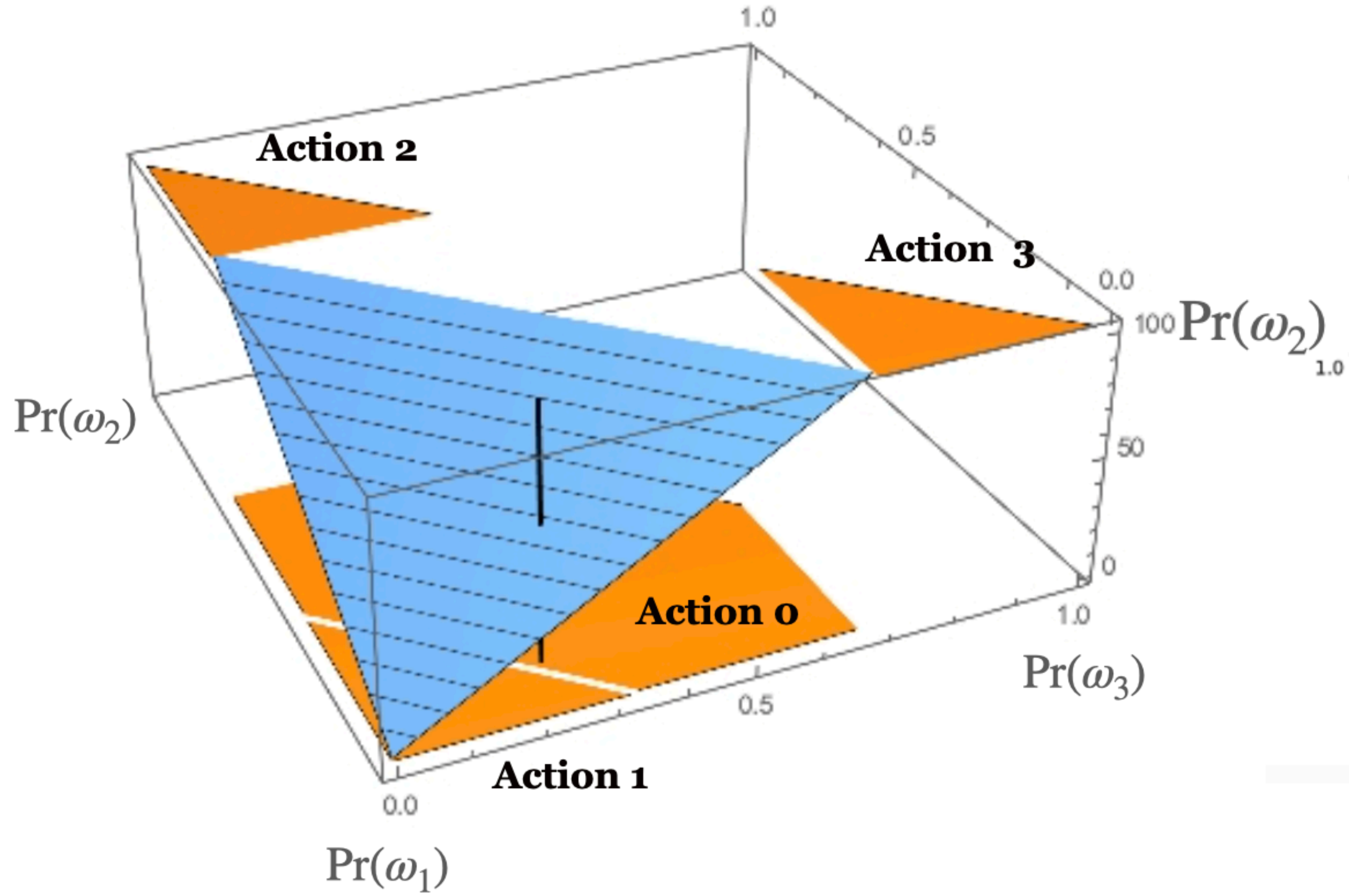
- $v_k(\mu_0)$ = **Largest payoff** Sender with prior μ_0 can achieve with k-signal
- **Marginal Value of a signal** is bounded

$$v_k\left(\mu_0\right) - v_{k-1}\left(\mu_0\right) \leq \frac{2}{k} v_k\left(\mu_0\right)$$

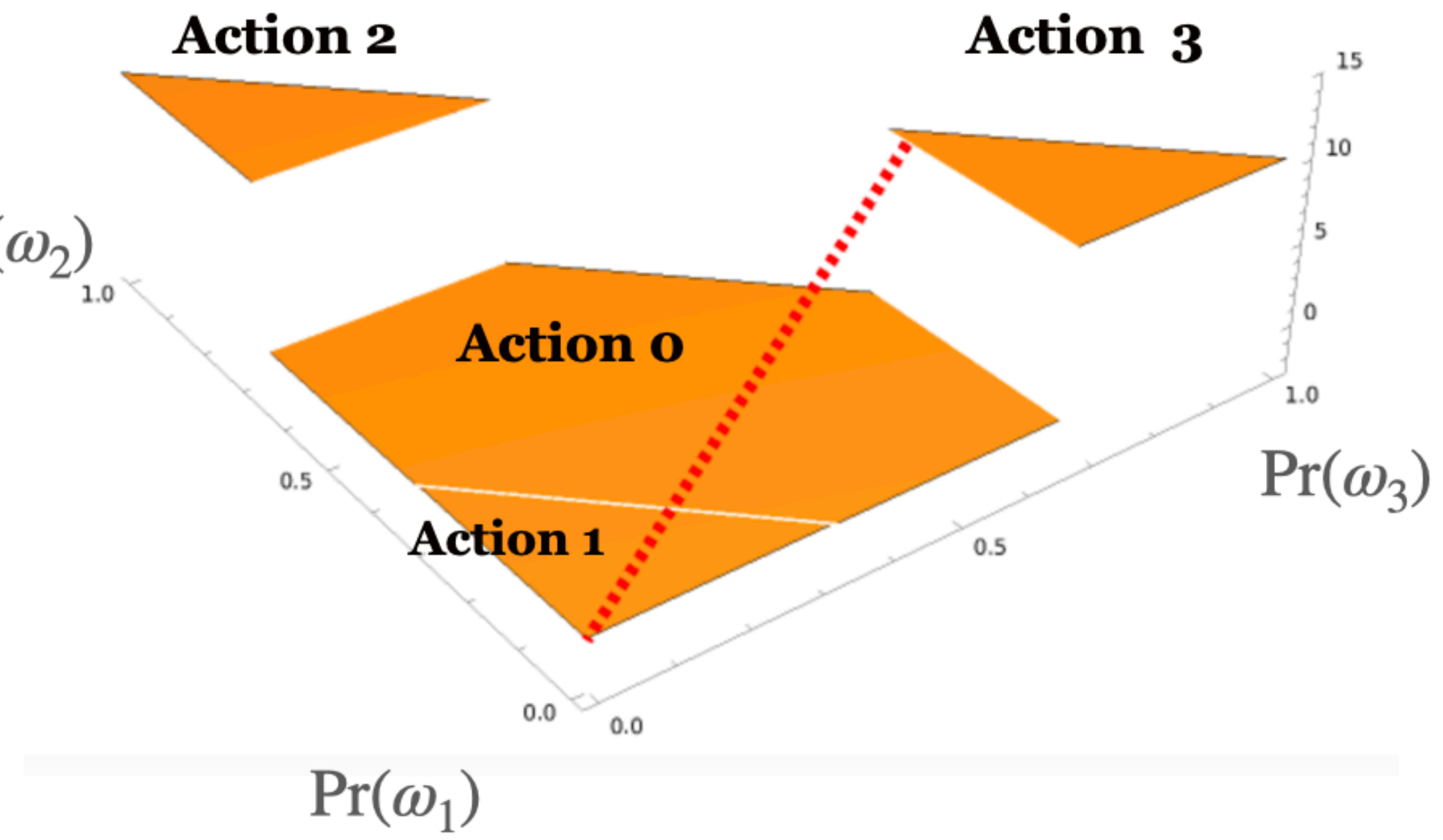
- **Equivalently:** $\frac{k-2}{k} v_k\left(\mu_0\right) \leq v_{k-1}\left(\mu_0\right) \leq v_k\left(\mu_0\right)$

Signals and Information

- Sender always does better with more signals. What about Receiver?



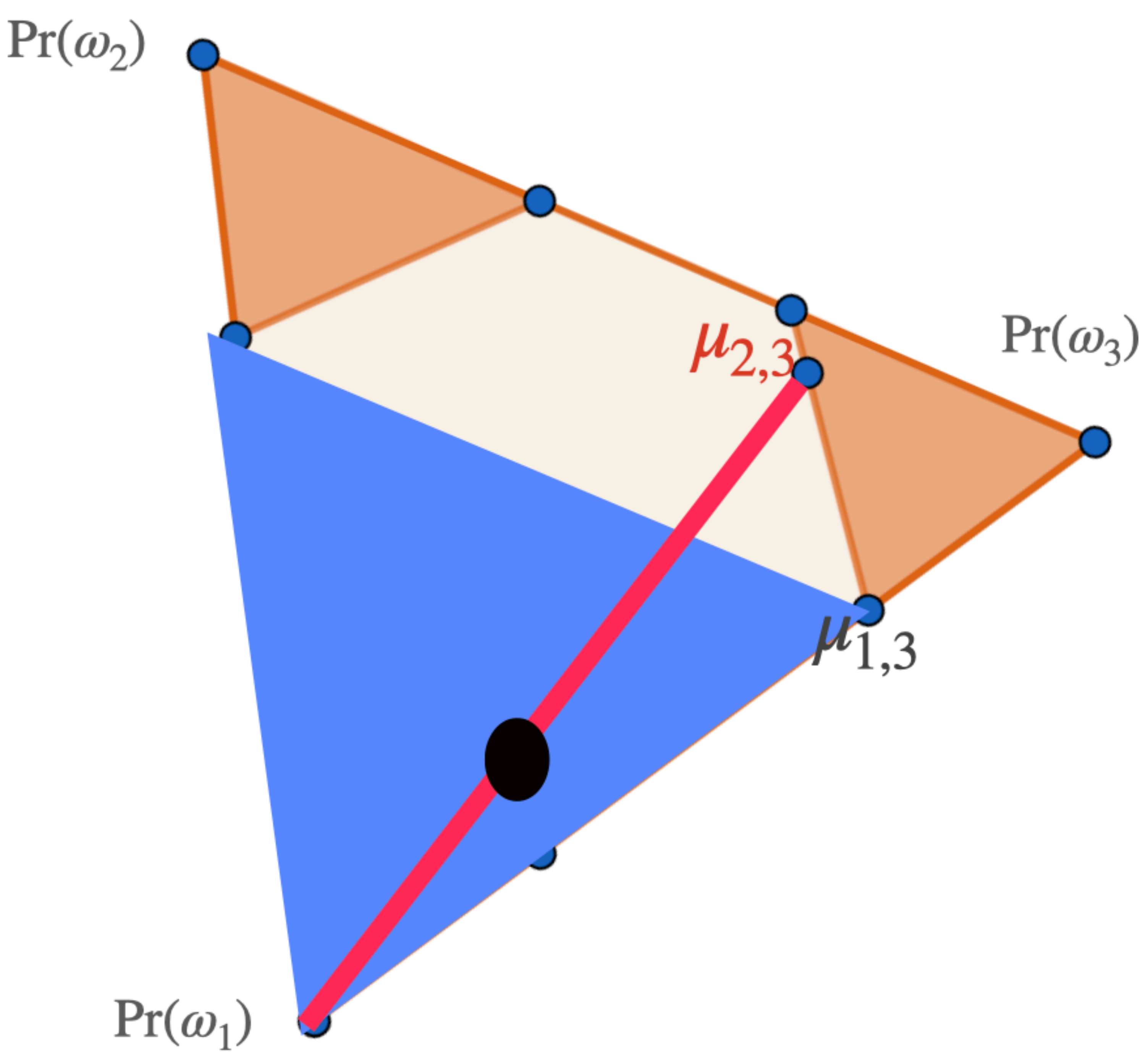
Full Communication

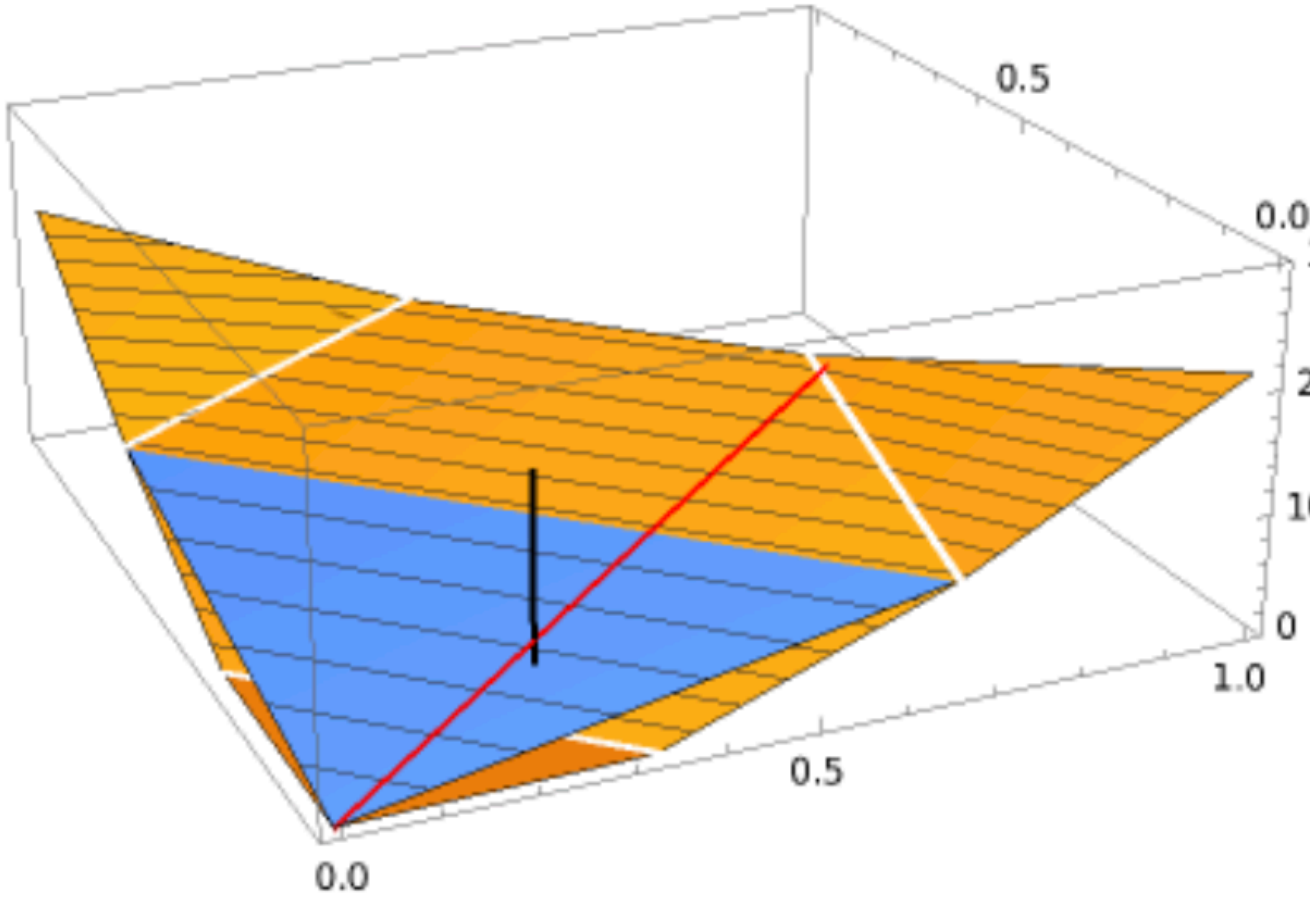


Coarse Communication

Receiver Limiting the Sender

- **More messages ≠ better information** (Blackwell sense)
- Receiver might be better of limiting the Sender to simpler advice





Conclusion

- We study the effect of **limited signals** on communication
- We provide an **algorithm** to find the **optimal information structure**
- More of signals leads to larger persuasive power of the **Sender**
- Receiver can do better of by asking **simpler advice**
  - A weakened form of pre-commitment — Similiar to Kolotilin (2013)