

# Inferential Approach to Mining Surprising Patterns in Hypergraphs

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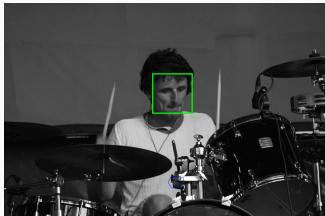
AGI-19, Shenzhen



SingularityNET



# Reframing learning as reasoning



$\Rightarrow$

$\mathcal{T} \vdash \mathcal{F}$

# Reframing mining surprising patterns as reasoning

1. Learning frequent patterns
2. Assessing their surprisingness

Learning how to **reason efficiently**.

- Unified Rule Engine
  - Evolves Inference Trees TODO: add pic
  - **Control Rules** to select premises and rules

# Inference Control Meta-learning

Learning how to **reason efficiently**.

- Unified Rule Engine
  - Evolves Inference Trees TODO: add pic
  - **Control Rules** to select premises and rules
- Learn Control Rules for efficient reasoning TODO: diagram with learning control rules controlling inference.

# Mining Frequent Patterns

Brute force algorithm:

- $S$ : minimum support
  - $P, Q$ : patterns
  - $\mathcal{C}$ : pattern pool
  - $\mathcal{D}$ : database
1. Select  $P$  from  $\mathcal{C}$
  2. Select *specialization*  $Q$  of  $P$  such that  $S \leq \text{support}(Q, \mathcal{D})$
  3. Add  $Q$  to  $\mathcal{C}$
  4. Repeat

## Mining Frequent Patterns as Reasoning

$$\frac{S \leq \text{support}(Q, \mathcal{D}) \quad \text{spec}(Q, P)}{S \leq \text{support}(P, \mathcal{D})} \text{ (AP)}$$

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$$\frac{S \leq \text{support}(P, \mathcal{D}) \quad \text{spec}(P, \text{Top})}{S \leq \text{support}(\text{Top}, \mathcal{D})} \text{ (AP)}$$

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$\Downarrow$

$$\frac{S \leq \text{support}(Q, \mathcal{D}) \quad \text{spec}(Q, P)}{S \leq \text{support}(P, \mathcal{D})} \text{ (AP)} \quad \frac{\text{spec}(P, \text{Top})}{S \leq \text{support}(\text{Top}, \mathcal{D})} \text{ (AP)}$$

# Mining Frequent Patterns as Reasoning

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⇓

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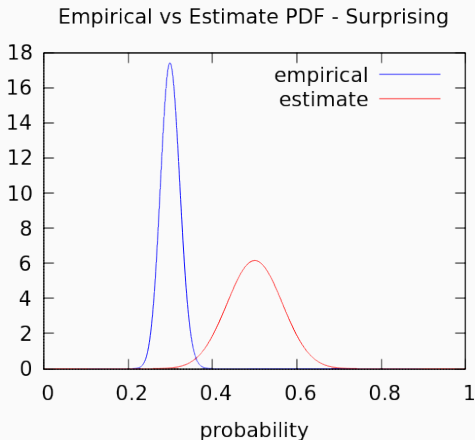
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$$\frac{\frac{\frac{S \leq \text{support}(R, \mathcal{D}) \quad \text{spec}(R, Q)}{S \leq \text{support}(Q, \mathcal{D})} \text{ (AP)} \quad \text{spec}(Q, P) \text{ (AP)}}{S \leq \text{support}(P, \mathcal{D})} \text{ (AP)} \quad \text{spec}(P, \text{Top}) \text{ (AP)}}{S \leq \text{support}(\text{Top}, \mathcal{D})} \text{ (AP)}$$

# Mining Surprising Patterns

## Definition

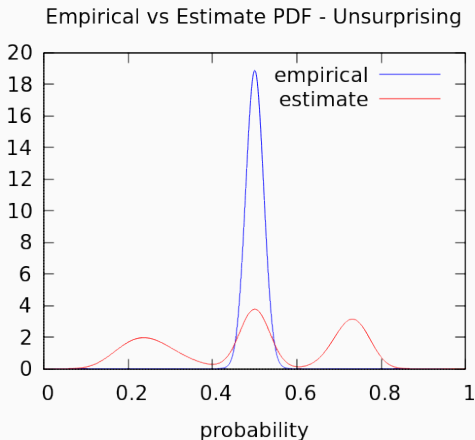
*surprise*: **contrary to expectation**



# Mining Surprising Patterns

## Definition

*surprise*: **contrary to expectation**



# Mining Surprising Patterns as Reasoning

$$\frac{S \leq \text{support}(P, \mathcal{D}) \quad \frac{\frac{P \quad \mathcal{D}}{\text{emp}(P, \mathcal{D})} \text{ (DE)} \quad \frac{\frac{P \quad \mathcal{D}}{\text{est}(P, \mathcal{D})} \text{ (IS)}}{\text{dst}(\text{emp}(P, \mathcal{D}), \text{est}(P, \mathcal{D}))} \text{ (JSD)}}{\text{surprising}(P, \mathcal{D}, \text{dst}(\text{emp}(P, \mathcal{D}), \text{est}(P, \mathcal{D})))} \text{ (S)}$$

# Examples