Active Comparison Based Learning
Incorporating User Uncertainty and Noise

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\( cost_{task}(\Theta) \)
\[ \min_{\Theta} \text{cost}_{task}(\Theta) \]
\textit{cost}_{\text{task}}(\Theta)
$cost_{task}(\Theta)$?
\[ \text{cost}_{task}(\Theta) \]
\begin{align*}
\text{cost}(C) &< \text{cost}(A) < \text{cost}(B) \\
\text{cost}(C) &< \text{cost}(A) < \text{cost}(B)
\end{align*}
cost(A) cost(B) cost(C)

\[ \text{cost(C)} < \text{cost(A)} < \text{cost(B)} \]

\[ C < A < B \]
Which do you prefer?

Left

Right
Comparison Based Learning

Test
(Left, Right)
Observation
Left > Right
Objective:
Learn their cost function with the fewest number of tests to minimize user burden
Active Learning
Select test that minimizes the expected number of tests needed.
Forcing a choice leads to "noisy" responses
Forcing a choice leads to noisy responses because the user is uncertain.
Users want to express uncertainty.
Forced Preference
Forced Preference
Forced Preference

Uncertain Preference
Key Insight
The user’s uncertainty is informative about their cost function
Cost(L)  Cost(R)
Cost(L) \approx Cost(R)
\[ \text{Cost}(L) \approx \text{Cost}(R) \]

\[ |\text{Cost}(L) - \text{Cost}(R)| < \varepsilon \]
Do not learn the user’s $\varepsilon$. 

**Equivalence Class Edge Cutting (EC²)**
Users can be noisy.
Query-Dependent Noise Model

CLAUS: Comparison Learning Algorithm for Uncertain Situations
User Evaluation
Noisy User Evaluation
Known Cost Function
Which line is longer?
Forced Preference vs. Uncertain Preference
How do you *label* uncertainty?
I am Not Sure

About Equal

Source: Noun Project
About Equal
I am not Sure
I am Not Sure

About Equal

Source: Noun Project
Forced Preference vs. Uncertain Preference
Key Insight

The user’s uncertainty is informative about their cost function
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