The More the Merrier?!  
Evaluating the Effect of Landmark Extraction Algorithms on Landmark-Based Goal Recognition

Kin Max Piamolini Gusmão  
Ramon Fraga Pereira  
Felipe Meneguzzi

Pontifical Catholic University of Rio Grande do Sul - Brazil

February 8, 2020
Summary

Motivation

Goal Recognition and Landmark-Based Goal Recognition

Experimentation Methodology
  - Heuristics and Algorithms;
  - Dataset;
  - Evaluation Metrics

Results
  - Missing and Full Observations
  - Missing, Noisy and Full Observations

Conclusions
Motivation

- **Explore** different landmark extraction algorithms with landmark-based heuristics for goal recognition;
- **Evaluate** whether more landmarks lead to a more precise recognition;
- **Inform** future fine-tuning of algorithms to enhance recognition precision;
Goal Recognition and Landmark-Based Goal Recognition

- **Goal Recognition**: recognize agent’s goal based on its interactions with the environment;

- **Landmarks**: necessary facts or actions that must be present in any solution plan;

- **Landmark-Based Goal Recognition**: goal recognition techniques that leverage on landmarks.
Experimentation Methodology

- Heuristics and Algorithms
- Dataset
- Evaluation Metrics
2 landmark-based heuristics for goal recognition\(^1\):
- Goal Completion Heuristic \((h_{gc})\);
- Landmark Uniqueness Heuristic \((h_{uniq})\).

5 landmark extraction algorithms:
- Exhaust;
- \(h^m_2\);
- \(RHW^3\);
- Zhu & Givan\(^4\);
- Hoffmann et al.\(^5\)

2 threshold values: 0% and 10%.

\(^1\) Pereira et al., Landmark-Based Heuristics for Goal Recognition. AAAI, 2017.
\(^2\) Keyder et al., Sound and complete landmarks for and/or graphs. ECAI, 2010.
\(^3\) Richter et al., Landmarks revisited. AAAI 2008.
\(^5\) Hoffmann et al., Ordered landmarks in planning. JAIR, 2004.
Experimentation Methodology: Dataset

- Dataset with goal and plan recognition problems\(^6\);
- Problems from 15 classical planning domains;
- 6313 problems with missing and full observations with 5 observability levels (10%, 30%, 50%, 70% and 100%);
- 2850 problems with missing, noisy and full observations with 4 observability levels (25%, 50%, 75% and 100%).

Percentage of extracted landmarks;
Accuracy (%);
Spread in $G$;
Accuracy/Spread in $G$ ratio;
Recognition time (s).
Results

- Missing and Full Observations
- Missing, Noisy and Full Observations
Results: Missing and Full Observations

Figure: Percentage of extracted landmarks.
Results: Missing and Full Observations

Figure: Accuracy/Spread in $G$ ratio for $h_{gc}$. 

The More the Merrier?!  
February 8, 2020 11 / 21
Figure: Accuracy/Spread in $G$ ratio for $h_{uniq}$. 

Results: Missing and Full Observations
Figure: Recognition time for $h_{gc}$. 

Results: Missing and Full Observations
Results: Missing and Full Observations

Figure: Recognition time for $h_{uniq}$.
Figure: Percentage of extracted landmarks.
Results: Missing, Noisy and Full Observations

Figure: Accuracy/Spread in $\mathcal{G}$ ratio for $h_{gc}$.
Results: Missing, Noisy and Full Observations

Figure: Accuracy/Spread in $\mathcal{G}$ ratio for $h_{uniq}$. 
Results: Missing, Noisy and Full Observations

Figure: Recognition time for $h_{gc}$.  

Kin Max Piamolini Gusmão  
The More the Merrier?!  
February 8, 2020  
18 / 21
Figure: Recognition time for $h_{uniq}$. 
Conclusions

- Quantity is not more important than quality;
- Algorithms with higher extraction capability obtained better performance with $h_{uniq}$;
- Quantity matters more when dealing with noisy observations.
Thank You!

Questions?