Heuristics and A* implementations

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Abstract

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Domain

Six domains were tested in the implementations. In this section, I explain this domains.

Blocksworld

Dinner

Dompteur

DWR

Logistics

TSP

Heuristics

In this section, I discuss the different heuristics implemented in the Jupyter notebook. The implementation uses the *pddl* package to parse the tested PDDL domains and problems.

h_{max} heuristic

In a nutshell, this heuristic returns the maximum cost to achieve a goal. From an initial state, the heuristic returns the longest path to reach all goals.

```
1  from pddl.heuristic import Heuristic
2
3  class MaxHeuristic(Heuristic):
4    def h(self, actions, state, goals):
5      reachable = state
6      goals_missing = goals[0]
7      max_cost = 0
8      while not goals_missing.issubset(
       reachable):
9        last_state = frozenset(
10         [a for a in actions if a.
       positive_preconditions.issubset(
       reachable)]
11       )
12       new_reachable = reachable.union([pre
       for a in last_state for pre in a.
       add_effects])
13       if new_reachable == reachable:
14         return float("inf")
15       reachable = new_reachable
16       max_cost += 1
17     return max_cost
```

Listing 1: h_{max} implementation

In the Listing 1, the function *h* returns the maximum cost to reach the *goals* from an initial *state*, considering a set of possible *actions*.

The first reachable states are the initial states, as shown in line 5. The next two lines define the goals[1] and the maximum cost to achieve the goals from the reachable state. Therefore, if all goals are in the initial state, the maximum cost is 0 and the return in line 8 is *False*.

When the goals are not in the reachable state, the algorithm takes two step:

- line 9: get all actions in which the preconditions are applicable to the current set of reachable actions.
- line 12: get the effects from the actions applicable to the current reachable state. Each time the algorithm performs this step, the reachable state becomes larger, that is, it is more likely that the goals are in the reachable state.

At least, in line 13, it is tested whether the new reachable states are the same as the current reachable state. If true, there are no more states to reach and the heuristic has not achieved the goals. Therefore, *infinite* is returned. When there are more states to test, the maximum cost is increased until all goals are reached.

h_{add} heuristic

Formatting Requirements in Brief

We need source and PDF files that can be used in a variety of ways and can be output on a variety of devices. AAAI imposes some requirements on your source and PDF files that

[1]The goals received as a parameter are divided into positive and negative. Negative goals are those with the negative sign (*not*) in the PDDL. To perform the heuristic I only consider the positive goal.

must be followed. Most of these requirements are based on our efforts to standardize conference manuscript properties and layout. These requirements are as follows, and all papers submitted to AAAI for publication must comply:

- Your .tex file must compile in PDFLaTeX — **no .ps or .eps figure files.**
- All fonts must be embedded in the PDF file — **this includes your figures.**
- Modifications to the style sheet (or your document) in an effort to avoid extra page charges are NOT allowed.
- No type 3 fonts may be used (even in illustrations).
- Your title must follow US capitalization rules.
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- Fonts that require non-English language support (CID and Identity-H) must be converted to outlines or removed from the document (even if they are in a graphics file embedded in the document).
- Two-column format in AAAI style is required for all papers.
- The paper size for final submission must be US letter. No exceptions.
- The source file must exactly match the PDF.
- The document margins must be as specified in the formatting instructions.
- The number of pages and the file size must be as specified for your event.
- No document may be password protected.
- Neither the PDFs nor the source may contain any embedded links or bookmarks.
- Your source and PDF must not have any page numbers, footers, or headers.
- Your PDF must be compatible with Acrobat 5 or higher.
- Your LaTeX source file (excluding references) must consist of a **single** file (use of the "input" command is not allowed.
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- All your graphics files.
- The LaTeX-generated files (e.g. .aux and .bib file, etc.) for your compiled source.
- All the nonstandard style files (ones not commonly found in standard LaTeX installations) used in your document (including, for example, old algorithm style files). If in doubt, include it.

Your LaTeX source will be reviewed and recompiled on our system (if it does not compile, you may incur late fees). **Do not submit your source in multiple text files.** Your single LaTeX source file must include all your text, your bibliography (formatted using aaai.bst), and any custom macros. Accompanying this source file, you must also supply any nonstandard (or older) referenced style files and all your referenced graphics files.

Your files should work without any supporting files (other than the program itself) on any computer with a standard LaTeX distribution. Place your PDF and source files in a single tar, zipped, gzipped, stuffed, or compressed archive. Name your source file with your last (family) name.

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In the LaTeX source for your paper, you **must** place the following lines as shown in the example in this subsection. This command set-up is for three authors. Add or subtract author and address lines as necessary, and uncomment the portions that apply to you. In most instances, this is all you need to do to format your paper in the Times font. The helvet package will cause Helvetica to be used for sans serif, and the courier package will cause Courier to be used for the typewriter font. These files are part of the PSNFSS2e package, which is freely available from many Internet sites (and is often part of a standard installation).

Leave the setcounter for section number depth commented out and set at 0 unless you want to add section numbers to your paper. If you do add section numbers, you must uncomment this line and change the number to 1 (for section numbers), or 2 (for section and subsection numbers). The style file will not work properly with numbering of subsubsections, so do not use a number higher than 2.

```
\documentclass[letterpaper]article
% Required Packages
\usepackage{aaai}
\usepackage{times}
\usepackage{helvet}
\usepackage{courier}
\setlength{\pdfpagewidth}{8.5in}
\setlength{\pdfpageheight}{11in}
%%%%%%%%%
% PDFINFO for PDFLaTeX
% Uncomment and complete the following for metadata
(your paper must compile with PDFLaTeX)
\pdfinfo{
/Title (Input Your Paper Title Here)
/Author (John Doe, Jane Doe)
/Keywords (Input your paper's keywords in this optional
area)
}
%%%%%%%%%
% Section Numbers
% Uncomment if you want to use section numbers
% and change the 0 to a 1 or 2
% \setcounter{secnumdepth}{0}
%%%%%%%%%
% Title, Author, and Address Information
\title{Title}
\author{Author 1 \and Author 2\\
Address line\\
Address line\\
\And
Author 3\\
Address line\\
Address line}
%%%%%%%%%
% Body of Paper Begins
\begin{document}
\maketitle
...
%%%%%%%%%
% References and End of Paper
\bibliography{Bibliography-File}
\bibliographystyle{aaai}
\end{document}
```

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\bibliography{Bibliography-File}
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- caption
- titlesec
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```
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Address line \\ ... \\ Address line}
```

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```
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{\bf Author 2}\\ ... \\ {\bf Author n}\\
Address line \\ ... \\ Address line}
```

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\And ... \And Author n\\
Address line\\ ... \\ Address line}
```

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```
\author{Author 1\\ Address line \\ ... \\ Address line\\
\AND
Author 2 \\ Address line \\ ... \\ Address line\\
\And
Author 3 \\ Address line \\ ... \\ Address line\\
}
```

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Appendices. Any appendices follow the acknowledgments, if included, or after the main body of text if no acknowledgments appear.

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Low-Resolution Bitmaps. You may not use low-resolution (such as 72 dpi) screen-dumps and GIF files—these files contain so few pixels that they are always blurry, and illegible when printed. If they are color, they will become an indecipherable mess when converted to black and white. This is always the case with gif files, which should never be used. The resolution of screen dumps can be increased by reducing the print size of the original file while retaining the same number of pixels. You can also enlarge files by manipulating them in software such as PhotoShop. Your figures should be a minimum of 266 dpi when incorporated into your document.

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Fonts in Your Illustrations You must embed all fonts in your graphics before including them in your LaTeX document.

References

The aaai.sty file includes a set of definitions for use in formatting references with BibTeX. These definitions make the bibliography style fairly close to the one specified below.

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\bibliographystyle{aaai} \bibliography{bibfile1,bibfile2,...}

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\cite: Cites the given reference(s) with a full citation. This appears as "(Author Year)" for one reference, or "(Author Year; Author Year)" for multiple references.
\shortcite: Cites the given reference(s) with just the year. This appears as "(Year)" for one reference, or "(Year; Year)" for multiple references.
\citeauthor: Cites the given reference(s) with just the author name(s) and no parentheses.
\citeyear: Cites the given reference(s) with just the date(s) and no parentheses.

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Formatted bibliographies should look like the following examples.

Book with Multiple Authors
Engelmore, R., and Morgan, A. eds. 1986. *Blackboard Systems.* Reading, Mass.: Addison-Wesley.

Journal Article
Robinson, A. L. 1980a. New Ways to Make Microcircuits Smaller. *Science* 208: 1019–1026.

Magazine Article
Hasling, D. W.; Clancey, W. J.; and Rennels, G. R. 1983. Strategic Explanations in Consultation. *The International Journal of Man-Machine Studies* 20(1): 3–19.

Proceedings Paper Published by a Society
Clancey, W. J. 1983b. Communication, Simulation, and Intelligent Agents: Implications of Personal Intelligent Machines for Medical Education. In Proceedings of the Eighth International Joint Conference on Artificial Intelligence, 556–560. Menlo Park, Calif.: International Joint Conferences on Artificial Intelligence, Inc.

Proceedings Paper Published by a Press or Publisher
Clancey, W. J. 1984. Classification Problem Solving. In *Proceedings of the Fourth National Conference on Artificial Intelligence,* 49–54. Menlo Park, Calif.: AAAI Press.

University Technical Report
Rice, J. 1986. Poligon: A System for Parallel Problem Solving, Technical Report, KSL-86-19, Dept. of Computer Science, Stanford Univ.

Dissertation or Thesis
Clancey, W. J. 1979b. Transfer of Rule-Based Expertise through a Tutorial Dialogue. Ph.D. diss., Dept. of Computer Science, Stanford Univ., Stanford, Calif.

Forthcoming Publication
Clancey, W. J. 1986a. The Engineering of Qualitative Models. Forthcoming.

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dvipdf Script Scripts such as dvipdf which ostensibly bypass the Postscript intermediary should not be used since they generally do not instruct dvips to use the config.pdf file.

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Additional Resources

LaTeX is a difficult program to master. If you've used that software, and this document didn't help or some items were not explained clearly, we recommend you read Michael Shell's excellent document (testflow doc.txt V1.0a 2002/08/13) about obtaining correct PS/PDF output on LaTeX systems. (It was written for another purpose, but it has general application as well). It is available at www.ctan.org in the tex-archive.

Acknowledgments

AAAI is especially grateful to Peter Patel Schneider for his work in implementing the aaai.sty file, liberally using the ideas of other style hackers, including Barbara Beeton. We also acknowledge with thanks the work of George Ferguson for his guide to using the style and BibTeX files — which has been incorporated into this document — and Hans Guesgen, who provided several timely modifications, as well as the many others who have, from time to time, sent in suggestions on improvements to the AAAI style.

The preparation of the LaTeX and BibTeX files that implement these instructions was supported by Schlumberger Palo Alto Research, AT&T Bell Laboratories, Morgan Kaufmann Publishers, The Live Oak Press, LLC, and AAAI Press. Bibliography style changes were added by Sunil Issar. \pubnote was added by J. Scott Penberthy. George Ferguson added support for printing the AAAI copyright slug. Additional changes to aaai.sty and aaai.bst have been made by the AAAI staff.

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