AI Project – Test Schedulling

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Keywords—component, formatting, style, styling, insert (key words)

# Introduction

This report, written for our final project in the course, Introduction to Artificial Intelligence, will explain our project choice, how we intended to solve this issue, our final implementation and what we learned along the way. For this project we tried to tackle a problem that has been around the University for at least the past five years. Every year, the Nature part of Hebrew University plans the following year’s test schedule in an outdated and waist full manner while demanding tens of staff and students to plan the universities test schedule while considering all the effects each change to the schedule has on all the different courses, students and staff members. This is done by having a student representative from each track and staff members take part in a two-month long struggle to find a suitable test schedule that puts the least strain on all the students and staff members. We heard that the Student Association of The Hebrew University of Jerusalem has been asking for the past five years that the university update this process to a more practical one and we took it upon ourselves to solve for our final project in the course Introduction to Artificial Intelligence. Our first approach was to solve this issue with two types of Search Algorithms that were taught in this course, a Genetic Algorithm and a combination of Constraint Satisfaction and Simulated Annealing Algorithm. We researched these algorithms more and decided in the end to solve this issue in a generic way while starting with a random testing schedule and improving it with either a Genetic Algorithm or a Simulated Annealing Algorithm.

# Finding the Data (explains the dataloader)

## Retrieving the Data

After our initial brain storm we came to the conclusion that the best form of data to work on would be a list of all the students in the Nature part of our university and the courses they are planning on taking in which semester. With this we would be able to formulate a weight function to understand and give a fix float number to symbolize to what extent a course effects another course. We were not given permission from the university to retrieve this information so instead we made a google sheet and sent it out to all the track representatives to fill in the courses their track takes on which semesters. We then deduced a weight function from this sheet by to fill in, alon. And transformed the sheet into to fill in, alon.

## Retrieving the Data to Test Our Results.

In order to test our results, we took the test schedules that were used for this current year, 2021, and the few previous years, transferred it to the type of data structure that we use in our implementation and compared the results to see if our solutions are better than the solutions that were made by the student representatives and staff members. The Testing process and results are explained more in detail in Section IV.

# Solutions

To solve this problem, we initially sought to find an optimal solution by running a genetic algorithm on a random test scheduling state and by running an algorithm that builds starting states with a Constraint Satisfaction algorithm and improves them with a Simulated Annealing algorithm.

Following our initial meeting to plan our project with Yoni, a staff member in this course, we also found that we will have to split our constraints on any solution into hard and soft constrains. Hard constraints include for example, the need for there to be 21 days in between any courses Moed Aleph date, and Moed Beit date. Soft constraints include for example, the maximation of dates in between two tests of two courses with a certain weight between them, given by the weight function explained above.

## General Build

In order to solve this problem with ease we created a genetic build to our implementation. Firstly, we have an abstract class Solver, which the two solvers (Genetic and S.A) inherit from. Secondly, we created a class, State, which symbolizes schedule which is a division of courses to dates. Each state can be evaluated and given a float score (penalty – we wish to minimize this) of how a given state is. In addition, we created classes for Courses, Majors, Evaluators (mentioned above), and more classes which will be explained more in detail. Lastly, we created GUI classes to give a friendly interface to run our project through.

## Genetic Solver (Avinoam)

* Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as “3.5-inch disk drive”.
* Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.
* Do not mix complete spellings and abbreviations of units: “Wb/m2” or “webers per square meter”, not “webers/m2”. Spell out units when they appear in text: “. . . a few henries”, not “. . . a few H”.

Identify applicable funding agency here. If none, delete this text box.

* Use a zero before decimal points: “0.25”, not “.25”. Use “cm3”, not “cc”. (*bullet list*)

## SA Solver (Yair)

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Number equations consecutively. Equation numbers, within parentheses, are to position flush right, as in (1), using a right tab stop. To make your equations more compact, you may use the solidus ( / ), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

*a**b* 

Note that the equation is centered using a center tab stop. Be sure that the symbols in your equation have been defined before or immediately following the equation. Use “(1)”, not “Eq. (1)” or “equation (1)”, except at the beginning of a sentence: “Equation (1) is . . .”

## Some Common Mistakes

* The word “data” is plural, not singular.
* The subscript for the permeability of vacuum **0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.
* In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
* A graph within a graph is an “inset”, not an “insert”. The word alternatively is preferred to the word “alternately” (unless you really mean something that alternates).
* Do not use the word “essentially” to mean “approximately” or “effectively”.
* In your paper title, if the words “that uses” can accurately replace the word “using”, capitalize the “u”; if not, keep using lower-cased.
* Be aware of the different meanings of the homophones “affect” and “effect”, “complement” and “compliment”, “discreet” and “discrete”, “principal” and “principle”.
* Do not confuse “imply” and “infer”.
* The prefix “non” is not a word; it should be joined to the word it modifies, usually without a hyphen.
* There is no period after the “et” in the Latin abbreviation “et al.”.
* The abbreviation “i.e.” means “that is”, and the abbreviation “e.g.” means “for example”.

An excellent style manual for science writers is [7].

# Testing and results (Dan)

After the text edit has been completed, the paper is ready for the template. Duplicate the template file by using the Save As command, and use the naming convention prescribed by your conference for the name of your paper. In this newly created file, highlight all of the contents and import your prepared text file. You are now ready to style your paper; use the scroll down window on the left of the MS Word Formatting toolbar.

## Tests (what we ran and why)

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### For papers with less than six authors: To change the default, adjust the template as follows.

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## Results (what we got, why, and what can we improve)

Headings, or heads, are organizational devices that guide the reader through your paper. There are two types: component heads and text heads.

Component heads identify the different components of your paper and are not topically subordinate to each other. Examples include Acknowledgments and References and, for these, the correct style to use is “Heading 5”. Use “figure caption” for your Figure captions, and “table head” for your table title. Run-in heads, such as “Abstract”, will require you to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced. Styles named “Heading 1”, “Heading 2”, “Heading 3”, and “Heading 4” are prescribed.

## Figures and Tables

#### Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and tables after they are cited in the text. Use the abbreviation “Fig. 1”, even at the beginning of a sentence.

1. Table Type Styles

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1. Sample of a Table footnote. (*Table footnote*)
2. Example of a figure caption. (*figure caption*)

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

##### Acknowledgment

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

##### References

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For papers published in translation journals, please give the English citation first, followed by the original foreign-language citation [6].

1. G. Eason, B. Noble, and I. N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. *(references)*
2. J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
3. I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
4. K. Elissa, “Title of paper if known,” unpublished.
5. R. Nicole, “Title of paper with only first word capitalized,” J. Name Stand. Abbrev., in press.
6. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
7. M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.

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