FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE
Programming Exercise 2: Constraint Satisfaction Problem 18 November 2022
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Problem 2: Organizing Water Sports

Task Desription

You are the organizer of a water sports club, which provides 4 activities: **Stand-Up Paddle**, **Windsurf**, **Catamaran** and **Kayak**. Today, a group of 8 students arrived, namely **Anna, Barney, Claire, Davin, Elena, Freddy, Gloria, and Henry**. They haven't decided which one to participate in and ask for your help.

Figure 1: Different kinds of water sports.

The information about the provided activities is listed below:

Activity	Person per boat/board	Price per boat/board[1]
Stand-Up Paddle	1	6 €
Windsurf	1	10 €
Catamaran	2	15 €
Kayak	2	10 €

[1] Note that the price includes the cost of the whole equipment set.

Note that:

- These are merely 4 programs planned, which don't necessarily have to all take place. Which program(s) is/are actually going to take place depend(s) on the given constraints.
- Odd-numbered participants can also take part in Catamaran and Kayak, which means they will share the boat with strangers and pay half of the price.
- Every student can take part in **at most** 1 program. Students would be assigned to the program they want to attend by default if there are no additional statements.

Now consider the following constraints:

1. Elena and Freddy are good friends. They want to participate in a program where they can share a boat.
2. None of them want to share a boat with strangers.
3. Stand-up paddle is popular today, so there are only 3 spaces left.
4. Barney doesn't know how to swim, so he doesn't want to be in a program alone, otherwise he won't attend any program.
5. Elena and Gloria are good friends, such that they want to attend the same program or not attend any program.
6. Davin has a great passion for kayaking, so he either chooses kayak or nothing.
7. If Henry participates in a program, he is okay with any of them, except stand-up paddle.
8. Freddy neither wants to be in the same program as Henry nor stay on the shore together with him.
9. Anna wants to go either windsurfing or catamaran sailing. Otherwise, she will not attend any program.
10. Barney chooses to sail catamarans, and Claire is willing to teach him and join the same program.
11. The group has a limited budget so the total cost cannot exceed 60 €.
12. Anna, Davin, and Henry want to be together in the same activity, otherwise they are all willing to wait on shore.
13. Davin chooses to play SUP with his dog, but Elena is afraid of dogs, so she cannot join him.
14. No one wants to participate in an activity alone from the group. Otherwise, they don't participate in any activities.
15. If the group wants to attend windsurfing, they need to join a course with an instructor, which requires at least 3 participants to start.
16. The group wants to experience as much as possible, they wish to participate in at least 3 programs.

Model the constraint satisfaction problem in PYTHON. For each of the following subsets of constraints, find the solution, if it exists:

Problem 2.1: { 1 - 7, 9 - 11, 14, 15 }

Problem 2.2: { 7 - 16 }

Problem 2.3: { 1 - 3, 5, 7, 11, 12, 16 }

Problem 2.4: { 1, 4, 5, 11 - 16 }

Problem 2.5: { 2 - 12, 15 }

Problem 2.6: { 1 - 11, 14 }

Note that not all problems can be satisfied.

Programming Framework

For this programming exercise, a *Jupyter Notebook* will be used. To model the constraint satisfaction problem, you should know or look up Python's lambdas, lists and dictionaries. The main function of the template is in the **csp.ipynb** file, which is also the only file you have to work on. An example, on how to model a constraint satisfaction problem using the *AIMA*, is provided in the notebook **csp_demo.ipynb**. This example is taken from Exercise 3.4. The following steps are required to correctly set up the environment for the programming exercise and submission:

1. **Installation of AIMA**: Work through AIMA installation instructions on Moodle[2] (Using Docker is recommended for beginners)
2. **ARTEMIS**: Log into ARTEMIS[3] with your TUM credentials. Find the exercise *Constraint Satisfaction Problems* and follow the installation and submission instructions.

A pass will be awarded only if:

1. you submitted the **correct file** with the **correct name**, as shown above.
2. you **did not zip** your file.
3. you **pushed your files to your ARTEMIS branch**.
4. you **did not change** the **variable names** provided by us within the template.
5. your submitted files can be run in a Docker/Anaconda environment (Python 3.7 at least) with the packages provided by the *requirements.txt* in the *aima repository*, the utils.py, the search.py and the csp_programming_exercise.py provided by us **within a reasonable time (under 5 minutes)**.
6. the problem has been modeled correctly using the NaryCSP class from the module csp_programming_exercise.
7. like the rest of the programming exercises, this is an individual project and you **must** finish the task on your own. (We will use a plagiarism detection tool and any copied code will annul all bonus exercises from both the copier and the copied person!)

Submission will close on **Friday, 16.12.2022 at 23:59**. Your solution will be graded by ARTEMIS. There will be feedback on formatting errors and rightly solved CSP. Nonetheless, it is very important to follow the instructions exactly!

We offer preliminary checks of your solution and ARTEMIS will show your progress. You can submit your solution multiple times and get feedback for each submission. Your final submission will be checked. We award 1 point if all checks including plagiarism pass.

[2] https://www.moodle.tum.de/mod/page/view.php?id=2323882
[3] https://artemis.ase.in.tum.de/courses/222/exercises