Assignment 1: Evolutionary Algorithm in action
CS 451: Computational Intelligence

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Figure 1: Graphical examples of the O, Ω, and Θ notations [**?**].

1. Robot Race

You have designed a robot to compete in a race on a track that is n units long. Your robot can cover 1 or 2 units in a single step. At the start of the race, your robot generates all possible sequences of steps to cover the n units and evaluates each sequence according to various parameters—wind condition, battery, competitive advantage, status of the joints, etc.—in order to pick an optimum. We are interested in estimating, $f(n)$, the size of the solution space, i.e. the number of sequences that the robot has to consider, for a given n.

Example The table below shows the possible sequences for some values of n and the resulting value of $f(n)$.

n	Possible sequences	$f(n)$
1	$\{1\}$	1
4	$\{1,1,1,1\}$, $\{1,1,2\}$, $\{1,2,1\}$, $\{2,1,1\}$, $\{2,2\}$	5

Tasks

- Implement the function, `num_sequences`, in the accompanying file, `test_sequences.py`, that returns the size of the solution space for a given n.
- Run `pytest` locally to check your implementation.
- Include in the solution below, a diagram containing a plot of $f(n)$ against n for n in `range(1,20002, 100)`.
- Add to your diagram, plots for $c_1 f_1(n)$, $c_2 f_2(n)$, $d_1 g(n)$ and $d_2 g(n)$, where $f(n) = O(f_1(n)) = \Omega(f_2(n)) = \Theta(g(n))$ and c_1, c_2, d_1, and d_2 are the corresponding constants.
- Make sure that each plot is clearly labeled, or the diagram contains a clearly visible legend.
- Make sure that the axis limits are set such that the plots are clearly visible and occupy a large portion of the diagram.

- Indicate the expressions/values for $f_1(n), f_2(n), g(n), c_1, c_2, d_1$, and d_2 in your solution below.
- Argue below for the values of the constants.
- Share your diagram as a comment on the WC03 post in the course group.

Tip: You may consider `matplotlib` for plotting purposes.

References

[1] Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein. 2022. *Introduction to Algorithms*, Eighth Edition (8th. ed.). The MIT Press.

Solution: