

# POETRY OF PROGRAMMING

## CLOJURE PROJECTS

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Solving these problems may require a bit of thinking and planning. This is exactly the challenge: decomposing the problem into simpler tasks.

- (1) **Creating interactive drawings and animations.** Using the Quil library available at <http://quil.info/>, which is the Clojure version of the Processing library. More than one student can do a Quil project, assuming that they develop a different sketch. Look at the examples to get some inspiration and check the source code for ideas.
- (2) **Live coding music project.** The Overtone library is a programming interface to a synthesizer, see <https://overtone.github.io/>. The library itself can be found at <https://github.com/overtone/overtone/>. The main difficulty could be to get it working on a given computer, see the wiki for installation <https://github.com/overtone/overtone/wiki/Installing-Overtone>. A very early demo: <https://vimeo.com/22798433>.
- (3) **Solving a logic puzzle with the `core.logic` library.** See: <https://github.com/clojure/core.logic/wiki/A-Core.logic-Primer>
- (4) **Australian Voting** (Adapted from [1]) Australian ballots require that voters rank all the candidates in order of choice. Initially only the first choices are counted, and if one candidate receives more than 50% of the vote then that candidate is elected. However, if no candidate receives more than 50%, all candidates tied for the lowest number of votes are eliminated. Ballots ranking these candidates first are recounted in favor of their highest-ranked non-eliminated candidate. This process of eliminating the weakest candidates and counting their ballots in favor of the preferred non-eliminated candidate continues until one candidate receives more than 50% of the vote, or until all remaining candidates are tied.  
Input: ballots for a given list of candidates. Output: the winner of the election.

```
(au-voting-winner ["John Doe" "Jane Smith" "Jane Austen"]  
                  [[1 2 3]  
                   [2 1 3]  
                   [2 3 1]  
                   [1 2 3]  
                   [3 1 2]] )  
"John Doe"
```

- (5) **Check the check** (Adapted from [1]) Input: a chess board position Output: yes if the king is in check, no if not in check.

```

" ..k.....
 ppp.pppp
 .....
 .R...B..
 .....
 .....
 PPPPPPPP
 K....."

```

The black king is in check.

- (6) **Wordfinder** Input: a  $m \times n$  grid of letters and a word. Output: find the location(s) of the word in the grid (in columns, rows and diagonals), give the sequence of coordinates for the letters of the word.

```

(wordfinder ["ahk" "pet" "klk" "ili" "pot"] "hello")
([1 2] [2 2] [3 2] [4 2] [5 2])

```

- (7) **The Caesar shift cipher**

The Caesar cipher is the simplest form of encryption, where each letter is substituted by another letter from the alphabet shifted by  $n$  letters. For example, "hello" can be encrypted as "ifmmp" when using the  $n = 1$  shift cipher. Write functions that produce encrypter and decrypter functions for a given  $n$ . Write another function that performs a brute-force attack on the cipher by trying all possible shifts.

- (8) **The halving method for finding roots**

The *root* of function is a value for  $x$  such that  $f(x) = 0$ . Write a CLJ function `find-root` that takes a continuous real function  $f : \mathbb{R} \rightarrow \mathbb{R}$  and two real numbers  $a, b$  such that  $f(a) < 0$  and  $f(b) > 0$ . This way  $f$  is bound to cross the  $x$ -axis at least once, and `find-root` can find a root by systematically halving the  $[a, b]$  interval and calling itself recursively. It should work up to some predefined level of precision.

- (9) **Efficient Collatz**

Calculate the return time of integers in the Collatz conjecture as efficiently as possible. This involves storing the return time for each intermediate number.

- (10) **Maze solver** A maze is described by a string. Character # represents wall, . path, S the start point, and D the destination.

```

S...
###.
....
.##.
...D

```

Write a program that outputs a path from start to destination. For instance, using o for the actual path taken.

```

Sooo
###o
..oo
.##o#
..oD

```

- (11) **Text search** Implement the Knuth-Morris-Pratt algorithm. [https://en.wikipedia.org/wiki/Knuth-Morris-Pratt\\_algorithm](https://en.wikipedia.org/wiki/Knuth-Morris-Pratt_algorithm)
  
- (12) **Map generation** Using Perlin-noise ([https://en.wikipedia.org/wiki/Perlin\\_noise](https://en.wikipedia.org/wiki/Perlin_noise)), create believable 2D (not necessarily 3D) maps of terrains. See for instance, the Minetest game <https://www.minetest.net/>, see a gallery here [https://wiki.minetest.net/Map\\_generator#Gallery](https://wiki.minetest.net/Map_generator#Gallery).

## REFERENCES

- [1] S.S. Skiena and M.A. Revilla. *Programming Challenges: The Programming Contest Training Manual*. Texts in Computer Science. Springer New York, 2006.