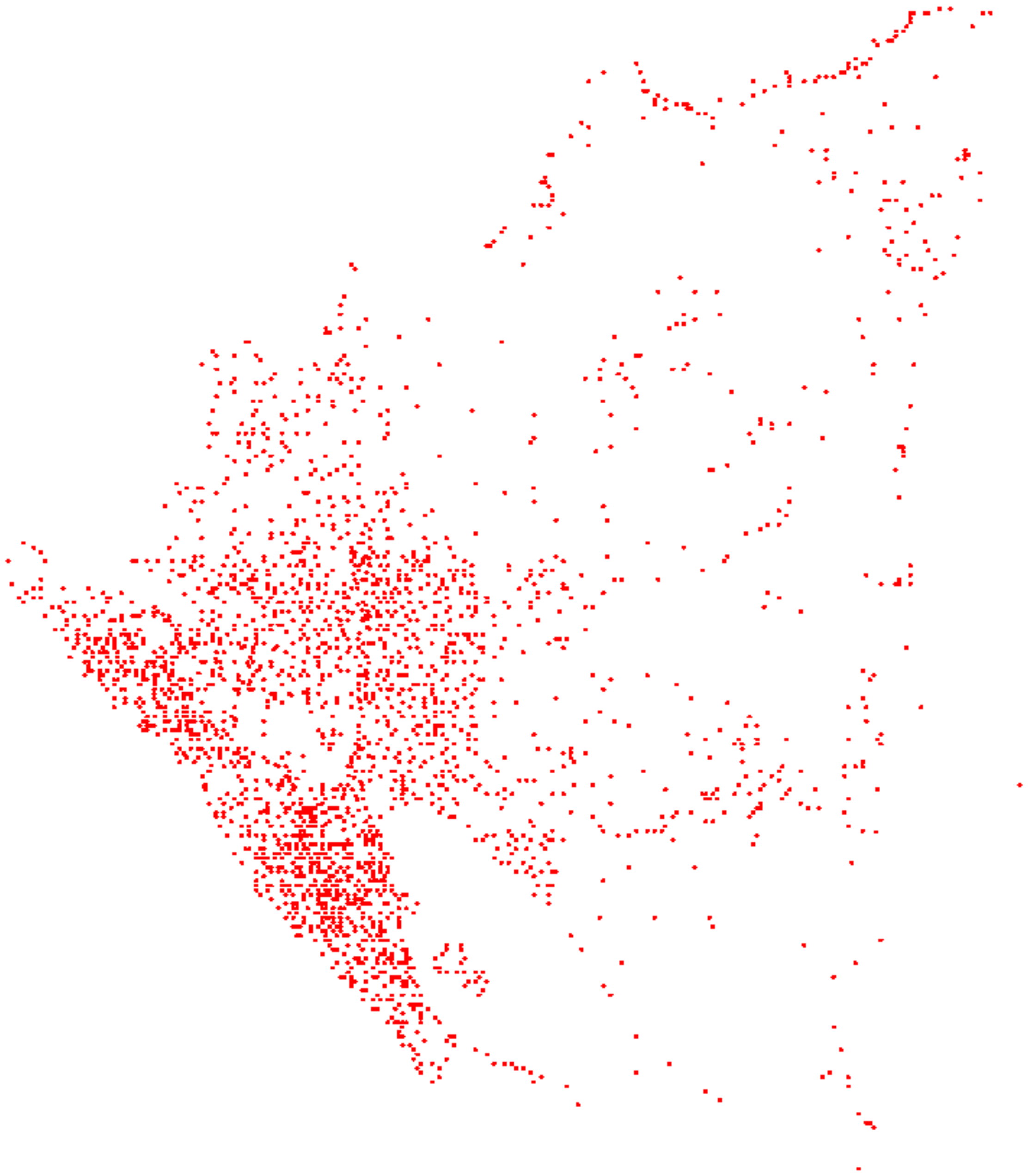
TSP Tutorial

SEP592, Summer 2021
Shin Yoo

Travelling Salesman Problem

- Given **`N`** points in space (usually 2D surface)
- Find the shortest tour of all points.
- Search space: **`N!`**
- Computational complexity: NP-complete
- Brute Force: **`O(N!)`**



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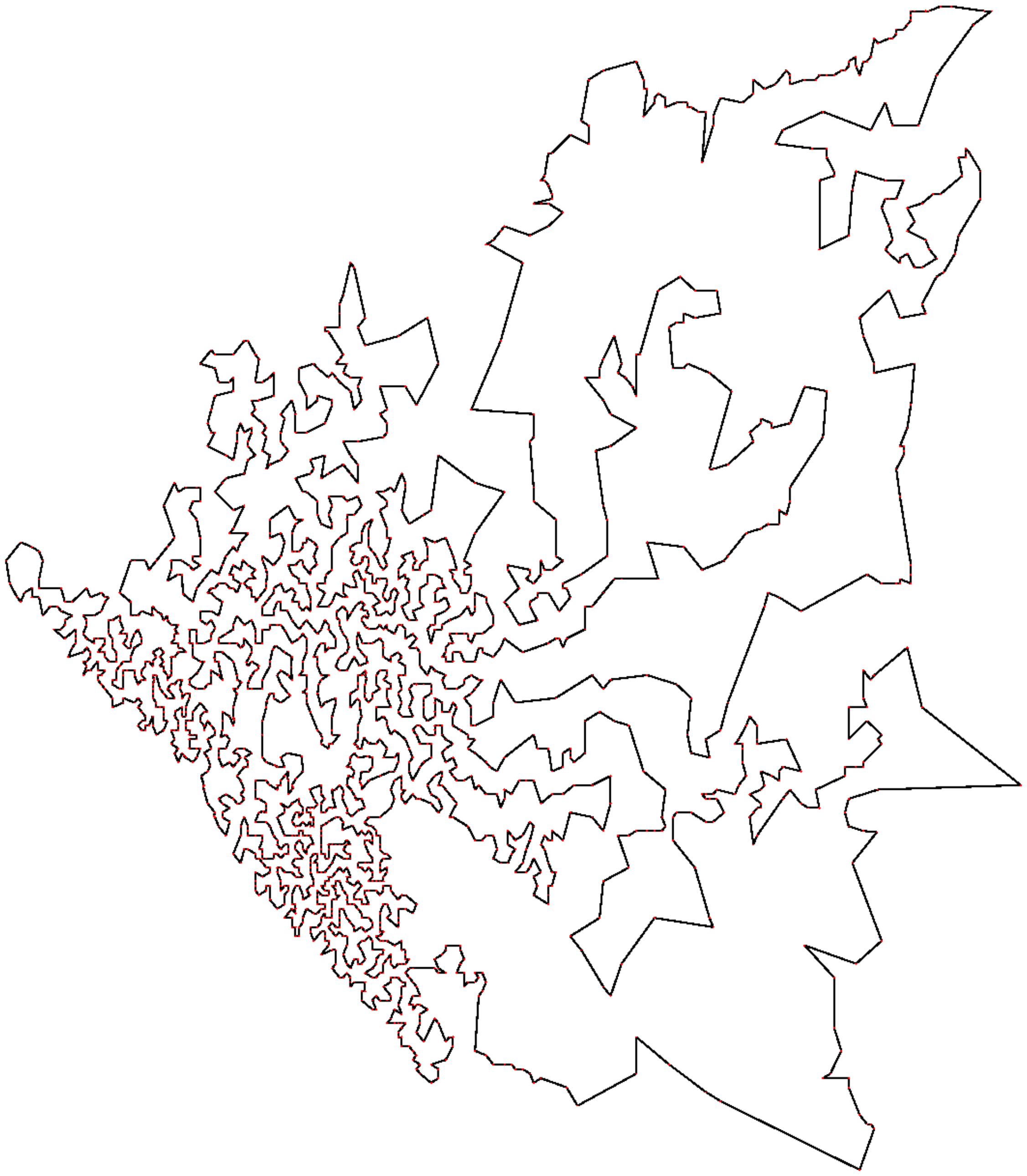


Exact Algorithms

- Early dynamic programming
  - Held-Karp algorithm: $O(n^2 2^n)$
- Linear Programming
  - 15,112 German cities: 22.6 CPU years on 500MHz Alpha, 2001
  - 33,810 points on a circuit board: 15.7 CPU years, 2005
  - 85,900 points: 136 CPU years

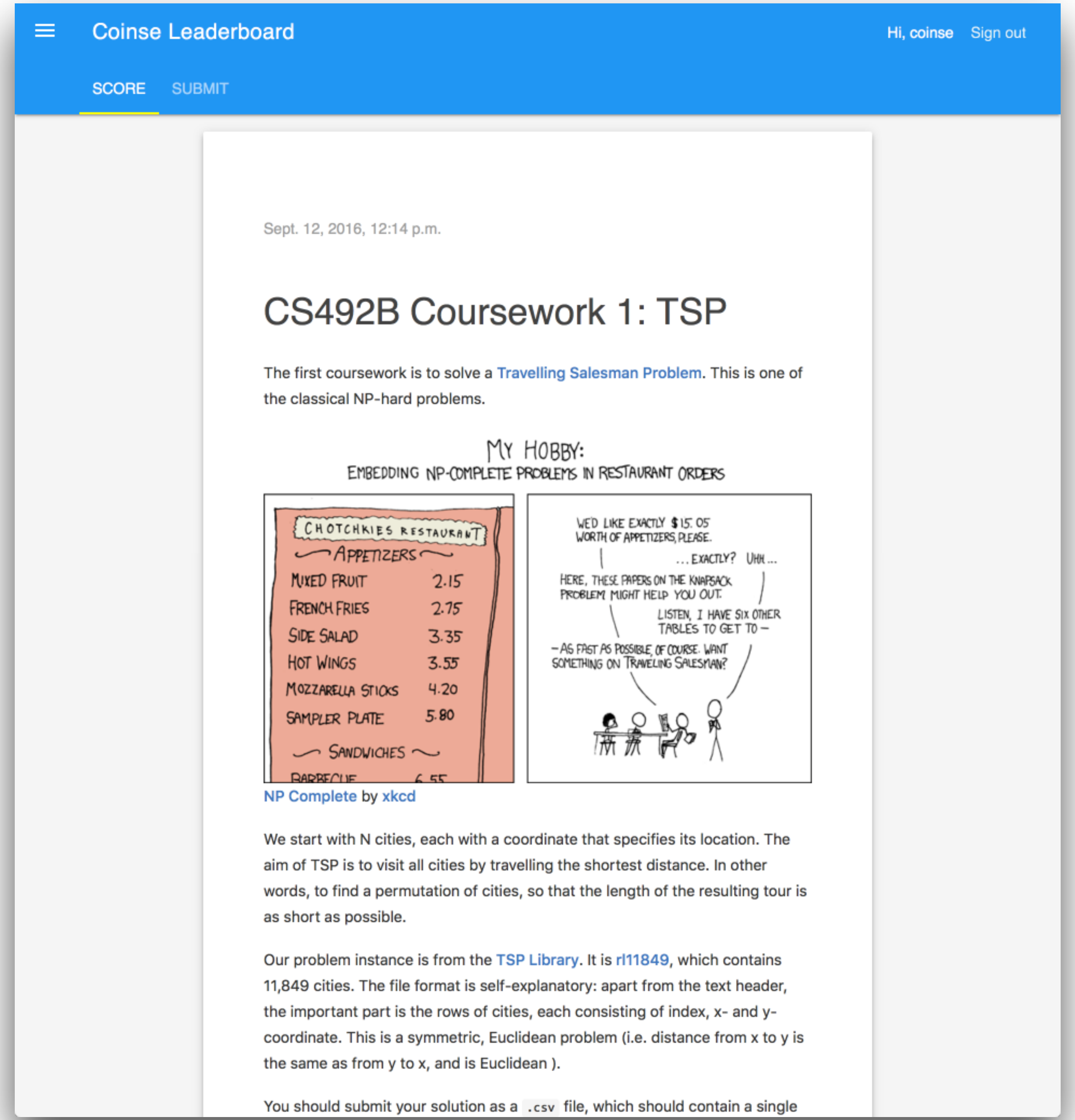
Heuristic Approach

- Many specific genetic operators have been designed.
- Use domain knowledge. For example:
  - Euclidean TSP observes triangular inequality.
- We’re still introducing new algorithms: you can apply them as we go.

Leaderboard

- http://coinse.kaist.ac.kr/leaderboard

- It will open soon :(



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Hi, coinse
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SCORE
SUBMIT

Sept. 12, 2016, 12:14 p.m.

CS492B Coursework 1: TSP

The first coursework is to solve a Travelling Salesman Problem. This is one of the classical NP-hard problems.

MY HOBBY:
EMBEDDING NP-COMPLETE PROBLEMS IN RESTAURANT ORDERS
CHOTCHKIES RESTAURANT
APPETIZERS
MIXED FRUIT 2.15
FRENCH FRIES 2.75
SIDE SALAD 3.35
HOT WINGS 3.55
MOZZARELLA STICKS 4.20
SAMPLER PLATE 5.80
SANDWICHES
BARBECUE 6.55
WE'D LIKE EXACTLY $15.05 WORTH OF APPETIZERS, PLEASE.
...EXACTLY? UHH...
HERE, THESE PAPERS ON THE KNAPSACK PROBLEM MIGHT HELP YOU OUT.
LISTEN, I HAVE SIX OTHER TABLES TO GET TO –
– AS FAST AS POSSIBLE, OF COURSE. WANT SOMETHING ON TRAVELING SALESMAN?

NP Complete by xkcd

We start with N cities, each with a coordinate that specifies its location. The aim of TSP is to visit all cities by travelling the shortest distance. In other words, to find a permutation of cities, so that the length of the resulting tour is as short as possible.

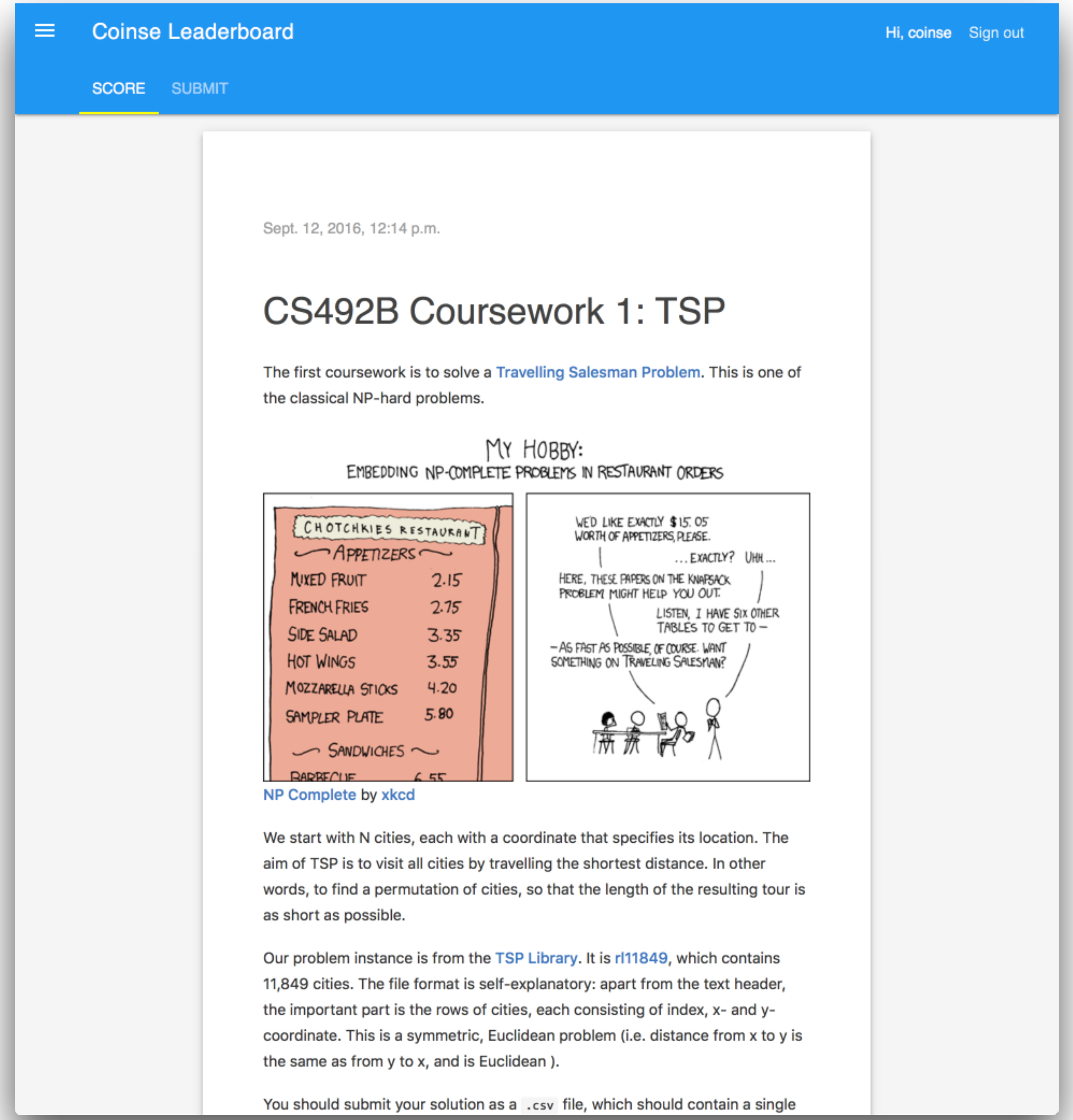
Our problem instance is from the TSP Library. It is rl11849, which contains 11,849 cities. The file format is self-explanatory: apart from the text header, the important part is the rows of cities, each consisting of index, x- and y-coordinate. This is a symmetric, Euclidean problem (i.e. distance from x to y is the same as from y to x, and is Euclidean).

You should submit your solution as a `.csv` file, which should contain a single

Leaderboard

- Register with your KAIST email and student ID number

- Submit your solutions to SEP592 Coursework 2: TSP



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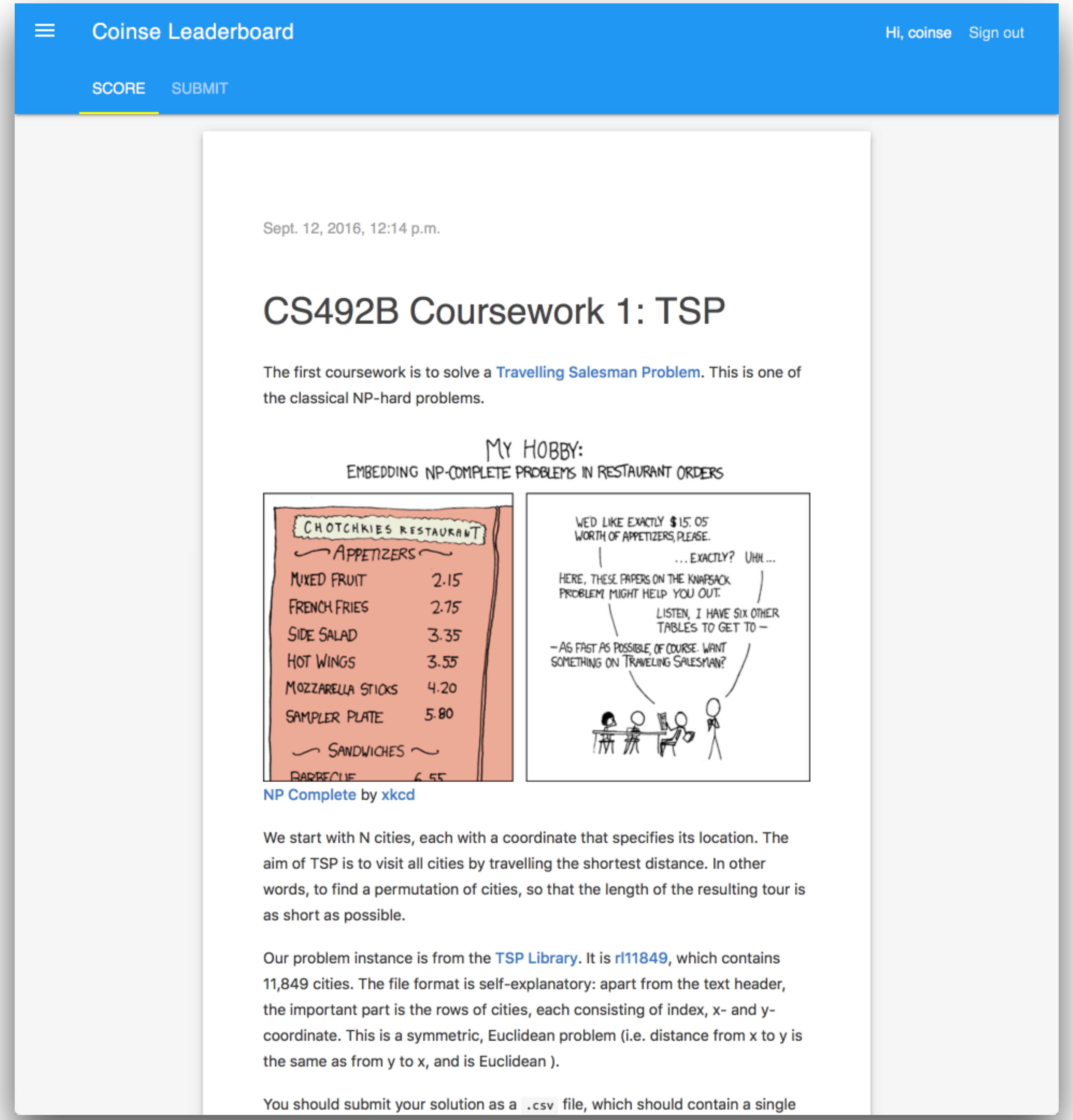
Leaderboard

- Top solution at the end of the coursework period will get a prize :)
- But this is separate from grading, which will also consider the report, the code quality, as well as the novelty in the approach



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Note

- Coursework: to write a TSP solver that can take any problem instance (in the TSPLIB format).
- Competition: to submit a solution to `rl11849` instance to the leaderboard using your solver.
    - Download the problem dataset from http://elib.zib.de/pub/mp-testdata/tsp/tsplib/tsplib.html