import.io: ML Test

April Shen
12 September 2015

Project Euler: Problem 67

[https://projecteuler.net/problem=67]

Problem Statement

- Find the maximum path sum of a given triangle, where a path moves from the top to bottom and each step moves to adjacent numbers in the next row
- Small example: max sum is 3+7+4+9 = 23

3

7 4

2 4 6

8 5 9 3

- Actual triangle has 100 rows

Approach

- Brute-force enumeration of paths is too slow
- Fortunately, perfect for dynamic programming
  - Overlapping subproblems
  - Optimal substructure
- Model triangle as DAG
  - (in your head, not necessarily explicit in program…)

Algorithm

- Recursion:

  max-sum-to(node) = node.value if node is root, else

  max{node.value + max-sum-to(p)} for parents p

  Answer = max{max-sum-to(l)} for leaves l

- Compute via DP table

  Answer = 7273 for the large triangle

Predict the Missing Grade

[https://www.hackerrank.com/challenges/predict-missing-grade]

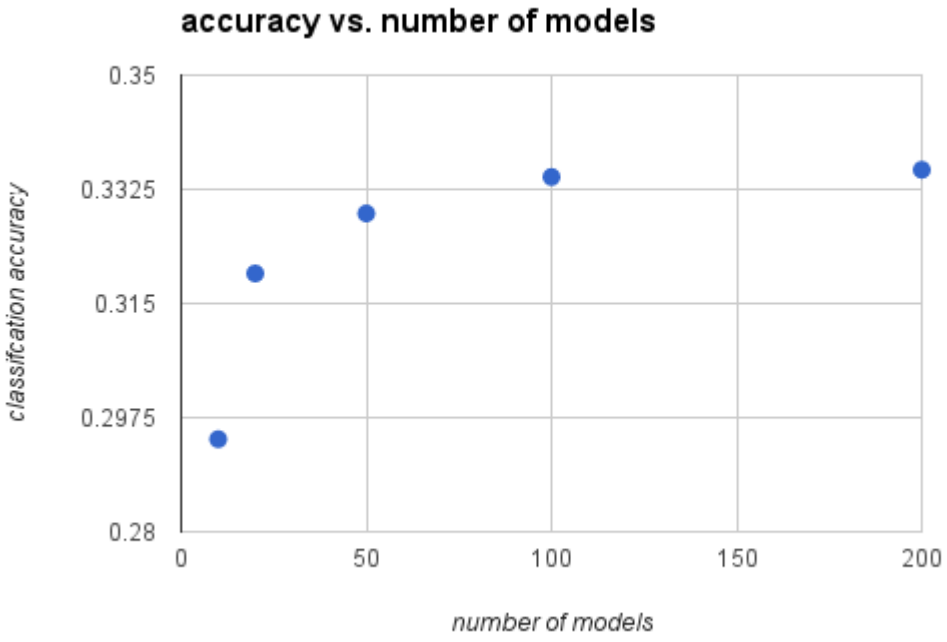
Problem Statement

- Given students' grade records for several subjects, predict what grade they received in Mathematics
  - Each student has taken 5 out of 10 possible subjects, and grades are numeric levels between 1 and 8
- Provided with training and test dataset
  - Training: 79,465 records
  - Test: 69,530 records (and their actual Math grades)

Approach

- Classification problem
  - Features are grades for each subject (or -1 if subject not taken)
  - Classes are grades for Mathematics
- Use AdaBoost with decision stumps as base learners
  - Iteratively builds ensemble of base learners that focus increasingly on hard-to-classify data
  - Good performance [Dietterich 2000]
  - Robust to overfitting (without too many rounds)
  - Interpretable model

Results



number of models	classifcation accuracy	hackerrank score
10	0.2942	17.09
20	0.3196	28.84
50	0.3288	30.8
100	0.3344	33.25
200	0.3355	32.71

hackerrank score = 100 * ((C-W)/N)
C = # correct predictions
(<= 1 grade level away from actual)
W = # wrong predictions
N = Total number of data instances

(cf. best score on HackerRank = 45.33, though on a different test set)

Discussion

- Can see effects of overfitting at 200 models
- Imbalances in training data
  - First 10 models are all rooted with either Physics or Chemistry
  - Besides Math itself (and English), Physics and Chemistry are by far the most frequent subjects appearing in the training data
    - >65,000 / 79,465 students for both
  - Possibly English grade just isn't as informative...
- Might get better ensemble by enforcing diversity in the models

The Punctuation Corrector

[https://www.hackerrank.com/challenges/punctuation-corrector-its]

Problem Statement

- Given sentences with either “it’s” or “its” removed, determine which should appear in the sentence
- Example:
  - In: “This restaurant is known for ??? emphasis on spicy cooking.”
  - Out: “This restaurant is known for its emphasis on spicy cooking.”
- Also provided with a corpus of text
- Test set consists of 32 sentences with a total of 36 missing it’s/its

Approach

- Similar to problem of lexical substitution
  - Given a marked word in context, choose an alternative word to replace it that preserves the meaning
- … Except the only alternatives are “it’s” and “its”
- Use criterion of syntagmatic coherence to rank candidates [Giuliano et al. 2007]

Algorithm

- Idea: given a sentence, search corpus for n-grams containing a candidate substitute (it’s/its)
- Prefer longer n-grams, with ties broken in favor of higher frequency
  - E.g., prefer w1 that appears once in a 5-gram to w2 that appears 1000 times in 4-grams.
- Use this to rank candidates and choose the best

Results

hackerrank score = 100 * ((C-W)/N)
C = # correct predictions
W = # wrong predictions
N = Total number of data instances

accuracy	hackerrank score
0.7778	55.56

(cf. best score on HackerRank = 78.46, though on a different test set)

Discussion

- Almost exclusively, the mistakes use “its” instead of “it’s”, rather than vice versa
  - Possibly “its” appears more in the corpus
  - Example: “It's one thing to engineer a great car but its another to produce it.”
- Adding basic knowledge of grammar/syntax could help a lot
- Ranking is unbiased as to whether the n-grams precede or follow the candidate, but usage of it’s/its depends much more on what follows than what precedes

Future Work

(Or things I would do differently if I had more time…)

- More thorough experiments
  - Average performance using 10-fold cross-validation
  - Compare with baseline algorithms
- Optimize code efficiency
- Grade predictor:
  - Try regression rather than classification; since the grade levels are just bins of continuous values, the discreteness is really superficial
- Punctuation corrector:
  - Since “it’s” and “its” are different parts of speech, could really benefit from part-of-speech tagging and use of grammar models

References

Dietterich, T. G. (2000). An experimental comparison of three methods for constructing ensembles of decision trees: Bagging, boosting, and randomization. *Machine learning*, *40*(2), 139-157.

Giuliano, C., Gliozzo, A., & Strapparava, C. (2007, June). Fbk-irst: Lexical substitution task exploiting domain and syntagmatic coherence. In *Proceedings of the 4th International Workshop on Semantic Evaluations* (pp. 145-148). Association for Computational Linguistics.

Zhu, J., Zou, H., Rosset, S., & Hastie, T. (2009). Multi-class adaboost. *Statistics and its Interface*, *2*(3), 349-360.