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CSCI 3104 Algorithms Homework 1

1. Input => Output
    a. Driving directions: destination address => quickest route from current location
    b. Course scheduling: class number, subject, level, time => list of related open classes that fit time schedule
    c. Google web search engine: search query => list of related links including words from the search sorted by most relevant and visited
    d. Amazon item recommendation: item or items of interest, previous purchases => list of recommended items that other users that have purchased the same item have also purchased because they are related or of similar interest
    e. Fedex shipment scheduling: date and time ordered, type of delivery (standard, same day, etc), size of object, distance away => plot route of most efficient prioritized delivery
2. Recipe for meat lasagna: http://allrecipes.com/recipe/23600/worlds-best-lasagna/?internalSource=popular&referringContentType=home%20page

Ingredients

- 1 pound sweet Italian sausage
- 3/4 pound lean ground beef
- 1/2 cup minced onion
- 2 cloves garlic, crushed
- 1 (28 ounce) can crushed tomatoes
- 2 (6 ounce) cans tomato paste
- 2 (6.5 ounce) cans canned tomato sauce
- 1/2 cup water
- 2 tablespoons white sugar
- 1 1/2 teaspoons dried basil leaves
- 1/2 teaspoon fennel seeds
- 1 teaspoon Italian seasoning
- 1 tablespoon salt
- 1/4 teaspoon ground black pepper
- 4 tablespoons chopped fresh parsley
- 12 lasagna noodles
- 16 ounces ricotta cheese
- 1 egg
- 1/2 teaspoon salt
- 3/4 pound mozzarella cheese, sliced
- 3/4 cup grated Parmesan cheese

Directions

1. In a Dutch oven, cook sausage, ground beef, onion, and garlic over medium heat until well browned. Stir in crushed tomatoes, tomato paste, tomato sauce, and water. Season with sugar, basil, fennel seeds, Italian seasoning, 1 tablespoon salt, pepper, and 2 tablespoons parsley. Simmer, covered, for about 1 1/2 hours, stirring occasionally.
2. Bring a large pot of lightly salted water to a boil. Cook lasagna noodles in boiling water for 8 to 10 minutes. Drain noodles, and rinse with cold water. In a mixing bowl, combine ricotta cheese with egg, remaining parsley, and 1/2 teaspoon salt.
3. Preheat oven to 375 degrees F (190 degrees C).
4. To assemble, spread 1 1/2 cups of meat sauce in the bottom of a 9x13 inch baking dish. Arrange 6 noodles lengthwise over meat sauce. Spread with one half of the ricotta cheese mixture. Top with a third of mozzarella cheese slices. Spoon 1 1/2 cups meat

sauce over mozzarella, and sprinkle with 1/4 cup Parmesan cheese. Repeat layers, and top with remaining mozzarella and Parmesan cheese. Cover with foil: to prevent sticking, either spray foil with cooking spray, or make sure the foil does not touch the cheese.

5. Bake in preheated oven for 25 minutes. Remove foil, and bake an additional 25 minutes. Cool for 15 minutes before serving.

If this recipe were an algorithm or set of instructions for a computer to handle, the input would be clear and concise with exactly what's going in and what amount, but the work between that and getting to the output of the finished lasagna the computer might crash or give back an error for ambiguity. A computer needs to know exactly what to do, and it will do so, but you can't leave it up to the computer on how to interpret certain information and come to a conclusion on what's expected or implied by a vague direction. The recipe starts out by specifying to cook in a Dutch oven which is good, but wouldn't pass as an algorithm as it doesn't go in to detail on how to handle meats (does it need to be cut into small bites?) and could already end up with large pieces of meat in a lasagna that requires small bits. Following that, the descriptions medium heat and well browned are both too ambiguous for a computer to handle correctly. When stirring is required, it needs to be specified how long and or how it should look and in a specific time interval rather than "occasionally." The recipe goes on with this type of ambiguity as bringing "a large pot of lightly salted water to boil" with two more problems of what exactly is large and how much salt? This type of unspecific directions goes on through the recipe, so there would need to be some major changes in description for measurements and handling for this to pass as an algorithm.

3. Big-O Notation $f = O(g)$, $f = \Omega(g)$, $f = \Theta(g)$
    a. $f = \Omega(g)$ because f has highest degree polynomial and rest can be ignored, $n^7 > n^5$
    b. $f = O(g)$ because $n^3 > n^2$ thus grows faster
    c. $f = \Omega(g)$ because 3^n grows more rapid than n^5
    d. $f = \Omega(g)$ because $(5/3)^n$ grows more rapid n^8 as the exponent gets larger
    e. $f = \Theta(g)$ because $(n-1)!$ The -1 is so insignificant it can be ignored thus the same as $n!$

4. Runtimes for python selection sort
    a. Runtime stats for n = 10^3 - Min: 0.039771 Max: 0.04222 Avg: 0.0410725
    b. Runtime stats for n = 10^4 - Min: 4.102126 Max: 4.262148 Avg: 4.1754885
    c. Runtime stats for n = 10^5 - Min: 467.036834 Max: 514.012116 Avg: 492.1277312

On Ubuntu 64 bit virtual machine OS with 2048MB base memory and 2 processors.

Honor Code Pledge: "On my honor, as a University of Colorado at Boulder student, I have neither given nor received unauthorized assistance."