CSU Channel Islands
COMP/MATH 354 Exam
May 14, 2019
40:00–6:00 in Broome 1360

Duration: 2 hours

No Aids Allowed.
There are 3 questions worth a total of 15 marks (5 marks each).
Answer all questions on the question paper.
Use backs of pages.


Please complete this section:

Name (please print): ⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯⎯

For use in marking:

1.⎯⎯⎯⎯⎯⎯ /5

2.⎯⎯⎯⎯⎯⎯ /5

3.⎯⎯⎯⎯⎯⎯ /5

Total: ⎯⎯⎯⎯⎯⎯ /15

1. The Dole Food Company operates banana plantations throughout Central and South America, and other places. Dole banana crates are placed on pallets and pallets are placed in refrigerated containers. Those containers are shipped to the Port of Long Beach.

CRATE OF
BANANAS
     PALLET OF   CONTAINER OF
     CRATES   PALLETS
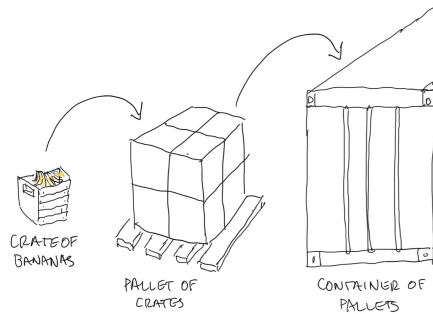
A crate i has a weight of c_i, a pallet j has a capacity p_j, and a container k has a capacity c_k.

You are part of a team optimizing shipping, and your task is to develop a system to pack crates into Pilates, and pallets into containers. The computations have to be done efficiently as there are tens of thousands of crates to be processed.

Please answer the following:

(a) What algorithm will you employ to pack both pallet and containers (they can be packed sequentially, i.e., first plates, then containers).

(b) What is the running time of the algorithm?

(c) What is the computational bottleneck, meaning what can delay the computations significantly, and how can you address that problem?

Solution to question 1 continued . . .

2. Recall Kruskal's algorithm, where, in order to check for cycles, we have to maintain a data structure keeping track of connected components. The following algorithm merges two connected components; what is its running time estimate in Big-O notation?

```
1: k ⟵ D[r]
2: l ⟵ D[s]
3: for j : 1..n do
4:    if D[j] = l then
5:        D[j] ⟵ k
6:    end if
7: end for
```

3. Design an algorithm which on input s, a binary string, checks whether s has the same number of 0s and 1s, and outputs 'Yes' or 'No' accordingly.

   For example, the output on 10101100 would be 'Yes' (4 zeros and 4 ones), and the output on 0111 would be 'No' (one zero but three ones).

   (a) Present the algorithm in pseudo-code
   (b) Propose a pre-condition and a post-condition
   (c) Propose a loop invariant
   (d) Prove by induction that the loop invariant holds
   (e) Conclude that your algorithm is correct

(Use this page and the next.)

Solution to question 3 continued . . .