Canberra Computer Science Enrichment: Algorithms

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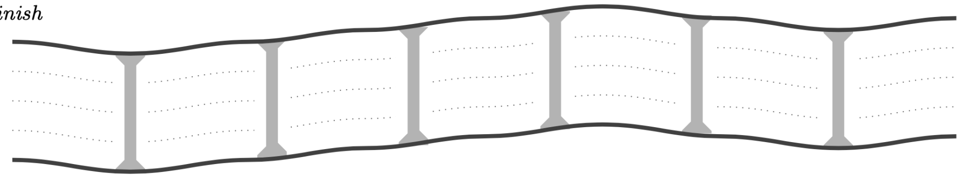
Acknowledgement: These problems are taken from David Clark, Computational and Algorithmic Thinking 2011-2015, AMT publishing 2016.

1 River Crossings

The annual fun run crosses all six bridges across a town's river.



All competitors have been allowed to chose their own route, inevitably with chaos ensuing.

How many routes are there to chose from? Can do devise an algorithm (or even a formula?) that answers this question for any (even) number of bridges?

2 Expedition Planing

You are leading an expedition to collect Hojari frankincense. This is available at a line of outlets spaced one league apart, between desert towns. You must travel at least two leagues a day, and once you stop at an oasis, you cannot go any further that day. You know how much frankincense is held by each oasis, and you need to work out the maximum amount you can purchase on your trip.

For example, if there are four oases that hold the following amounts:

- `4 3 4 3` you stop at oasis 1 and 3
- `2 4 5 4` you chose oasis 2 and 4
- `5 4 2 3` you chose oasis 1 and 4.

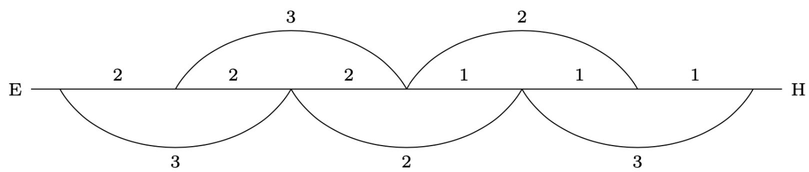
For each setup of oases and quantities below, determine the maximum amount of frankincense you can collect on a single trip.

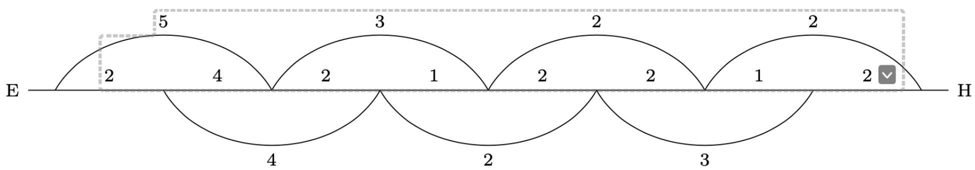
1. `2 5 2 4 7 4 5 5`
2. `1 2 4 3 2 1 2 3 1 2 1`
3. `3 1 4 1 5 9 2 6 5 3 5 8 9 8`

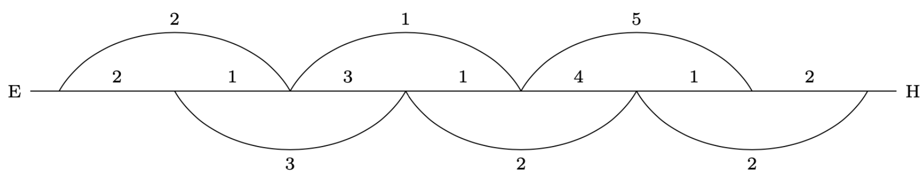
Can you describe an algorithm to do that?

3 Brown Treecreepers

Brown treecreepers are nesting and moving from an entry point to their hollow. In the graphs below, the numbers at the edges indicate the time it takes to traverse the respective arc. For each of the graph, what is the shortest travel time from the entry (E) to the hollow?







Again, can you describe an algorithm to do that?

4 Square Hopping

You need to hop over a number of squares from left to right. Each square has a number written on it. You have two moves.

- You can hop onto the square directly right of you, and collect the number of points written onto that square.
- You can hop over the square immediately on your right, and land on the next square. This will net you twice the number of points of the square you land on (but you will miss out on the points of the square you hopped over).

For example, for the squares $\boxed{4}\boxed{2}\boxed{3}$

- you get 4 + 2 + 3 = 9 points by hopping onto all squares
- you get 2 * 2 + 3 points by hopping over the first square
- you get 4 + 2 * 3 = 10 points by hopping over the second square.

Consider a sequence of squares with the numbers below written into them:

1. `4 5 6 7 4 5`
2. `2 1 4 5 1 2 5 6 3 2`
3. `2 3 5 3 4 6 4 5 8 5 6 9`

What is the maximal number of points you can obtain for each row of squares?