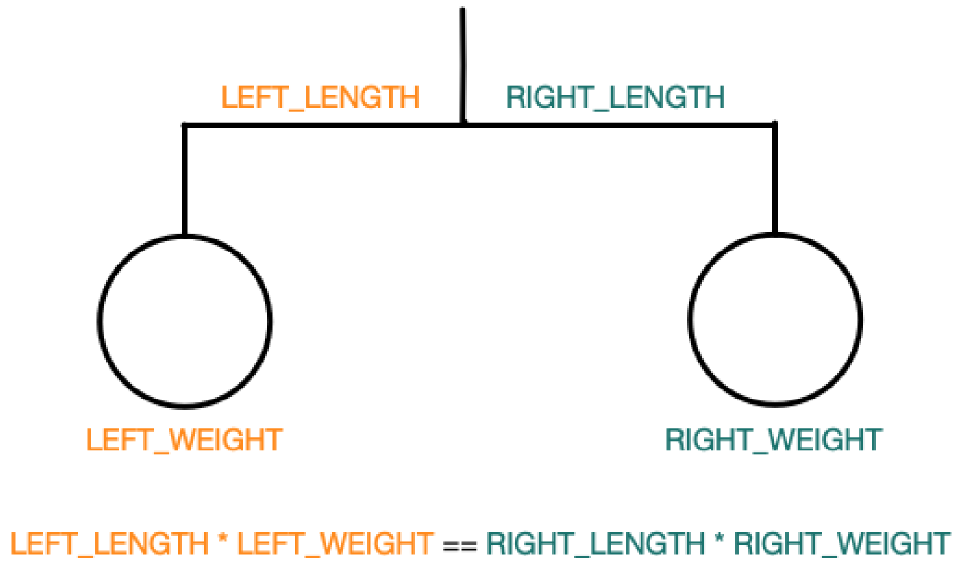
Computational Problem Solving CSCI-603
Mobiles Problem Solving

10/16/2021



1 Introduction

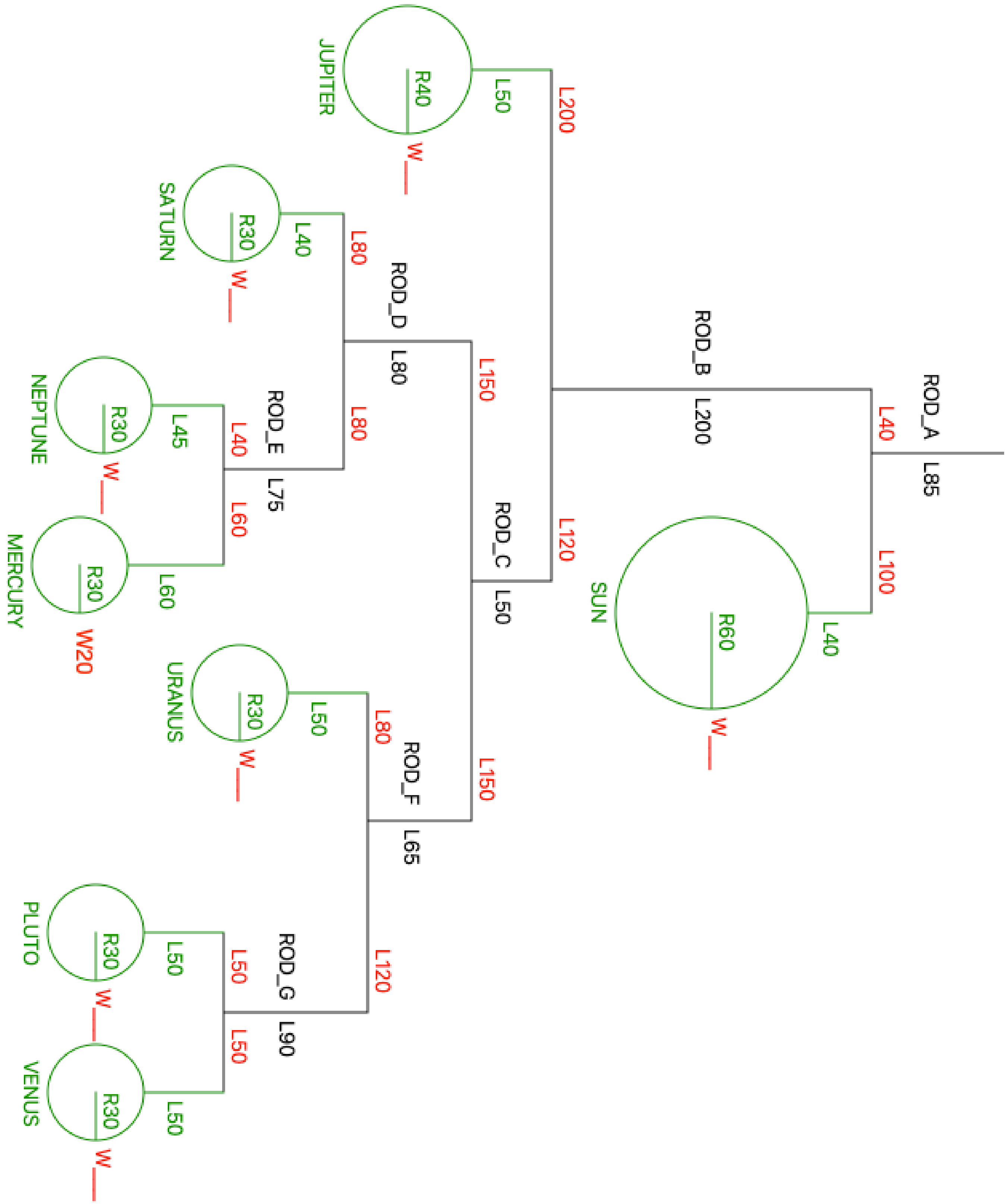
A *mobile* is a tree like structure that you often find hanging above a baby crib. It is composed of a hierarchy of *rods* with *arms* of various lengths and *balls* of various weights that are connected together by *cords*.

A mobile in *equilibrium* is defined by a delicate balance of forces in motion known as *torque*, τ. Considering only the weights of the balls, the torques on each side of the mobile must be equal for the mobile to maintain a perfect balance:

$$left\_\tau = left\_arm\_length * left\_arm\_weight$$
$$right\_\tau = right\_arm\_length * right\_arm\_weight$$
$$left\_\tau == right\_\tau$$

2 Problem Solving

1. Given the mobile on the following page, fill in the weights of the balls so the mobile is perfectly balanced.



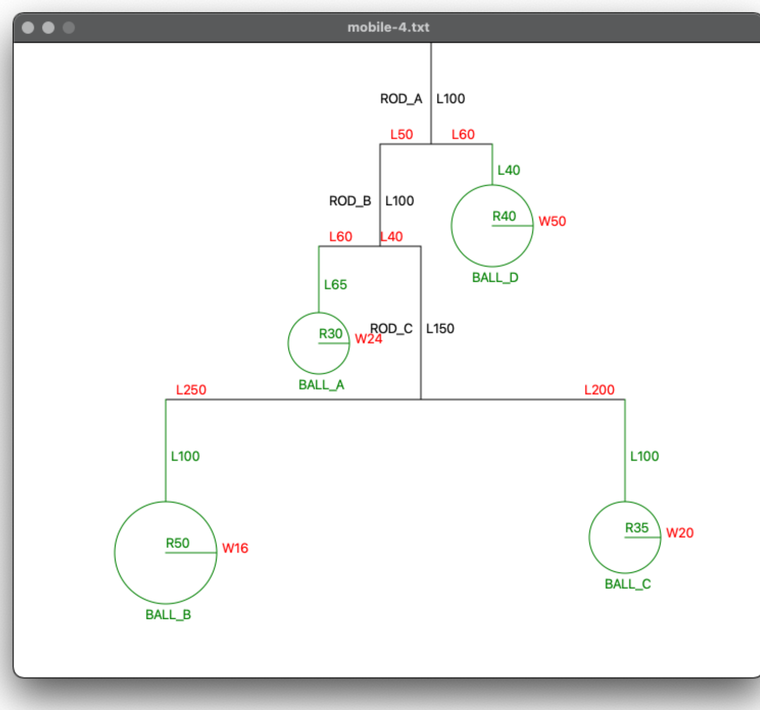
ROD_A
L85
L40
L100
SUN
R60
W___
L40
ROD_B
L200
L200
L120
JUPITER
R40
W___
L50
ROD_C
L50
L150
L150
ROD_D
L80
L80
L80
SATURN
R30
W___
L40
ROD_E
L75
L40
L60
NEPTUNE
R30
W___
L45
MERCURY
R30
W20
L60
ROD_F
L65
L80
L120
URANUS
R30
W___
L50
ROD_G
L90
L50
L50
PLUTO
R30
W___
L50
VENUS
R30
W___
L50

2. We will consider representing our mobile as a binary tree of nodes who are either rods or balls. Regardless its type, every node must provide methods to:
   (a) Get the integer weight of the node, `getWeight()`.
   (b) Tell whether the node is balanced or not, `isBalanced()`.

3. Implement a class to represent a `Ball`.
   (a) A ball can be constructed with the following parameters, in order:
      i. A string name
      ii. An integer cord length
      iii. An integer radius
      iv. An integer weight
   (b) By definition a ball by itself is always balanced.

4. Implement a class to represent a `Rod`.
   (a) A rod can be constructed with the following parameters, in order.
      i. A string name
      ii. An integer cord length
      iii. An integer left arm length
      iv. A left child that can either be a `Rod` or `Ball`
      v. An integer right arm length
      vi. A right child that can either be a `Rod` or `Ball`
   (b) Recall that a rod is balanced if the torque of the left and right child is the same.

5. We would also like to draw balance puzzles from a text description. When drawn, it might look something like this:



To do so, we need to compute the width of every node in the tree. Add a method, `width()`, to the `Ball` and `Rod` classes that computes the width. This method is similar to the algorithm discussed in class that computes the height of a tree.

Take a look at the mobile above and see if you can figure out how the left width of ROD_B is computed to be 260. Or likewise why the right width of ROD_A is 225.