

IPD Placement Exam

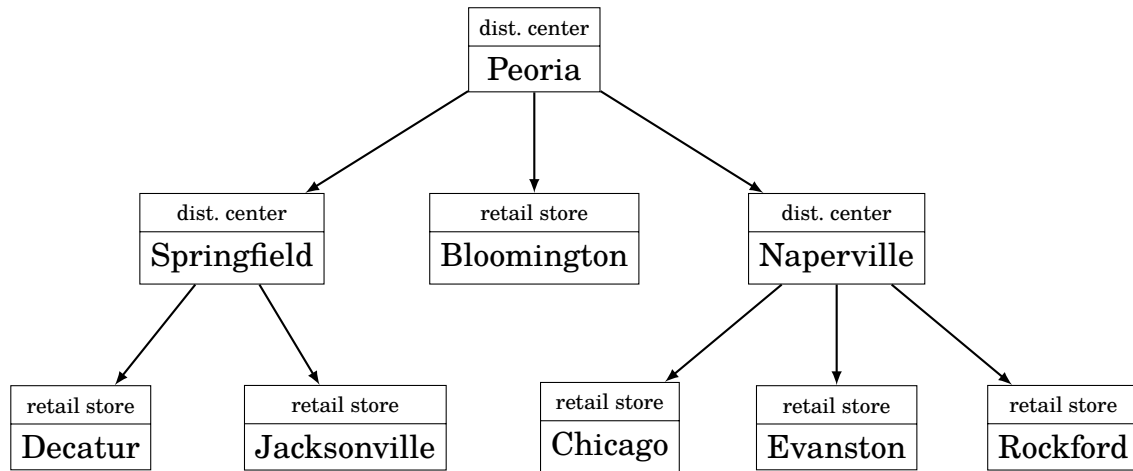
Name: _____

Instructions:

- *Answer each question the best you can.*
- *It is your responsibility to ensure your code is understandable; if we can't understand how your code works or why some part is written the way it is, then we may deduct points even if the code technically works.*
- *For coding questions, you may use any real programming language of your choice, but you may not use pseudocode. You may use the standard library of your language of choice.*
- *This is a closed-book, no computer, no calculator, no notes, no smartphone, no neighbor, do-it-all-by-yourself exam.*
- *If you need extra space, you may use the back of the page, provided you indicate this clearly.*
- ***Read all of the questions before answering any of them.***
- *If you have a question, please ask a proctor.*

Illinois Widget Works manufactures widgets in Peoria, Ill., and sells its products throughout the state via a tree-like distribution network comprising two kinds of nodes, *distribution centers* and *retail stores*. Each node (except the root, at Peoria) receives its widgets from some *upstream* distribution center. Each distribution center distributes widgets downstream to some number of other nodes (either kind). Stores are leaves and don't have downstream nodes.

Here's an example distribution network of three distribution centers and six retail stores:



In the above network, downstream of distribution center Peoria are two distribution centers (Springfield and Naperville) and one retail store (Bloomington). Downstream of distribution center Springfield are two retail stores (Decatur and Jacksonville); downstream of distribution center Naperville are three retail stores (Chicago, Evanston, and Rockford).

As an example of how distribution works, a widget manufactured in Peoria might pass through the distribution center in Naperville on its way to the retail store in Evanston.

1. Design a data structure or data type in the language of your choice for representing a distribution network (as described on the previous page). Don't include any functions or methods in your design at this point, because we just want to understand how the information is represented. (In some languages you'll have to write a constructor.)

***Hint:* Read the rest of the exam before writing anything on this page.**

2. Demonstrate how to represent the example distribution network from p. 2 using your data type from p. 3. In particular, show how to define a value or instance representing that example.

3. Design a function or method on distribution networks that counts the number retail stores in the network.

For example, given the distribution network on p. 2, the result should be 6.

4. Design a function or method on distribution networks that takes the name of a goal node (either a retail store or a distribution center) and returns the path from the root to the goal node, if it exists.

For example, given the distribution network on p. 2 and goal node name “Jacksonville,” the result should be the path Peoria, Springfield, Jacksonville. However, given the same distribution network and goal node name “Moline,” there’s no path to be found.