Huntington-Hill Apportionment Algorithm

The Huntington-Hill Method is an iterative process to apportionment representatives. The algorithm is described as follows:

1) Ensure every state starts with exactly 1 representative
2) For all remaining representatives, allocate them one at a time to the state with the **highest priority score**

The priority score for a given state is:

$$Priority_{state} = \frac{population_{state}}{\sqrt{n * (n + 1)}}$$

In the above formula *n* is the number of representatives the state already has.

Let's look back at the 5-state example we used in Part 1. Let's allocate 25 representatives to the states below.

Name	Population
Delaware	989948
Maryland	6177224
Pennsylvania	13002700
Virginia	8631393
West Virginia	1793716

Let's assign one representative to every state and calculate the priority (note that the number was rounded for display purposes only, and you should not round priority). This means we have 20 representatives left to allocate.

Name	Population	Representatives	Priority
Delaware	989948	1	699999
Maryland	6177224	1	4367957
Pennsylvania	13002700	1	9194297
Virginia	8631393	1	6103317
West Virginia	1793716	1	1268349

In this situation, Pennsylvania has the highest priority, so Pennsylvania gets the next representative (going to 2). Then we repeat this process to allocate the next representative.

Name	Population	Representatives	Priority
Delaware	989948	1	699999
Maryland	6177224	1	4367957
Pennsylvania	13002700	2	5308330
Virginia	8631393	1	6103317
West Virginia	1793716	1	1268349

Notice that Pennsylvania has a lower priority now, since they have more representatives. This leaves Virginia with the highest priority, so Virginia gets the next representative.

Name	Population	Representatives	Priority
Delaware	989948	1	699999
Maryland	6177224	1	4367957
Pennsylvania	13002700	2	5308330
Virginia	8631393	2	3523751
West Virginia	1793716	1	1268349

Now Pennsylvania has the highest again, so it gets a third representative

Name	Population	Representatives	Priority
Delaware	989948	1	699999
Maryland	6177224	1	4367957
Pennsylvania	13002700	3	3753556
Virginia	8631393	2	3523751
West Virginia	1793716	1	1268349

So far, we have allocated 8 representatives. If we repeat this process to allocate the remaining 17, we get:

Name	Population	Representatives	Priority
Delaware	989948	1	699999
Maryland	6177224	5	4367957
Pennsylvania	13002700	10	3753556
Virginia	8631393	7	3523751
West Virginia	1793716	2	1268349

If you look back at the same example, you'll notice that, compared to the Hamilton approach, West Virginia gained one seat, and Pennsylvania lost one seat. This is because Hamilton tends to slightly favor larger seats (with a degree of randomness), whereas Huntington-Hill slightly favors smaller states.

However, a key advantage is that Huntington-Hill can never result in the paradox we discussed earlier with Rhode Island. That is, for any number of allocated representatives, allocating additional representatives will never cause any state to lose representatives.