Pirates

By Admin | April 16, 2010 0 Comments

Five pirates have 100 gold coins. they have to divide up the loot. in order of seniority (suppose pirate 5 is most senior, pirate 1 is least senior), the most senior pirate proposes a distribution of the loot. they vote and if at least 50% accept the proposal, the loot is divided as proposed. otherwise the most senior pirate is executed, and they start over again with the next senior pirate. what solution does the most senior pirate propose? assume they are very intelligent and extremely greedy (and that they would prefer not to die).

Solution

(to be clear on what 50% means, 3 pirates must vote for the proposal when there are 5 for it to pass. 2 if there are 4. 2 if there are 3. etc…)

solution: most of the time i get people who give answers like “the most senior pirate takes half and divides the rest up among the least senior pirates.” um, you missed the whole point to begin with. sorry.

any answer without a specific logic behind it is invalid. if i ask you why pirate 5 gave x coins to pirate 1, please don’t say “because he’s nice”.

now for the real solution. pirate 5 being the most senior knows that he needs to get 2 other people to vote for his solution in order for him not to be executed. so who can he get to vote for him, and why would they choose to vote for him? if you start thinking that pirate 4 will never vote for him, because he would rather have 5 die and then be in charge and take it all for himself, you are on the right track. but it gets more complicated.

lets consider if there were only 1 pirate. obviously he would take it all for himself and no one would complain.

if there were 2 pirates, pirate 2 being the most senior, he would just vote for himself and that would be 50% of the vote, so he’s obviously going to keep all the money for himself.

if there were 3 pirates, pirate 3 has to convince at least one other person to join in his plan. so who can he convince and how? here is the leap that needs to be made to solve this problem. **pirate 3 realizes that if his plan is not adopted he will be executed and they will be left with 2 pirates**. he already knows what happens when there are 2 pirates as we just figured out. pirate 2 takes all the money himself and gives nothing to pirate 1. so pirate 3 proposes that he will take 99 gold coins and give 1

coin to pirate 1. pirate 1 says, well, none, and since i know if i don't vote for pirate 3, i get nothing, i should vote for this plan.

now we know what happens when there are 3 pirates. so what happens with 4? well pirate 4 has to convince 1 other person to join in his plan. he knows if he walks the plank then pirate 3 will get 99 coins and pirate 1 will get 1 coin. pirate 4 could propose giving pirate 1 two coins, and surely pirate 1 would vote for him, since 2 is better than 1. but as greedy as he is, pirate 4 would rather not part with 2 whole coins. he realizes that if he gets executed, then pirate 3's scenario happens and pirate 2 gets the shaft in that scenario (he gets zero coins). so pirate 4 proposes that he will give 1 coin to pirate 2, and pirate 2 seeing that 1 is better than 0 will obviously vote for this plan.

a common objection is that pirate 2 is not guaranteed to vote for this plan since he might hope for the case when there are only 2 pirates and then he gets all the booty. but that is why i said that the pirates are extremely intelligent. pirate 2 realizes that pirate 3 is smart enough to make the optimal proposal, so he realizes that there will never be 2 pirates left, because 3 doesn't want to die and we just showed that 3 has a winning proposal.

so lets sum up at this point

```
Pirate 1  2  3  4  5
    5. ?  ?  ?  ?  ?
    4. 0  1  0 99  -
    3. 1  0 99  -  -
    2. 0 100 -  -  -
    1.100
```

once you see the pattern it becomes very clear. you have to realize that when a pirate's plan does not succeed then that means you are in the same situation with one less pirate.
1. pirate 1 needs 0 other people to vote for him. so he votes for himself and takes all the money. 2. pirate 2 needs 0 other people to vote for him. so he votes for himself and takes all the money. pirate 1 gets 0. 3. pirate 3 needs 1 other person to vote for him. he gives 1 coin to pirate 1 for his vote – if we are reduced to 2 pirates, pirate 1 gets 0 so pirate 1 knows 1 is better than none. pirate 3 takes 99. pirate 2 gets 0. 4. pirate 4 needs 1 other person to vote for him. he gives 1 coin to pirate 2 – if we reduce to 3 pirates, pirate 2 gets 0 so pirate 2 knows 1 is better than none. pirate 4 takes 99. pirate 3 gets 0. pirate 1 gets 0. 5. pirate 5 needs 2 other people to vote for him. its clear now that the 2 people he needs to convince are the 2 who get shafted in the 4 pirate scenario – pirate 3 and pirate 1. so he can give them each 1 coin (which is better than 0 – what they would get otherwise) and keep 98 for himself.

```
Pirate 1  2  3  4  5
    5. 1  0  1  0 98
```

what happens if there are 15 pirates? pirate 15 needs 7 other people to vote for him, so he recruits pirates 13,11,9,7,5,3, and 1 with 1 coin each and keeps 93 coins himself. those pirates will all vote for him because they know that they get 0 coins if he dies and pirate 14 is in charge.

hope you enjoyed this one. its my favorite interview question of all. it really allows the candidate to ask a lot of interesting questions and its really amazing when they reach the solution all by themselves (as all fogcreek employees have done so far).

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