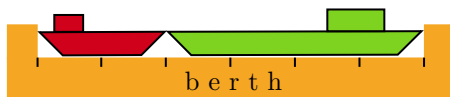


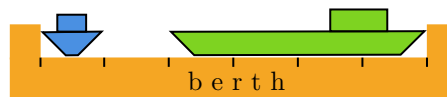
# Sort at the Port

## A Hands-On Game about Optimization

Cargo ships arrive at the port of Miami and need to be unloaded. The ships differ in size (their length) and in how long (in hours) it takes the cranes to offload their cargo (this depends on both the amount of cargo and how fragile it is). The place at the port where the ships dock for unloading is called the berth and it has a limited size. This means only a few ships can dock near the cranes to be unloaded at the same time. The question facing the port manager is: in what sequence should today's ships be unloaded in order to finish with all of them as early as possible? Let us look at an example. Suppose 3 ships arrived today at 8am. The red ship is 2 units long (1 unit = 20 feet) and takes 1h to unload. The green ship is 4 units long and takes 3h to unload. And the blue ship is 1 unit long and takes 4h to unload. If the port's berth is 6 units long, here is one way to unload these 3 ships:



Unload red and green from 8am to 9am. Red ship done at 9am.

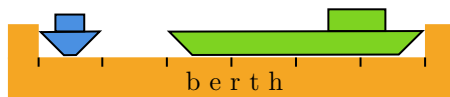


Unload blue and green from 9am to 11am. Green ship done at 11am.



Finish blue ship from 11am to 1pm. **Total time:** 5h (8am to 1pm).

And here is another way to unload them:



Unload blue and green from 8am to 11am. Green ship done at 11am.



Finish blue and red from 11am to 12pm. **Total time:** 4h (8am to 12pm).

Note that the second sequencing of ships saves 1 hour of unloading time. Do you think it is possible to unload all of these 3 ships in less than 4h? If so, how? If not, why not?

The next page has several ships that need to be unloaded and a berth of size 10 units. Cut out the pieces with a pair of scissors so that you can move the ships in and out of the berth. Ship sizes match their lengths (in units), and the time it takes to unload each ship is written inside the ship itself (in hours). Assume all ships arrived today at 8am and are waiting at the port to be unloaded. How would you sequence their unloading in order to be finished with all ships as soon as possible? When you are finished playing with the ships on the next page, feel free to come up with your own ships and try to sequence them as well.

### Additional Questions for Discussion:

How do you know for sure that your solution is the best possible?

What assumptions or simplifications from a real-life situation were made while solving this problem?

Variations of the game: (a) In our game we assumed all ships arrived at the same time in the morning, but what if they arrive at different times during the day? How would you incorporate this detail in your solution procedure? (b) It could be that some ships have precedence over others (their cargo needs to be unloaded first). How would that affect the solution?

This game is about scheduling a shared resource that can handle tasks in parallel in order to minimize the total completion time of all tasks. Another example would be a supercomputer that needs to run several important calculations in parallel (for instance, scientific experiments) and you want to schedule the calculations to complete them as quickly as possible. Can you think of other examples of this sort?

(This game was created by [Prof. Tallys Yunes](#) from the University of Miami. It is licensed under a [Creative Commons Attribution-NonCommercial 3.0 Unported License](#).)

# Sort at the Port

## A Hands-On Game about Optimization

