Exercise 2 The sinking boat

2 passengers want to go on a boat with their luggage to make a crossing across a wide fjord. Each can bring, in principle, unlimited luggage. There is no quota. However, the boat can carry only a limited weight before it sinks. What that limit is, is not known to the passengers nor the captain. The captain and the passengers are all interested in the economics of the voyage. In addition to the fixed fee per passenger of 100 kroner per trip each kilogram of luggage earns him 10 kroner per trip. That is the price that the passengers must pay for bringing their luggage along. Unaccompanied luggage is not allowed due to security restrictions. Hence the luggage that is left behind on the first trip must be picked up on a second trip, which in addition to the price of the luggage will cost an additional 100 kroner for the return trip to fetch the left-behind luggage. The second crossing would, of course, impose an extra charge of 100 kroner too. Once a passenger is onboard with his luggage there is no way he or she can return to shore and pick up more luggage if the boat still floats. All decisions about carry-on luggage must be taken prior to the voyage. It seems then obvious that bringing the most of their luggage onboard for each passenger makes sense. Since they don't know the safety limit of the boat they just have to try. Of course, none of the people onboard would not like to lose their luggage in the water and swim to shore to pick up a new boat. That would imply a loss of 10.000 kroners for each.

Each person onboard weigh 100 kg.' If they had checked the floating properties of the boat, they would have found that is can carry 500 kg.

Passenger 1 has the following parcels:

Piece 1: 20 kg

Piece 2: 80 kg

Piece 3: 30 kg

Piece 4: 100 kg

Passenger 2 has the following luggage with him:

Piece 1: 50 kg

Piece 2: 90 kg

Piece 3: 30 kg

Piece 4: 50 kg

a. Model this as an agent problem and program it. Let each agent pick pieces at random first. What is the probability that the boat will sink? What is the likely balance point between max luggage and a floating vessel?

b. Model this as a Q-learning problem. A successful voyage is worth 10.000 kroners for each passenger. How many epochs does it take before both passengers figure out what is possible to carry on in order to have a safe trip?
c. What happens if the passengers are given the chance to add more luggage once they are onboard? How does this change your program?

Some theoretical reflections:

1. Is there a Pareto curve associated with this problem? Explain you answer.
2. What normal form game does this problem adheres to?
3. Do you foresee any major changes if the number of passengers is expanded to 3 and even 10?
4. Would it have made a difference if all would know the load capacity of the boat up front?
5. What if the captain becomes more cautious and lower the capacity with 20%
6. Could you have modeled the learning problem here according to the Ever - Roth reinforcement method?
7. Try to comment on the issue of self-interest versus common interest in the context of this problem.
8. Can a Nash equilibrium be achieved between the two passengers? What could this NE possibly be?