DPRL Assignment week 1

- Consider a seasonal product that you can sell during 150 time periods with an initial inventory of 5 items
- Every time period there is a random demand $D_t \in \{0,1\}$ with $P(D_t = 1)$ increasing in time t linearly from 1/150 to 1
  - thus $P(D_1 = 1) = 1/150,\ P(D_2 = 1) = 2/150,\ \ldots,\ P(D_{150} = 1) = 150/150 = 1$
- Every time unit you can order 1 item. Delivery is immediate (and before a potential sale), but unreliable: the item arrives with probability 0.5.
- Profit from selling an item is 1, any item in inventory costs 0.1 per time unit. No other costs or rewards.
- Left-over items cannot be sold, no backorders

A. **Define** an appropriate state space $\mathscr{X}$ and action space $\mathscr{A}$ for this problem

B. **Define** and **solve** the problem as a finite-horizon DP. **Report** the expected maximal reward and **plot** the optimal policy (as a function of time and inventory). **Interpret** your results

C. **Simulate** the process 1000 times under the optimal policy. **Report** the average reward and make a histogram of the rewards. **Interpret** your results

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How and what to submit:

- Report (.pdf) of max 2 A4 pages plus appendix with relevant figures/tables/screenshots
- Separate Python code file (.py)
- Implement the algorithm in an efficient way, it should run very fast
- Report should include the solution method. Mathematically describe the method that you coded, including implementation choices and initialization
- Comment on your findings, are they as expected?

Grading:

- 1 pt start, A 1 pts, B 5 pts, C 3 pts
- All **bold** terms are rubrics (1 pt) in the grading

Details for this and future reports

Your report is expected to cover the following four points.

Explain the problem
At first, you should explain what the problem is that you are going to solve. What are your assumptions and why do they make sense or where do they deviate from reality.

Describe your methods
From your report, it should become clear what you did exactly and why this makes sense. In general, you can use as a guideline that a reader should be able to repeat your methods and is able to get to the same results. You can assume that your target audience would be any another student in the same study area. But this does **not** mean that you can leave out any parts up to be guessed / filled in by the reader. It is not required that your grandmother can understand it, however being able to explain her what you did is a good exercise that will come in handy whenever you plan to work in/for companies, where you will also often have to explain what you have done to persons lacking any mathematical/programming knowledge.

For this specific assignment, this means that:

- -Copying the provided value function as given is not sufficient. Explain why it makes sense and don't forget to add the base cases/boundary conditions.
- -Just stating that you did a simulation is not sufficient. Explain how this was done / what was exactly simulated and what was used from your solution in the first part.

Report your results
You should report all (requested and/or relevant) results in a meaningful way. Report on the exact outcomes or provide plots, whatever makes the most sense in the situation. The goal should be that the reader gets presented all the insights that you want to show, in a clear way.

For this assignment, this means that:

- -You should provide the expected revenue for your optimal policy and the total revenue of your simulation.
- -Providing the optimal policy and offered prices/remaining capacity over time makes the most sense as a plot. Printing e.g. (a part of) a 600x100 matrix, does not provide any insights to the reader.
- -You should make sure all the plots are interpretable. At least add labels to all axes, including the color scale! (And do not use a continuous color scale for discrete values)
- -You should make sure all plots make sense. E.g. using 0 as optimal policy for the boundary in your implementation is okay, but does not make sense to include in your results/plots.

Discuss your results
Often more important than the exact values you obtained, are the conclusions you can draw from them. What do the results show, what can be seen in a plot, why do certain values do make sense. E.g. a good way to check yourself was to see if the average revenue over a large number of simulations converged towards your expected revenue. But be careful to draw conclusions on one single random simulation run!

These expectations have been shortly mentioned in the assignment, but are also very general for any report, ranging from a two pager up to your thesis. In total, this should lead to a report that is fully self-containing without the need to read/understand your code. We use the provided code to check your implementation, as well as to be able to give you partial points for correct results with incorrect/insufficient explanations. But for the rest, the code is mainly the way to get to your report/results, it is not the result itself.