In-Class Work: Traffic Flow

4. Distance

Copy into your working directory the following solution program which determines the distance `d` for each car on the road
`~kvollmay/share.dir/inclass.dir/traffic4.py`
or if you had at the end of last class a working program for this task, then you may use your program from last class. I will explain at the beginning of class what exactly the program does.

5. Update Velocities

5a. For the update of the velocities we will need a function which determines the smallest number of three integers. Python has a function which does this, for example `min(3,1,9)` gives `1` as result. Test this function with a few print commands

5b. Use the program `traffic4.py` and copy it into `traffic5.py` and add to it that it determines all new velocities (and updates them in the `road` array), and prints out the road with the new velocities. Check your program with print commands.

6. Update Positions

Now you are ready to add to your program the update of the positions. To do so use a new loop over all cars and update both the `carpos` array and the `road` array. For the update of `road` make sure to first copy the new velocity into a variable (e.g. `vnew`), then empty the old site and then put the car in road on its new site `xnew = xold + vnew` with the new velocity (the order of these commands matters). After the update of all positions print the complete road and check if it is what you expected. Using the same parameters as used in `traffic4.py` compare your result with
`~kvollmay/share.dir/inclass.dir/traffic6_PCAR03.data`
Rerun the simulation for `PCAR=0.5` and compare your result with
`~kvollmay/share.dir/inclass.dir/traffic6_PCAR05.data`

7. Finish Program (if time)

Now you are set to finish the program for our traffic flow model. Add to your program from 6. the time loop. Compare your result for the case of 100 timesteps (`MAXTIMESTEPS = 100`), `PCAR=0.3`, and otherwise the same parameters as before. Compare your output with
`~kvollmay/share.dir/inclass.dir/traffic7_PCAR03.data`
And again change the probability of a car on a road site to `PCAR=0.5` and comprare your output with
`~kvollmay/share.dir/inclass.dir/traffic7_PCAR05.data`

8. Space-Time Diagrams (IF TIME)

8a. Now we are ready to have a look at the flow of the cars. Switch back to `PCAR=0.3`. Next we will make a space-time diagram. This is an image of the road for successive time timesteps, i.e. on the x-axis is the road position and the y-axis is downwards and equal to the number of time steps. You find an example in Fig. 3 of the Chowdhury et al. traffic flow paper. This means that we want a picture similar to the DLA-fractal growth picture we made in class when we worked on the DLA model. You will need to first make a two-dimensional array which stores the space-time diagram data, for example named `spacetimearray`

Add to your program such an array and set the values of the `spacetimearray` during your time-loop. To print the array at the end into a file, you may use the following lines:

```
#print spacetimearray into file
fileoutdat=open("spacetime8.data",mode='w')
for i in range(MAXTIMESTEPS):
  for j in range(ROADLENGTH):
     print(spacetimearray[i,j], end=" ",file=fileoutdat)
  print("\n", end=" ",file=fileoutdat)
fileoutdat.close()
```

To test your program compare the resulting `spacetime8.data` with your results in step 7.

8b. To be able to see the main patterns (and to get nice pictures) use a larger road `ROADLENGTH=` 200. Now you are ready to make nice picture of this space-time diagram. You find an example for the python syntax at the end of `~kvollmay/share.dir/inclass.dir/classfractal3.py`
To get also a colorbar, use before the command `plt.savefig` the following command:
`plt.colorbar(orientation='horizontal')`
Look at the resulting space-time diagram and interpret it.

8b. To distinguish stopped cars easily from driving cars, let's indicate every empty site instead of with -1 now with -VMAX. Look at the space-time diagram.

8c. Vary PCAR. Interpret the resulting space-time diagrams. Once you have several space-time diagrams for different PCAR, get me so that we can discuss as a class your results.