CS440: State and Action Spaces

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Action Space

In the SUMO environemnt, there are four possible light values for each direction of travel. Each light can take on a value from the set {GreenStraight, GreenLeft, Yellow, Red}. The default SUMO traffic lights run on a 90 second loop that cycles through these four values. Yellow, however, is an intermediate light which comes immediatley after a green phase such that the light progression goes from green to yellow before finally turning red. Since, for a typical four way intersection, when the lights on one street are green, the lights signalling the orthogonal street will be red, we can limit the set of lights that we need to control to be the green value for each direction. That is, for a NS street intersecting and EW street, we only need to know which green to use from the set {EWG, EWLG, NSG, NSLG}, where EWG is an east-west green light, a EWLG is an east-west left turn signal, and so on. This will be the set from which my action will be drawn from. This was also the action-space used by Wade Genders and Saiedeh Razavi in their paper Using a Deep Reinforcement Learning Agent for Traffic Signal Control. However, this raises an issue with intersections that have more than 4 streets (See 5-street intersections and even some 6-street intersections). This is a topic for which I would like to investigate and think about more over the next few weeks, as I would like to find an action space that is independent of the number of streets for the intersections.

State Space

As for the state space, Genders and Razavi developed their discrete traffic state encoding (DTSE), which holds three vectors which signal presensce of a vehicle in a cell, the speed of a vehicle in the cell, and the current traffic signal. While this is information rich and provides a lot of the information you could gather in an ideal world, collecting the first two values seem challenging enough that it would be incredibly difficult to implement (especially easily) in a real world environment. Instead, I propose using a different state space. This state space holds the number of cars curently at the light, the number of cars going under a certain speed threshold which signifies the number of cars waiting at the light, and the current traffic signal. By not requiring specific locations of vehicles, we lose spatial information in the problem but we gain the ability to more quickly implement the example in the real world. However, knowing the raw number at the light leaves too much information out. Therefore, using the number of cars in each lane (but not their exact locations) may be the perfect balance of opnipotence and realism. Furthermore, knowing the exact speed of vehicles helps with determining future spatial information but again, would be difficult without advanced equipment. Instead, I would like to use the average speed over three reference frames. While this sounds complicated, the thought behind it is this: for a camera mounted on a traffic light, being able to use the angle downwards which it is pointing, and the visual change in size of vehicles over a few fractions of second, it might be plausable to have a sufficeiently accurate estimate of the speed of the vehicles in the visual frame.

Conclusion

In conclusion, the tentative action space is {EWG, EWLG, NSG, NSLG} for a given four way intersection. The problems with this were discussed above. The tentative state space uses the number of vehicles in each lane, the average estimated speed for each vehicle, and the current traffic light signal.