Summary of Class Discussion

The class discussed several issues during the presentation. One question prompted a discussion on the appropriate settings for the tuning parameters in the Fuzzy Ant System and the Bee System. Matt responded that the paper did not provide guidance on reasonable settings for these parameters, which was a limitation of the paper. Another topic we discussed was the large difference in time complexity between the benchmark with 100 nodes and the benchmark with 101 nodes. Matt suggested that improving the time complexity might be an area for further research.

After the presentation, we discussed the difference between verification and validation of these systems. Verification ensures that a system meets its specifications; validation ensures that the system meets its users’ actual needs. We discussed how much emphasis is needed on a perfect solution and whether it is more important to verify or validate the solution. We agreed that being able to deliver a solution better than the current optimal solution could be more important than a perfectly verified system. The extent of validation is a source of uncertainty in a system, and we noted this as a research challenge.

We next discussed the differences between bio-mimetic (mimicking nature), evolutionary computation and adaptive-control systems. We discussed whether it would be possible to categorize these types of systems by the sources of uncertainty they were best suited to handle. Specifically, we discussed the ability of these methods to handle sources of uncertainty such as train arrival and travel times, weather, road conditions, and driver behavior.

The class also discussed how adaptive control works. Questions included whether there is a stopping mechanism and how the controller handles switching between different surfaces. The explanation used an example of an adaptive controller trying to move a cup to a certain position on a surface with unknown friction. The adaptive controller would apply a certain amount of force based on an estimated value of the friction. Based on the output of the force applied, the controller would then make changes to the estimate of friction. This would increase or decrease the amount of force applied until either the desired movement was achieved or the cup was at the desired location. The stopping mechanism would be the controller using less or opposite force to ensure that the cup stopped at the desired location. Regarding the effect of changing surfaces, the response was that there are different mechanisms and techniques for situations of different complexity.

The discussion on adaptive control led to the suggestion of a research challenge to combine the methods of swarm-intelligence, evolutionary computing, and adaptive control. Specifically, can we use swarm-intelligence or evolutionary computing to search for an optimal adaptive controller? One student mentioned an online adaptive algorithm for mutating the controller for robots via run-time evolution. We discussed using methods initially developed...
to solve one type of uncertainty in a situation they were not intended to solve. For example, we discussed the use of machine learning methods such as neural nets to handle uncertainty.

The class also discussed the distinction between fuzzy and probabilistic decision-making. We noted that fuzzy logic is deterministic whereas probabilistic methods are non-deterministic. We also debated whether one technique was better suited for certain types of uncertainty. We agreed that probabilistic decision-making could only be applied to limited situations such as supervised learning and identifying when to replace physical sensors due to wear and tear. Yet probabilistic decision-making is less useful in situations such as weather prediction and actual physical interactions. One student mentioned that fuzzy logic can be used to handle uncertainty in systems not originally designed for that purpose.

Lastly, we explored whether it was possible to design a system that would be able to adapt in situations in which failure seems imminent. An example that one student provided was an adaptive vehicle facing an unavoidable collision. We discussed whether perfect adaptation can always prevent failure.