School of Engineering and Applied Science (SEAS), Ahmedabad University

CSE 400: Fundamentals of Probability in Computing

Project Scribe Submission

Group No.: S1 G17

Domain: ITS

Date: February 3, 2026

Scribe Question 1: Project System and Objective

What is the probabilistic problem being addressed in your project? Clearly state the system objective and identify the primary sources of uncertainty involved.

Answer: Our project is an interest to correlate the traffic lights on a road junction that is controlled on one side and synchronised in real time at the intersection of a road. This is aimed at minimizing the average waiting time in the stop line as well as the entire travel time across the junction.

We do not use an static time plan, but rather we consider the intersection to be a dynamical system that undergoes a rapid change of condition, during peak hours. We are thus trying to regulate signal cycle time Copt, the green phase splits in real time in accordance to what is being observed other than begin building queues.

Scribe Question 2: Key Random Variables and Uncertainty Modeling
Identify the key random variables in your project and describe how uncertainty is modeled for each. Clearly state any probabilistic assumptions currently being made.

Answer:

- Arrivals in time interval: Number of vehicles arriving at the crossroads in one interval Δt is random. We denote this arrival count by n.
- Arrival rate λ: The arrival rate is also treated as uncertain as it can fluctuate around accordingly with time.
- Input flow $q_{in}(k)$: Since arrivals are random, the input flow becomes random at each time step k.
- Output flow $q_{out}(k)$: The output flow is also uncertain because it depends on the signal $u(k)$ (green or red) and the current queue.
- Congestion state: Each movement can be placed into one of two states using a queue threshold: if queue > threshold it is congested, otherwise it is non-congested.
- State transitions: Because arrivals and departures change the queue, the congestion/non-congestion state can change over time, so we can model this using transition probabilities between states.

Scribe Question 3: Probabilistic Reasoning and Dependencies

Explain how probabilistic relationships (e.g., dependence, independence, conditionality) are used within your project system to support reasoning, inference, or decision-making.

Answer: In our project we adopt probabilistic relationships to draw a relationship between the random traffic flow and our control decisions. To start with, the number of arrivals (n) and the input flow (q in) are not constant; they are determined by the arrival rate (Lambda) and vary with time. Due to this randomness, the length of the queue is also not known. Output flow (q out) is affected by two factors, the signal (green or red) and the amount of vehicles in wait.

In determining what to do, we set partner queue lengths into Congestion States, according to some threshold. The most significant probabilistic relationship is the one called the State Transition. We make the assumption that the conclusion state is given by our action as a function of the existing state is affected only by the operation of the state (Markov property). We determine the likelihood of switching between a non congested state into a congested state (P i,j,k). This information allows our system to foresee which signal decision (u) is most likely to ensure that it does not result in traffic congestion despite the fact that we do not know the exact amount of cars that are to be received.

Scribe Question 4: Model–Implementation Alignment

Describe how the current probabilistic model aligns with this project's implementation or experience. Highlight any assumptions that influenced design or evaluation choices.

Answer: The probabilistic model is yet to be built, but the control system designated work has been decided. The system will observe the number of cars queued at the cross road and labels each of the directions as congested or non-congested based on a threshold number. If the length of a queue is more than the threshold, then the queue is considered congested, otherwise not. Based on these states and the signal action we will choose which lane gets green, the traffic condition can change in the next time step, and we represent this change using confitional probability.

This aligns with real operation because the next situation mainly depends on what we see now and what signal we apply now. If we give one direction green for longer, its queue can reduce, but other directions may keep waiting and their queues can grow, so every decision has a clear trade-off. One main assumption that affects our design is that vehicle arrivals are random and future arrivals are difficult to predict for a long time, so the controller should update decisions frequently using short time steps rather than relying on a single fixed plan.

Scribe Question 5: Cross-Milestone Consistency and Change

Describe the current state of your project's probabilistic model. Identify its key assumptions, components, or relationships that are presented as well-defined, and indicate which aspects are expected to evolve or require refinement in subsequent milestones. Briefly justify your expectations.

Answer: After examining the term probabilistic model, we are well aware of three things, namely 1) we desire a reduction in delay and queue, 2) we can regulate cycle time and green split as well as the largest uncertainty, that is, we can regulate the arrival of vehicles randomly. Still to be determined: the description of the system state (may be queue thresholds or levels), the estimation of arrival rates based on the available data, and the conversion of the state into a timing decision which is predictable. This information might vary due to differences based on the layout of cross-roads, the sensor data we possess and what works best with the various traffic that it is tested on.

Scribe Question 6: Open Issues and Responsibility Attribution

Identify any unresolved probabilistic questions or ambiguities in the project at this stage, and indicate which role(s) or tasks are responsible for addressing them in the next milestone.

Answer:

Our definitions are the primary issues now and where we obtain our information. We are yet to select variables that indicate the current state of the system. The choices are queue length, flow or simply a label crowded/ uncrowded. We desire also a sure method of estimating arrivals in real time when traffic is at its peak. The frequency of changing the signal times is another issue. Over updating is also beneficial for the signal to adapt but its computationally expensive and may also cause the lights to become unstable when we over react to it.

The following milestone on data and sensing work should be concerned with the way of capturing or estimating arrival and queue statistics. The modeling work is supposed to lay down the state and action structure and the assumptions. The algorithm work must come up with a stable decision rule that is not changing at a rapid pace which adheres to the safety rules.

End of Submission