**Motivation and Applications**

- **Traffic Management**
  - Predictive Aggregate Query: How many cars expected to be in downtown after 20 minutes.
  - Predictive Range Query: Send e-coupons to all customers predicted to show up within three miles from my store location in the next 30 minutes.

- **Location-Aware Advertising**
  - Predictive KNN Query: Find out the three drivers anticipated to be the nearest to a rider location within the next 10 minutes.

- **Ride Sharing**
  - Predictive Aggregate Query: The given road network reachability tree predictive aggregate query.

The iRoad system for evaluating predictive queries on moving objects for road networks. The main premise of the iRoad system is to support a variety of common predictive queries including predictive point query, predictive range query, predictive KNN query, and predictive aggregate query. Many applications can benefit from deploying iRoad, e.g., (1) in traffic management systems, (2) ride sharing systems (3) location-based advertising. Users are able to interact with iRoad through a well-designed Graphical User Interface to issue different types of predictive queries on a real road network, to obtain the predictive heatmap of the area of interest, to follow the creation and the dynamic update of the reachability tree around a specific moving object, and finally to examine the system efficiency and scalability.

**System Architecture**

- **Reachability Tree Builder Module**
  - The main task of this module is to construct a reachability tree for each object in the system. The root of the tree will be the object start location.

- **Movement Handler Module**
  - The idea of the movement handler module is to limit the updates caused by an object movement. This is done by limiting the space around each object using the concept of Reachability trees.

- **Query Processor Module**
  - Having the predicted objects at each node precomputed in advance by the movement handler module. Coming queries the query processor module fetches those results and adapt them according to the query type and returns the answer in very fast response time.

**Reachability Tree**


**Probability Computation**

The probability of a node Ni being a destination to the object O in its current Ni, is equal to the probability of Ni, parent node of Ni, being a destination to O divided by the number of children of Ni, where the probability of the object current node No is one.

\[
P(N_j|N_0) = \prod_{i} \frac{P(N_i|N_0)}{\text{fanout}(N_i)}
\]

**Generic Answer**

<table>
<thead>
<tr>
<th>Time</th>
<th>Predicted Objects</th>
<th>Answer for Predictive Range Query</th>
<th>Answer for Predictive KNN Query K=1</th>
<th>Answer for Predictive Aggregate Query</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>(09, 0.7), (01, 0.4), (05, 0.9)</td>
<td>(09, 01, 05)</td>
<td>(05)</td>
<td>2</td>
</tr>
</tbody>
</table>

**System Inside**

Provide an eye on the iRoad internal gears in general, with more focus on the Reachability tree.

**Issuing Predictive Queries**

User can issue different types of predictive queries. For example, for predictive range query, a user specifies a rectangular region on the map and ask to find out the objects predicted to appear there after 15 minutes.

**Predictive HeatMap**

Presents the predicted status of a specific area in the road network, useful in predictive routing services.