Insights from Some Studies on Control in Traffic Networks

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Transportation Ecosystem

Infrastructure

Human

Vehicle
Transportation System

Supply

Demand

Technology
Control in Networks: Some Studies

- Real-time dynamic traffic network control
  - Time-dependent conditions
  - Stochasticity: demand, supply
  - Technology: Role of information
  - Traveler behavior

- How information/connectivity can be used to manage networks and their performance
  - Congested traffic networks
  - Disaster response – planning and operations
  - Connected and/or autonomous transportation
  - Collaborative freight networks
  - Organizational networks
Realism
- Traffic flow characteristics (analytical, simulation)
- Travel behavior (departure time/route/mode, learning & evolution, familiarity, risk-taking)
- Driver behavior (familiarity, experience, aggressiveness)

Factors
- Heterogeneity (traveler/driver/human/vehicle)
- Stochasticity (demand/supply)
- Time scale (behavior/planning/operations)
- Interactions (vehicle-human-infrastructure)

Goals
- State (description, prediction, evolution)
- Performance and control
Mathematical properties
- Realism in modeling vs mathematical tractability
- Complexity of traffic flows
- Traveler behavior and learning
- Stochasticity, heterogeneity, dynamics

Computational time
- Real-time needs
- Tradeoffs with accuracy
- Sensitivity issues under emerging technologies
Emerging Technologies

- Connectivity
  - Reliability
  - Congestion
  - Control
  - Security

- Automation
  - Stability
  - Mixed flows
  - Platooning
  - Traffic characteristics
  - Safety and mobility
Needs

- Human-vehicle interactions
  - Transition of control

- In-vehicle interactions
  - In-vehicle devices
  - Mobile apps

- Motion planning
  - Maneuvering
  - Platooning
  - Intersections

- Connectivity-based control
  - In-vehicle/personal devices
Needs

- Transition and mixed traffic flows
  - Level of automation
  - Level of connectivity
  - Vehicle characteristics
  - Asymmetry in human behavior
  - Differences in human and machine approaches to driving
  - Misperception of AV capabilities

- Data
  - What does it reveal?
  - How to connect disparate data?
  - How can it be used to enhance modeling realism?
  - Human in the loop
Insights: Some Problems Addressed

- **Platooning**
  - Cooperative braking control (CVs)
  - Under V2X communications
  - CV information transmission time delays

- **Vehicular traffic flow**
  - Sliding mode controller
  - Non-lane discipline
  - Leveraging vehicle characteristics under connectivity
Insights

Transportation community
- Control as a goal enabler
- Effectiveness, goals (mobility, safety, energy, emissions)
- Vehicular interactions (behavior, traffic flow theory)
  - Car-following, merge/diverge,
- Network-level
  - Traffic interactions, traveler/driver behavior, topology/infrastructure effects

Control community
- Focus on controller and its properties
- Convergence, stability, consensus
- Vehicle as individual agent (inter-vehicle gap, velocity)
  - Negative spacing/velocity, uncomfortable acceleration/deceleration
- Micro- and corridor-level
  - Lateral control, longitudinal control
Value in collaboration

- Increased role of technology, especially automation, as a catalyst
- Data as enabler (Google, Nvidia, etc.)
- Focus on realism

Opportunities

- Infrastructure
- Human
- Vehicle
Thank you!

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