# Interdependence in vehicle-pedestrian encounters and its implications for vehicle automation

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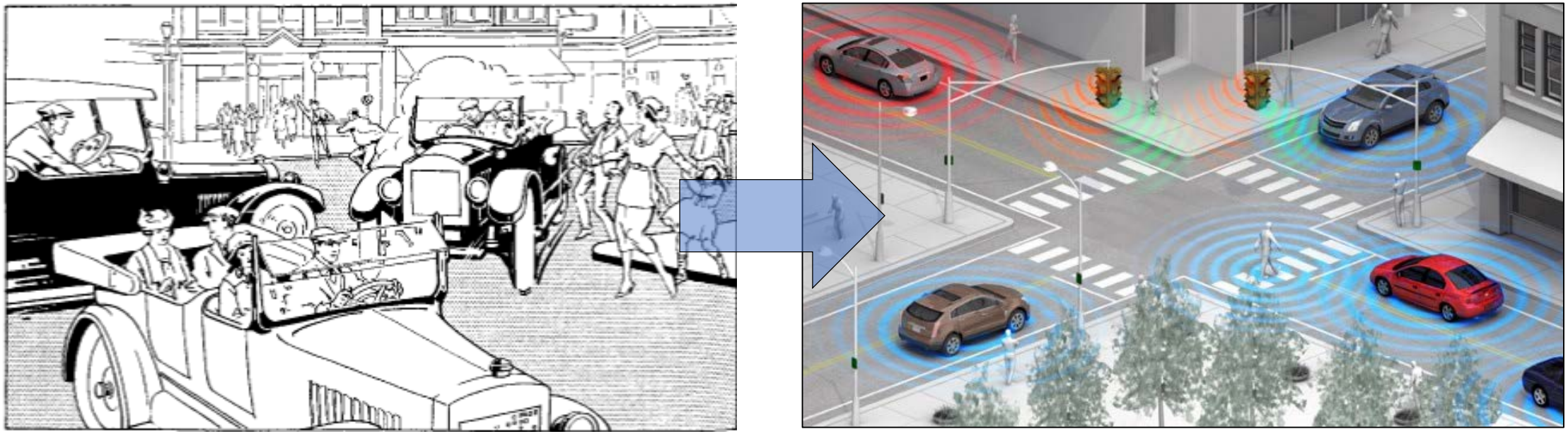
# The Problem

Vehicle automation may disrupt the social behaviors that society has developed over decades



# CSRC Research Overview

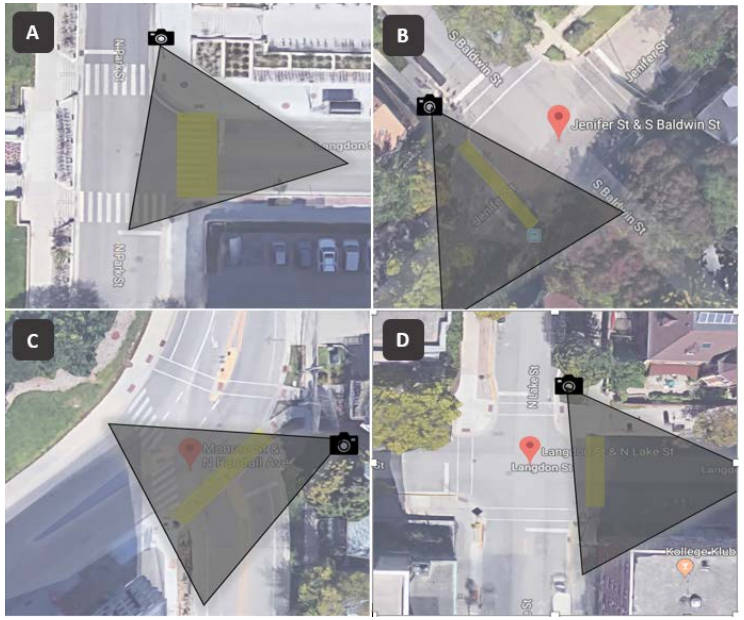
**(1)** As vehicle automation begins to replace drivers, what types of signals will be needed to support safety, efficiency, and tolerance?

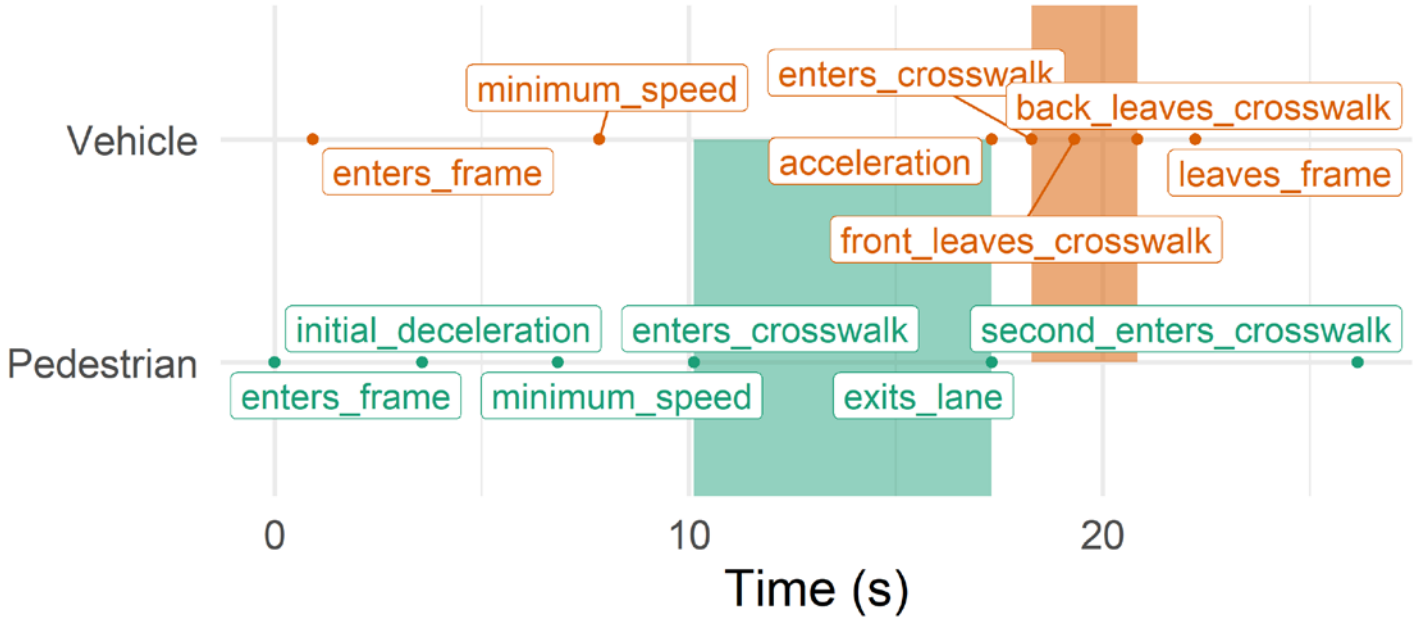
**(2)** How do we analyze vehicle-pedestrian interactions?

# What are the ways in which road users communicate?

# Naturalistic Observation Approach

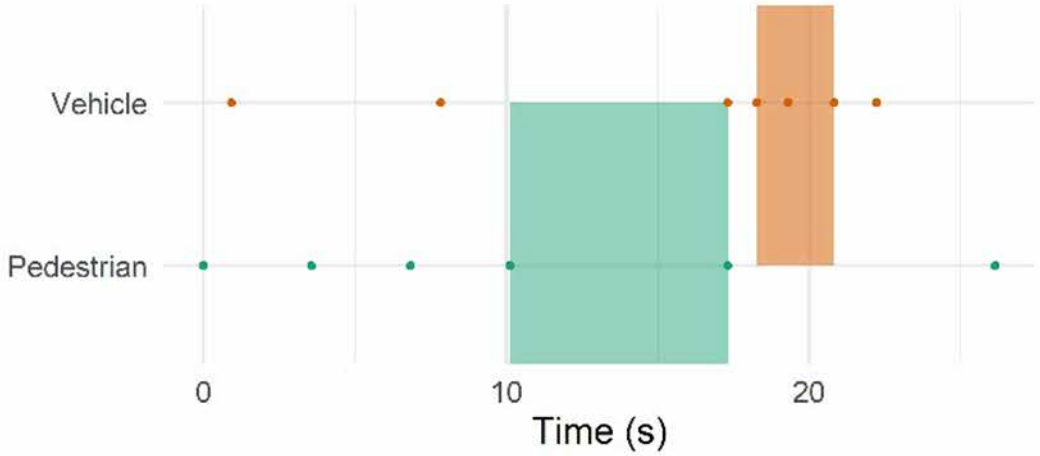
Coding vehicle and pedestrian behavior can reveal interdependence



# Naturalistic Observation Results

Road users communicate using implicit signals and supplement with explicit signals when needed

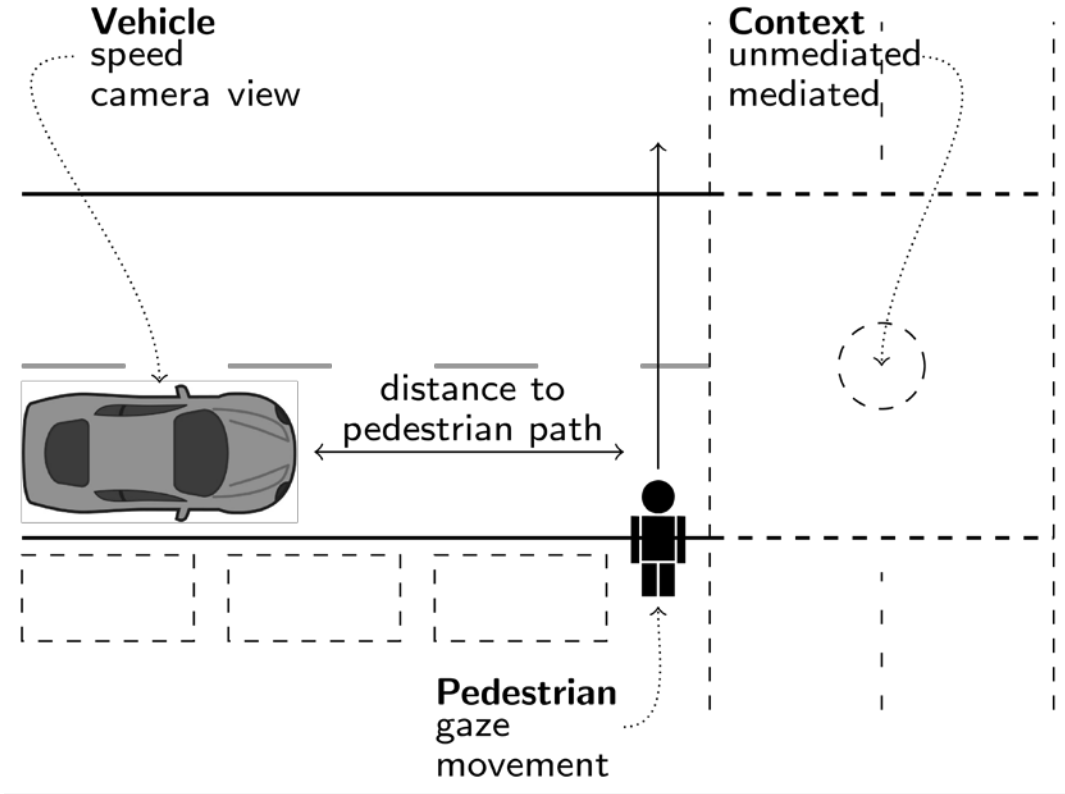


# How do we analyze vehicle-pedestrian interactions?

# Naturalistic Driving Study

- Vehicle and pedestrian implicit signals
- Research question
  - How does the intersection type affect **mutual outcomes** of vehicle and pedestrian encounters?
- Hypotheses
  - **Less structure** for intersection types will lead to poorer and more varied outcomes
  - Variables at each intersection type will affect **outcomes differently**
- Intersection type

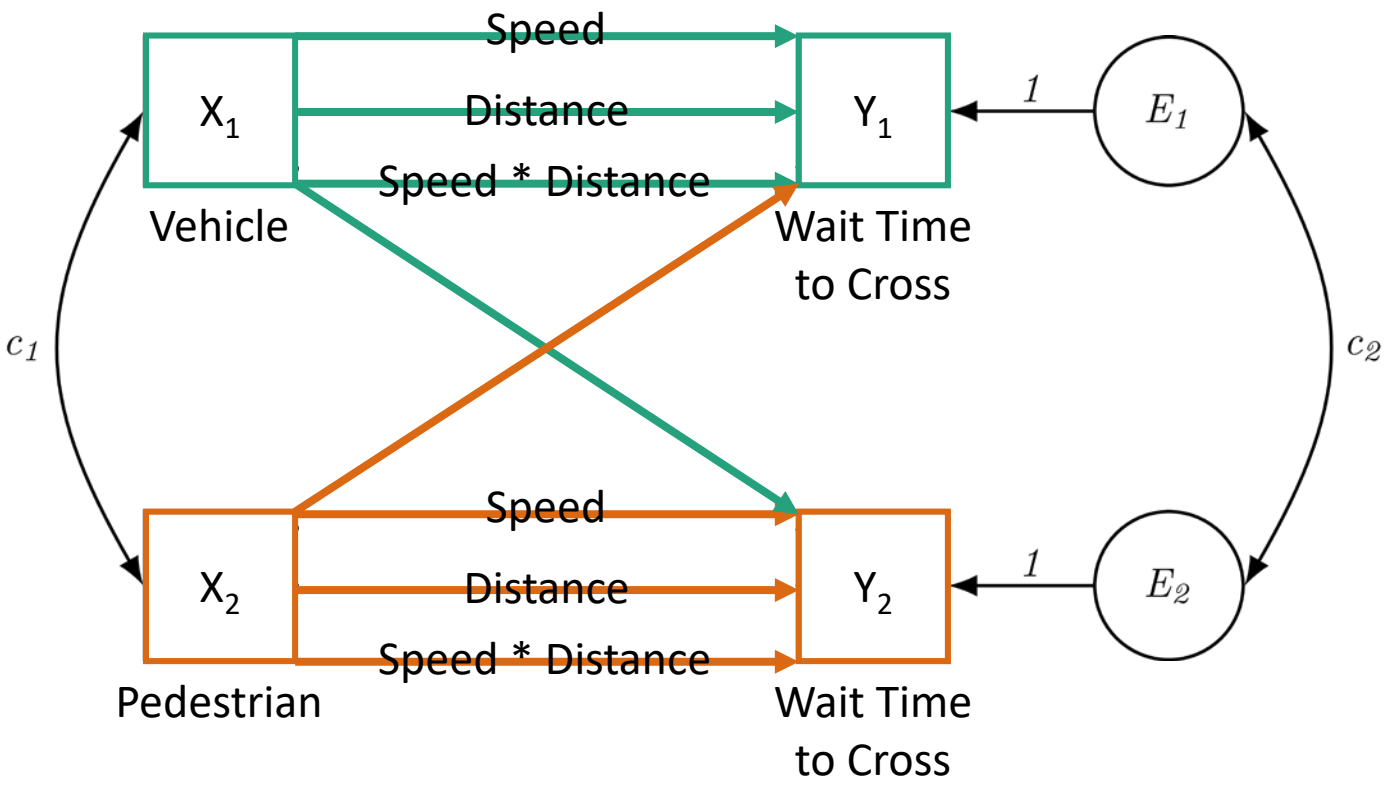
nonintersection unprotected stop indicator



PLAY VIDEO

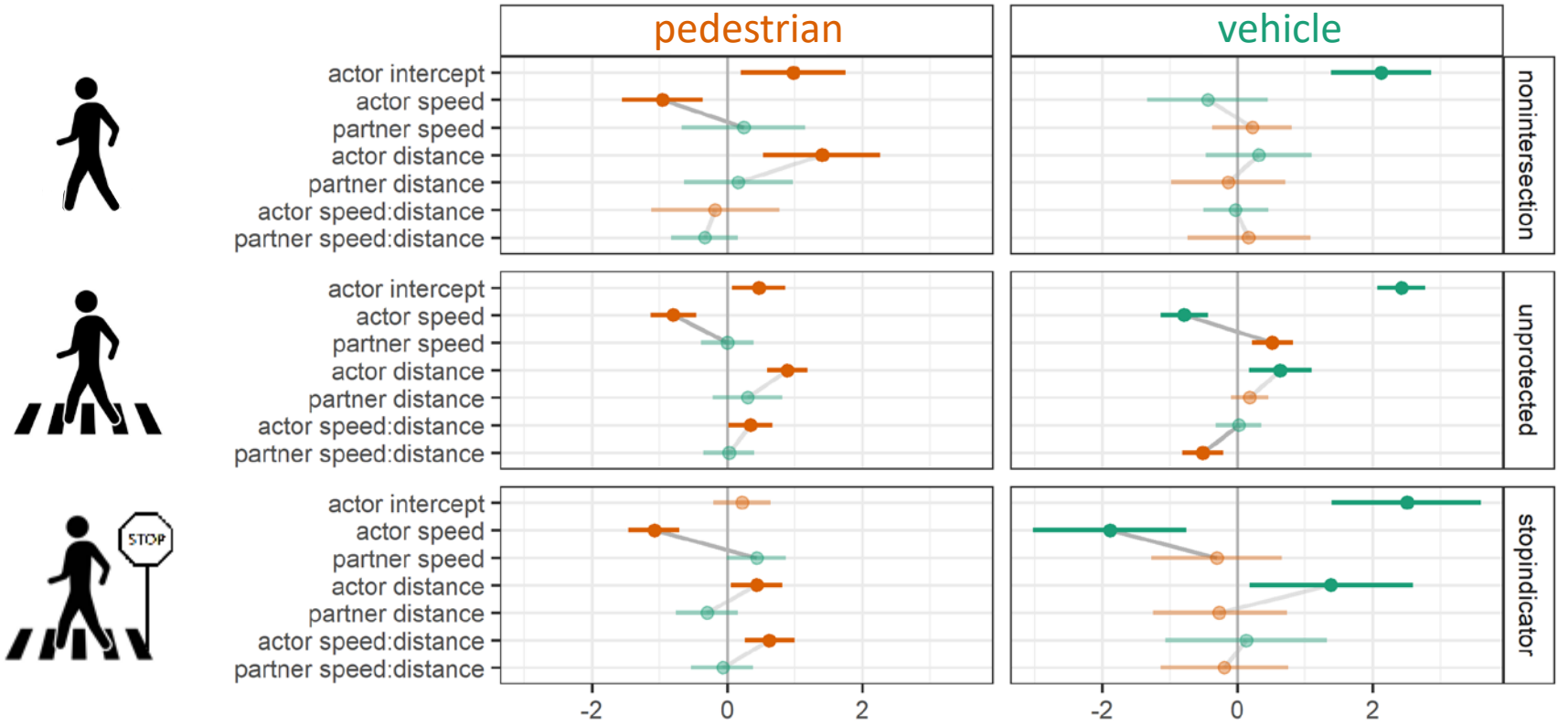
# Interdependence Model

Wait time to cross is an outcome that represents interdependence



# Wait Time Interdependence

Vehicle and pedestrian influence on each other's wait time differs across encounters and shows evidence for negotiation as the structure decreases




Pedestrian chooses conditions based on vehicle behavior

Vehicle and pedestrian negotiate

Vehicle and pedestrian effects are independent

# Conclusions

- Analyzing pedestrian data
  - Vehicle and pedestrian encounters are **dynamic**
  - **Mutual outcomes** show impact of communication
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- Designing the transportation system
  - Infrastructure is effective for separating decision processes of vehicle and pedestrian
  - Infrastructure aids in helping negotiate, and may be more necessary if AVs cannot replicate
  - Emergent pathways can be designed into automation and infrastructure
  - Additional signaling should **enhance** pedestrian interpretation of vehicle motion

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- Simulating traffic
  - Model can be applied to **traffic simulation** to realize real-world effects

# Implications

- Vehicle automation will need to exhibit social behaviors to communicate and coordinate with other road users

- Traditional methods for evaluating vehicle and pedestrian encounters may not capture the dynamic aspects important to automation

- Explicitly modeling and simulating the interdependence between road users provides an avenue for understanding mutual outcomes

# Questions?

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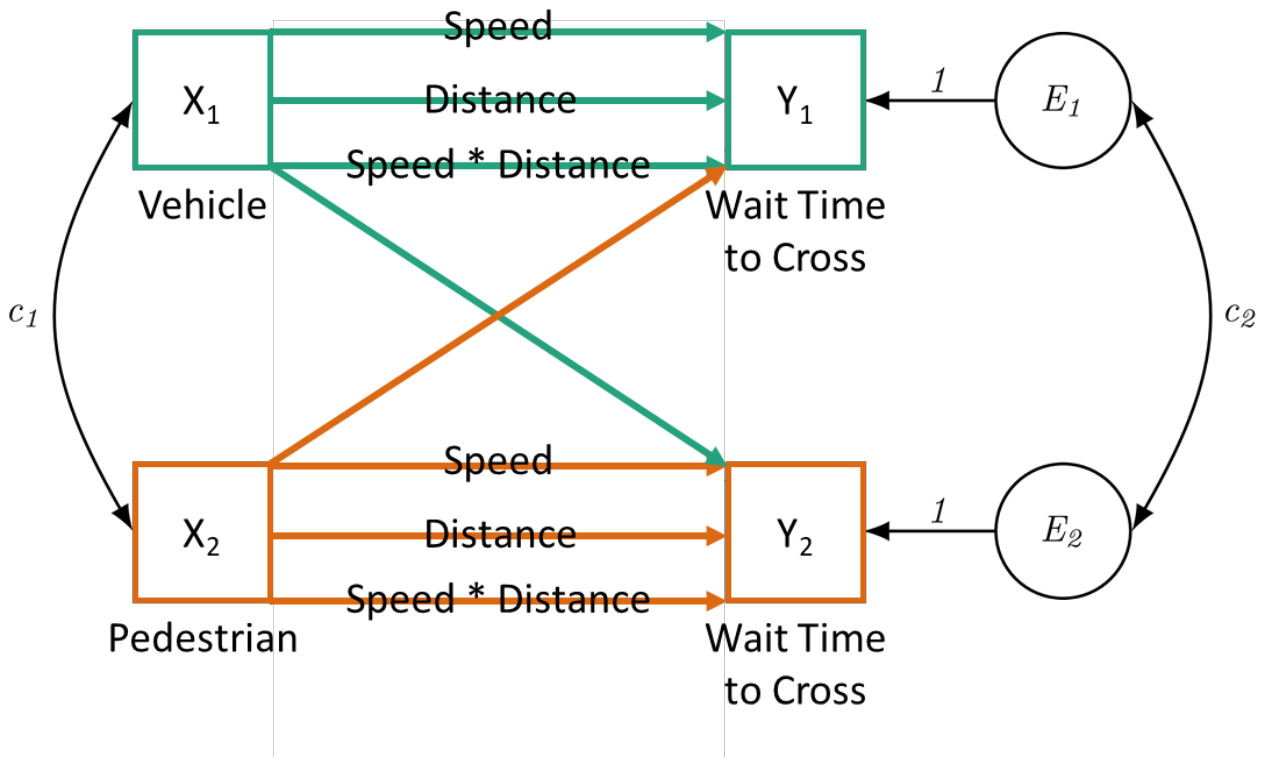
Collaborative Safety Research Center

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