

Can the Chicken Cross the Road?

A cyber physical system by
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Why study this problem?

- Real world applications
 - Avoiding obstacles with predetermined paths
 - Drone flying in airspace with commercial airlines
 - Moving through a crowd of people
 - Actually crossing the road
- Theoretical applications
 - Modeling an infinite stream of cars
 - Time-triggered and Event-triggered scenarios
 - Intro to a category of cyber physical systems

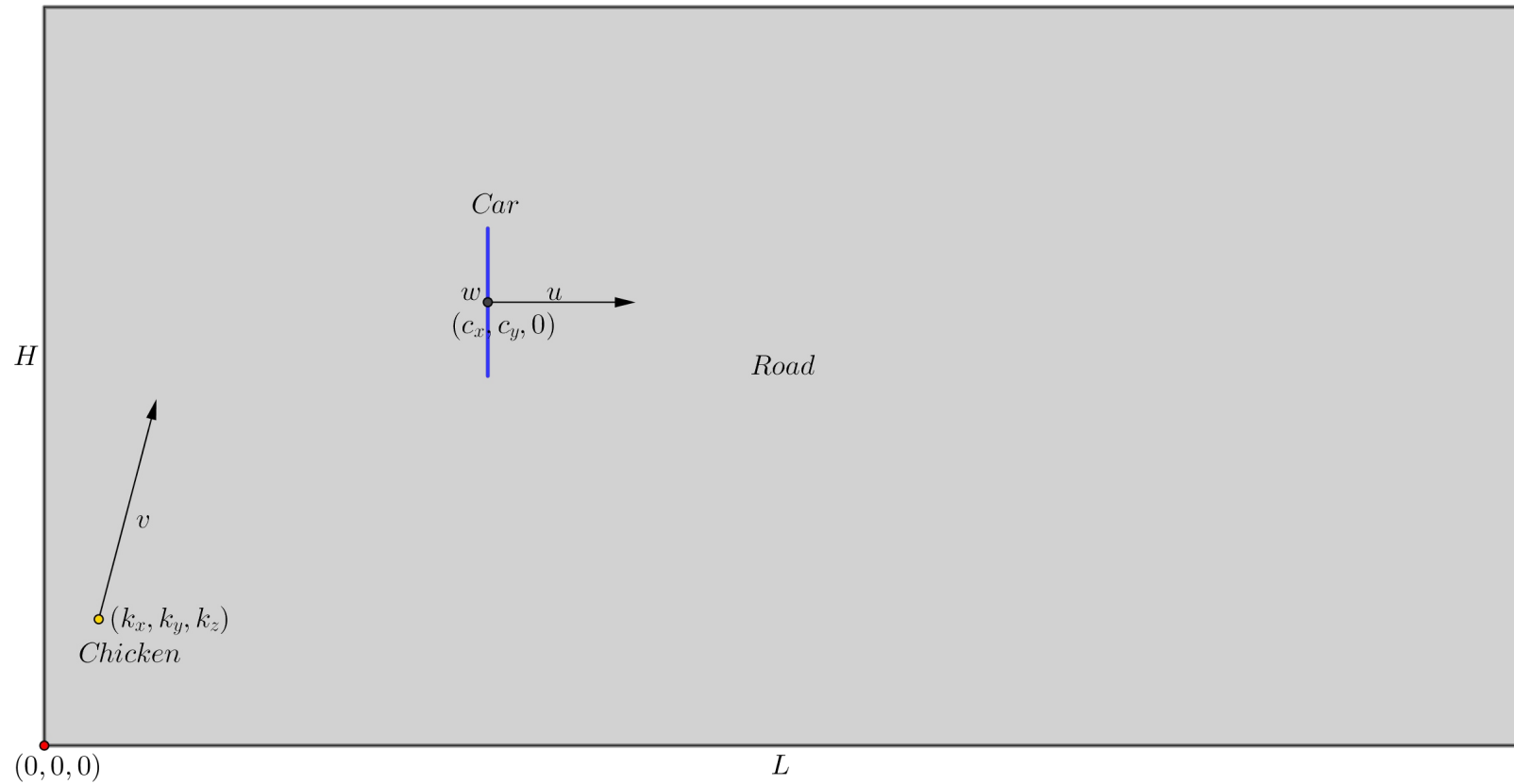
“Teleportation” Model

- Cars are always traveling down the road
- Use one car object to represent many cars
 - Circular motion
 - 2D
 - 3D
 - Circles are hard to deal with in Keymaera
 - Linear motion
 - Go back to start if you reach the end
 - Lines are easy to deal with
 - More relevant to real world

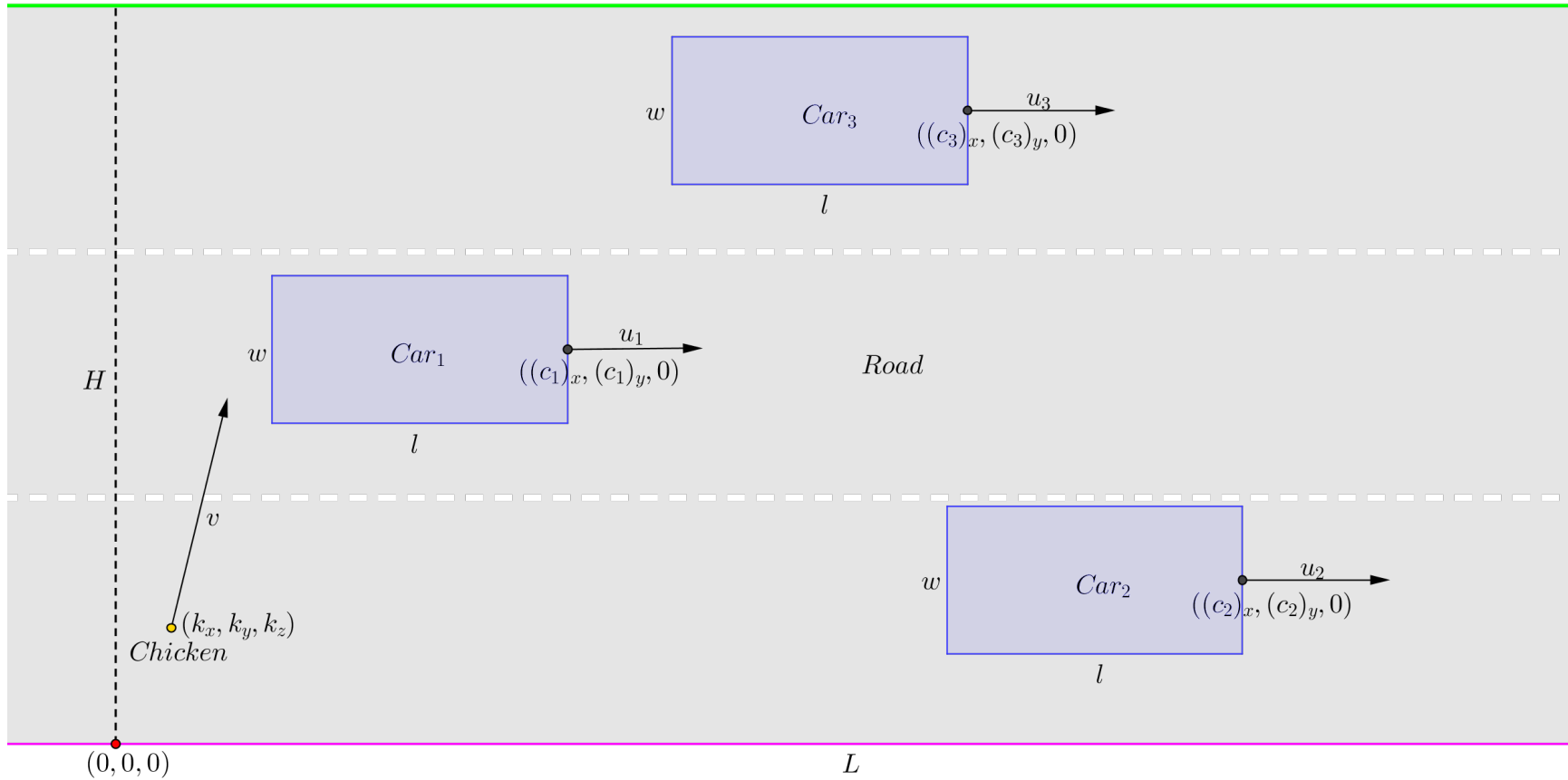
“Teleportation” Model

- Lanes are not necessary
- We can structure our system more generally
 - All cars can start anywhere within a bounding box
 - Some limitations to keep the problem interesting
 - Car gaps
 - Car overlaps
 - Certain initial configurations overlap with idea of lanes
 - If we can prove this, we will get a much more powerful result

“Teleportation” Model



Distributed Model



Time-Trigger vs. Event-Trigger

- How does the chicken make it's decision?
- Event Based
 - Chicken waits for an opening
 - Hard to wait in the middle of the road!
- Time Based
 - Chicken has a “reaction time”
 - Must plan path out piece by piece
 - Can we ensure a safe option at all times?
- Both types of program need some sort of default safe option

Time-Trigger vs. Event-Trigger

- Event-Triggered
 - Able to make the chicken sprint across the road
 - Only safe to idle when chicken is at front
- Time-Triggered
 - Computing the right preconditions is hard!
 - Give the chicken the ability to hover
 - Think of real world defense mechanisms such as shields or emergency maneuvers

Conclusion

- Success!
 - Time-Triggered Distributed Model
 - Give chicken full range of motion
 - Works for any number of cars
 - Only issue is the “hover” mechanic
- Next steps
 - Figure out the preconditions on the cars to eliminate the need to “hover”