



## CPS: Medium: Robust Learning for Perception-Based Autonomous Systems

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### Challenge:

- Shift from simple sensing devices to rich perceptual sensors: design of safety-critical CPS?
- ML/DL are key, but are they suitable for safety-critical control loops?

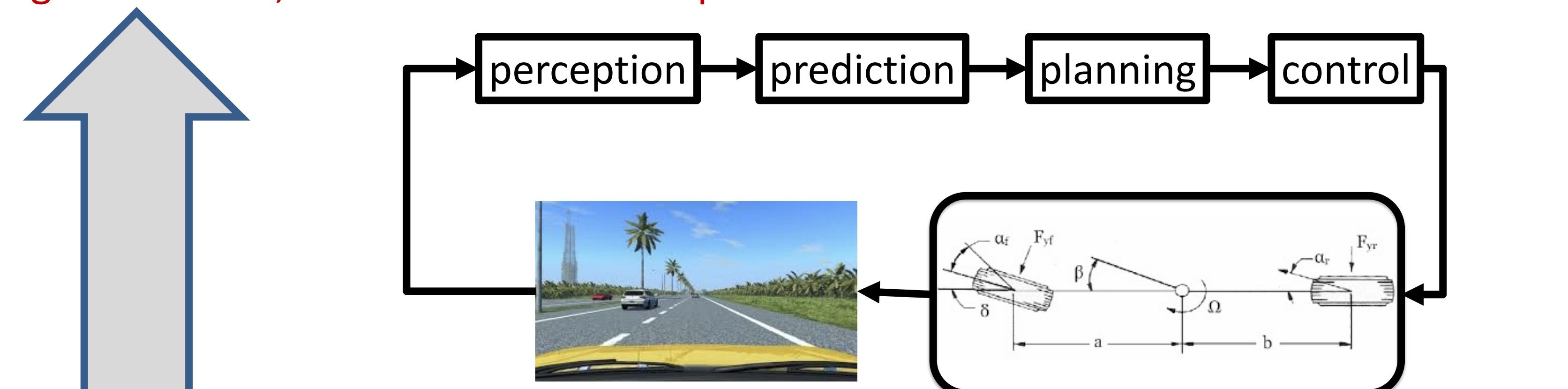
### Solution:

- **TA1:** Modular but *co-designed* pipeline w/ *uncertainty* as interface
- **TA2:** *Mid-level representations (MLR)*
- **KI1:** *Constrained ERM + MLR* for safe perception-based imitation learning
- **KI2:** Uncertainty-based exploration for active semantic goal navigation

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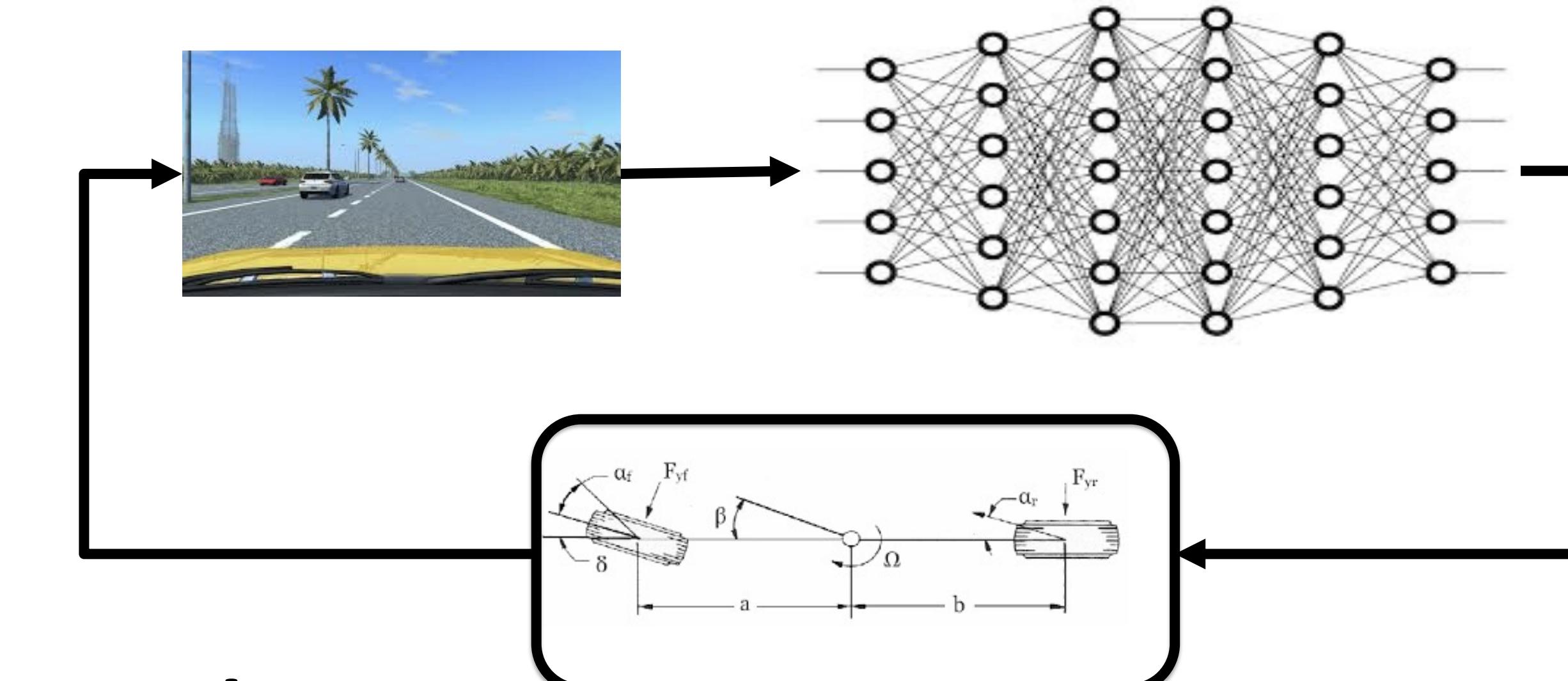
### modular

- + "easily" verified/validated, easier to integrate priors, "better engineering"  
- rigid interfaces, - limited end-to-end optimization



### co-design

- + rich interfaces  
+ mid-level reps give robustness  
+ end-to-end opt via module co-design



### end-to-end

- + high performance w/ end-to-end opt, adaptable  
- opaque/hard to troubleshoot, lack safety guarantees, harder to integrate priors

### Scientific Impact:

- Principled integration of learning-based perception, prediction, planning, & control
- Modular design pipeline w/ meaningful interfaces that allow for end-to-end metrics to be optimized
- Fundamental limits of robustness/performance in perception-based CPS

### Broader Impact:

- **Societal impact:** Autonomous transportation, search & rescue, disaster relief
- **Industry:** Google collaboration
- **Education:** new publicly available courses on L4DC
- **Outreach:** proposed CDC '21 workshop on robust deep learning-based control