

# EdgeDroid

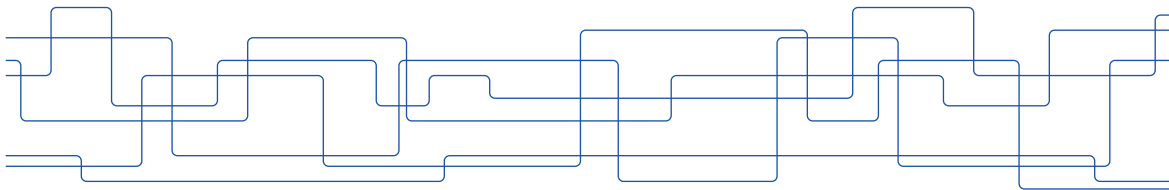
*An Experimental Approach to Benchmarking Human-in-the-Loop Applications*

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Sensory Input



Human-parseable  
Feedback



# Studying Human-in-the-Loop Applications

Need to understand and optimize these applications:

- ▶ How do they interact with each other?
- ▶ How do they interact with infrastructure?
- ▶ How do they scale?
- ▶ KPI: Delays, Round-Trip Times (RTTs).

With which methodology can we study these behaviors?



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**Costly**

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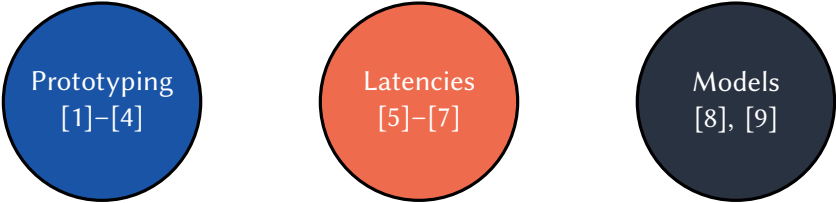
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**Costly, poor repeatability**

## Previous & Related Work



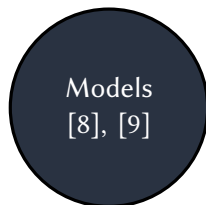
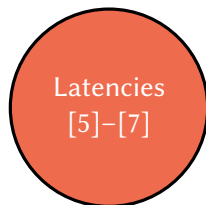
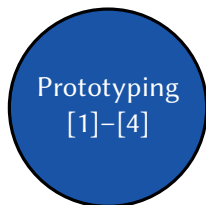
Prototyping  
[1]–[4]

Latencies  
[5]–[7]

Models  
[8], [9]



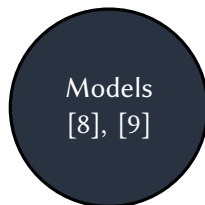
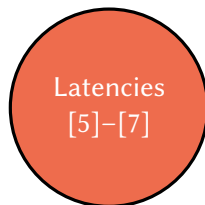
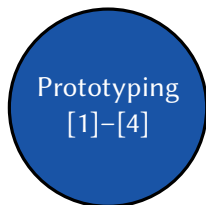
## Previous & Related Work



## Our Contributions

- ▶ A methodology for benchmarking human-in-the-loop applications.

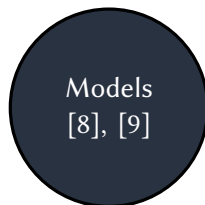
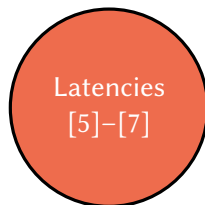
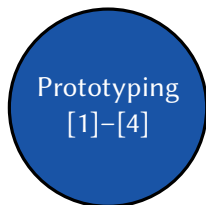
## Previous & Related Work



## Our Contributions

- ▶ A methodology for benchmarking human-in-the-loop applications.
- ▶ EdgeDroid: A benchmarking tool-suite.

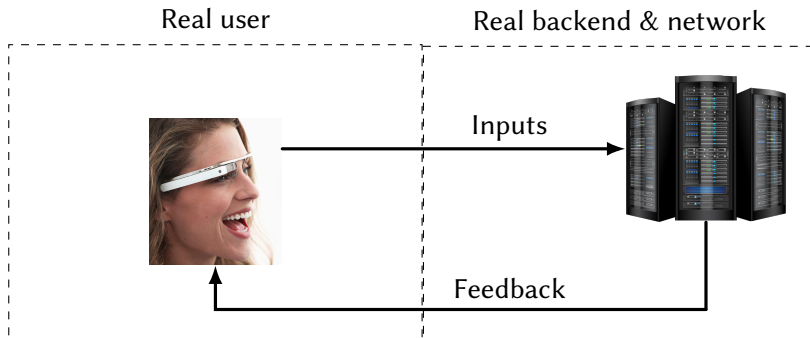
## Previous & Related Work



## Our Contributions

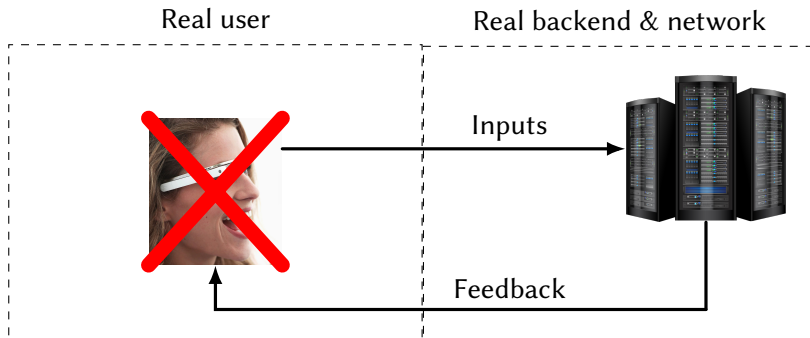
- ▶ A methodology for benchmarking human-in-the-loop applications.
- ▶ EdgeDroid: A benchmarking tool-suite.
- ▶ Experiments and measurements which show the effectiveness of the approach.

# Approach



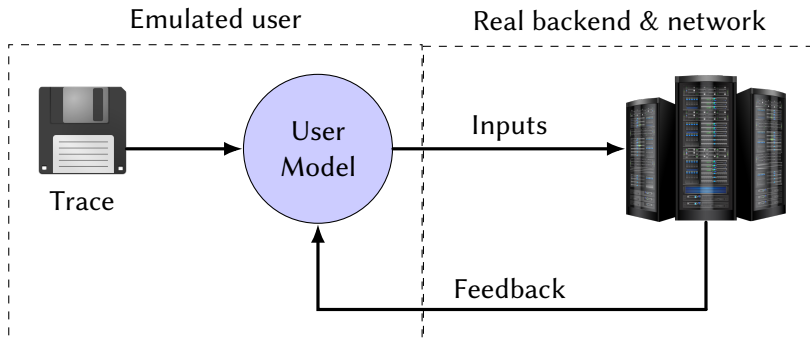
Benchmarking human-in-the-loop applications is HARD

# Approach



What if we could do away with the human users?

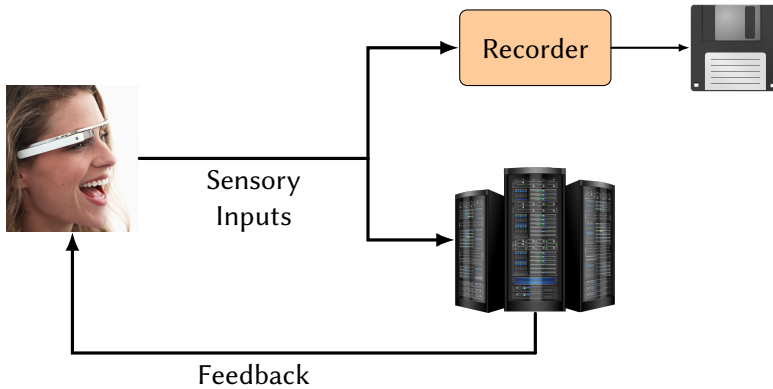
# Approach



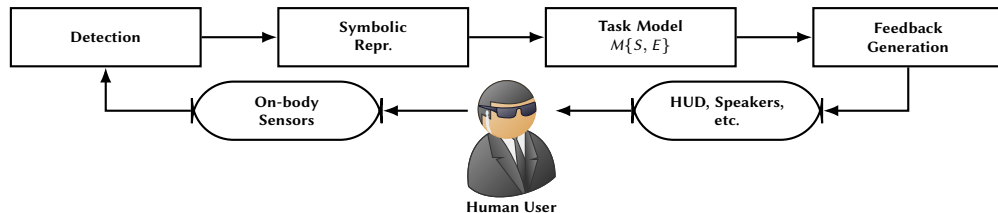
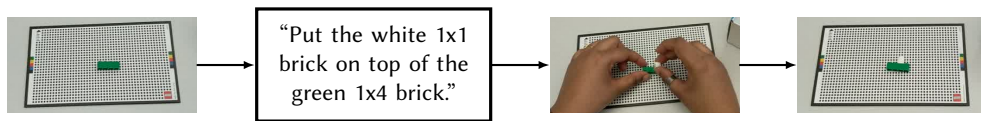
What if we could do away with the human users?

**Repeatable, scalable!**

# Tracing



## Example: Task Guidance WCA [1]

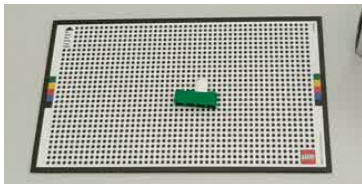




**Key purpose:**  
Demonstrate utility of EdgeDroid.

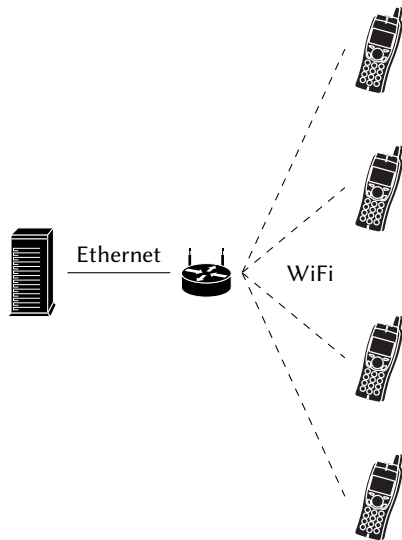
# Evaluation: Setup

## Application & Scenarios



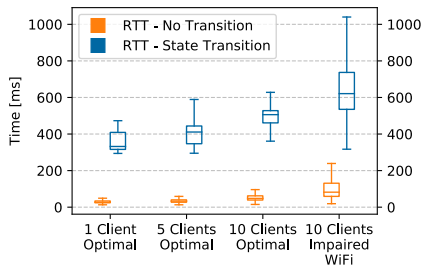
LEGO Assistant

- ▶ Three *optimal* scenarios with 1, 5 and 10 devices.
- ▶ Weakened wireless link with 10 devices.

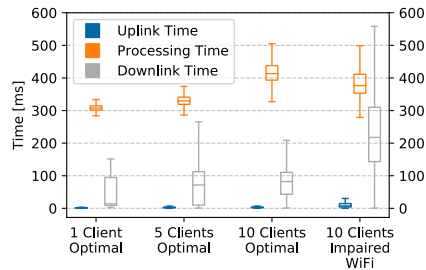


# Use Cases

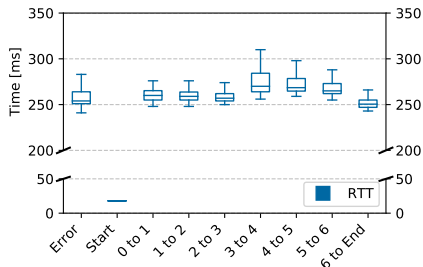
## State change vs. no state change.



## Times by pipeline segments.



## RTT by task step.



## Reference latency bounds for LEGO (Chen *et al.* [5])

Latency [ms]	Quality
< 600	Excellent
600 – 2700	Impaired
> 2700	Unusable

# Conclusions

## Future Work

- ▶ More accurate user model.
- ▶ Expand to other types of Applications.

## Summary

- ▶ There's a need to study the scaling of Human-in-the-Loop applications.
  - ▶ This is difficult due to human users.
- ▶ We present a methodology + tool suite for benchmarking:
  - ▶ **EdgeDroid**
  - ▶ Trace based.
  - ▶ Model of human behavior.
- ▶ We present results which show the utility of EdgeDroid.



# Thank you.

## Contact

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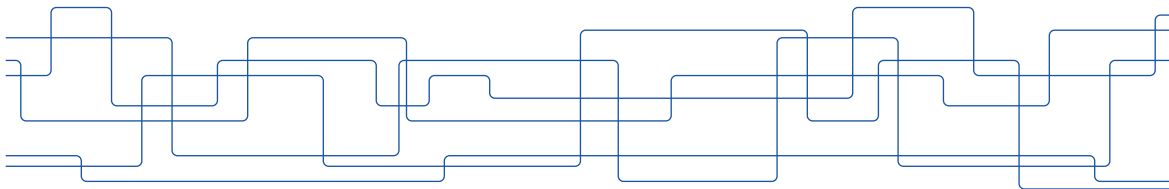
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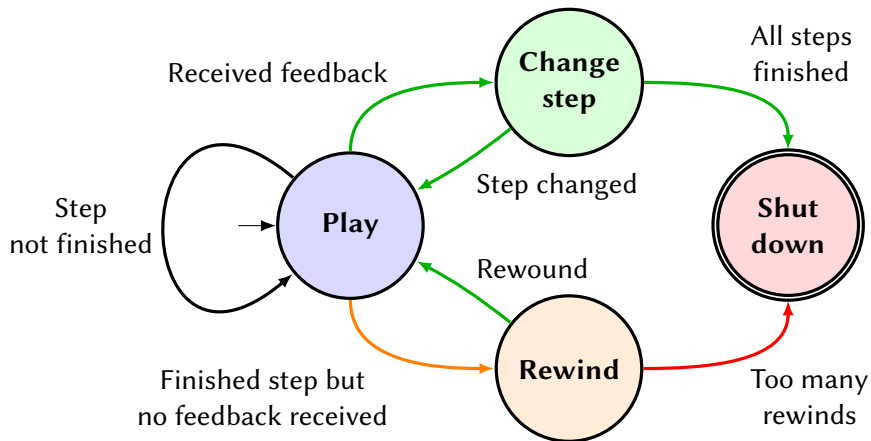


# Requirements

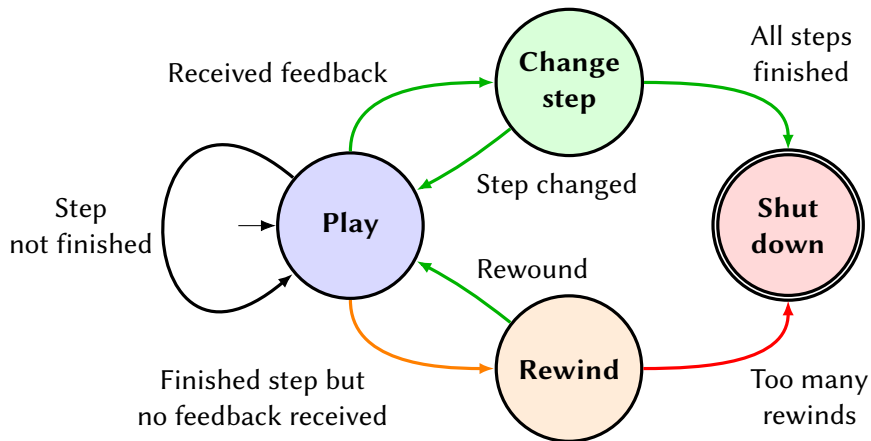
- ▶ Generate realistic, high-dimensional, real-time inputs.
- ▶ Correctly and realistically react to feedback.
- ▶ KPI: Delays.

**Trace of pre-recorded inputs  
& a model of user behavior**

# User Model



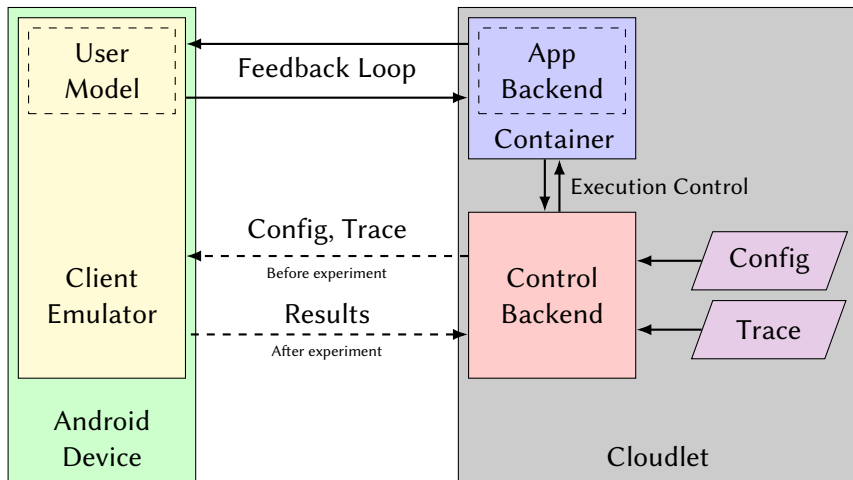
# User Model



Future work: more elaborate models.

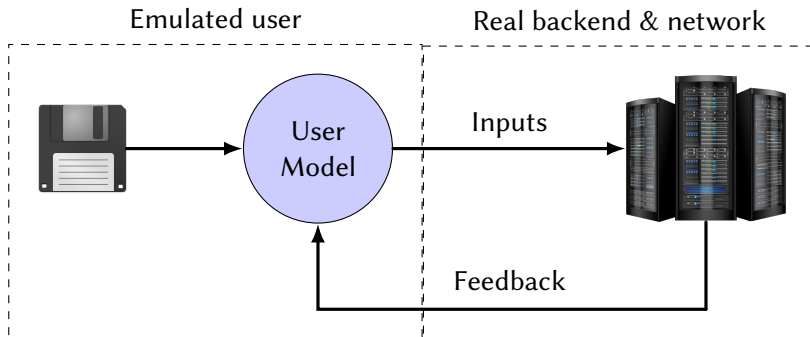


# Implementation

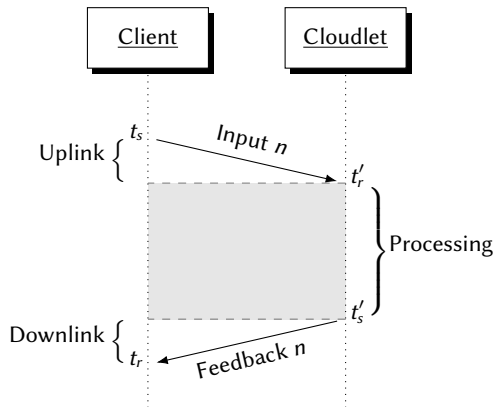


 <https://github.com/molguin92/EdgeDroid>

# Trace Replay



# Timestamping



Clocks are synchronized previous to the experiment.

Timestamps at key points to obtain:

$$\Delta T_{\text{up}} = t'_r - t_s \quad (1)$$

$$\Delta T_{\text{proc}} = t'_s - t'_r \quad (2)$$

$$\Delta T_{\text{down}} = t_r - t'_s \quad (3)$$

$$\Delta T_{\text{total}} = \Delta T_{\text{up}} + \Delta T_{\text{proc}} + \Delta T_{\text{down}} = t_r - t_s \quad (4)$$

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