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

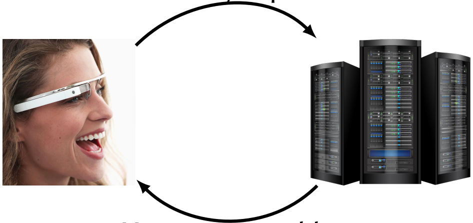
Manuel Olguín Muñoz

ISE Internal Seminar, Thursday March 28 2019


65
126ft
NE
354


SAMSUNG

Sensory Input



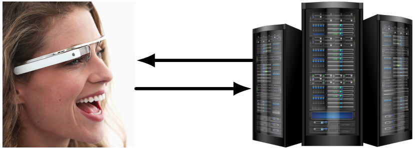
Human-parseable
Feedback

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?

With which methodology can we study these behaviors?



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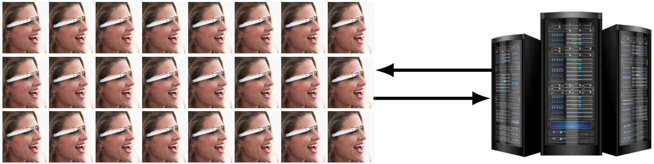

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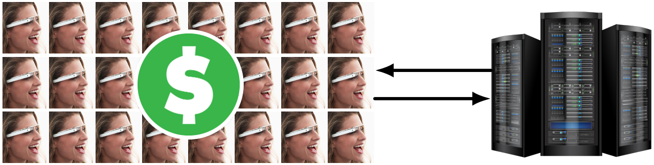

Costly

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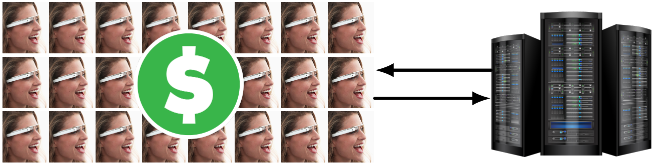

Costly, poor repeatability

Previous & Related Work

Prototyping
[1]–[4]

Latencies
[5]–[7]

Models
[8], [9]

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Our Contributions

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

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

Previous & Related Work

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[1]–[4]

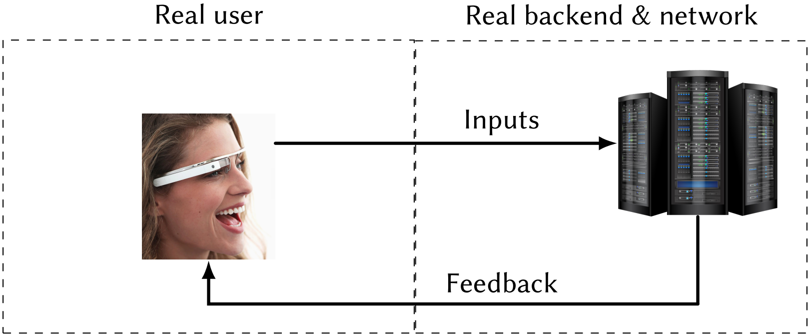
Latencies
[5]–[7]

Models
[8], [9]

Our Contributions

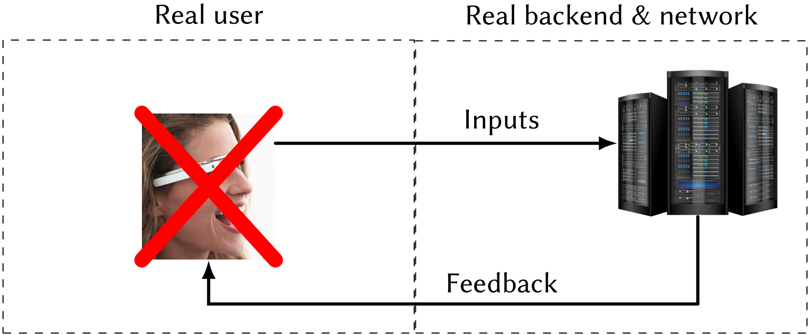
- A methodology for benchmarking human-in-the-loop applications.
- EdgeDroid: A benchmarking tool-suite.
- Experiments and measurements which show the effectiveness of the approach.

Approach



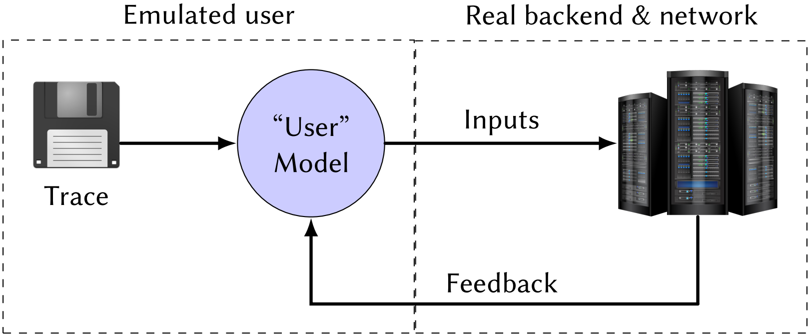
Benchmarking human-in-the-loop applications is HARD

Approach



What if we could do away with the human users?

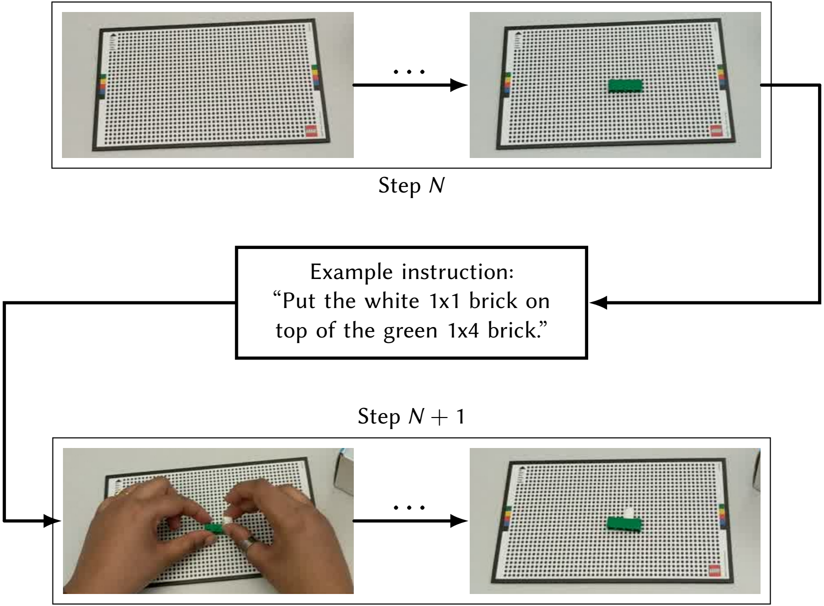
Approach



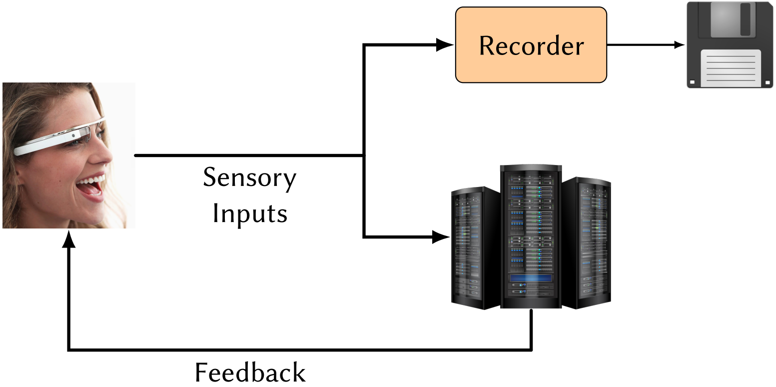
What if we could do away with the human users?

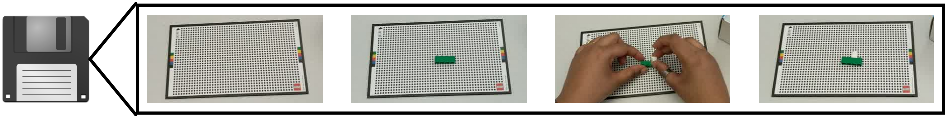
Repeatable, scalable!

Example: Task Guidance Wearable Cognitive Assitance, LEGO [1]



Tracing





Trace Replay

Non-trivial Challenge

- Changes in system responsiveness require adapting trace.
- System delays affect user behavior as well.

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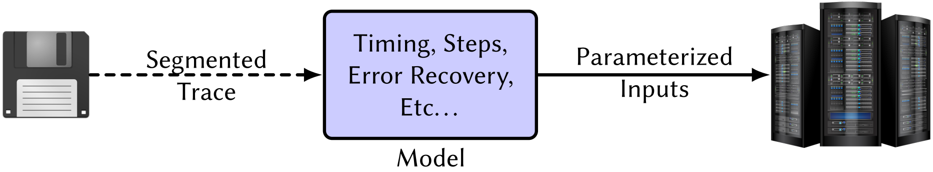
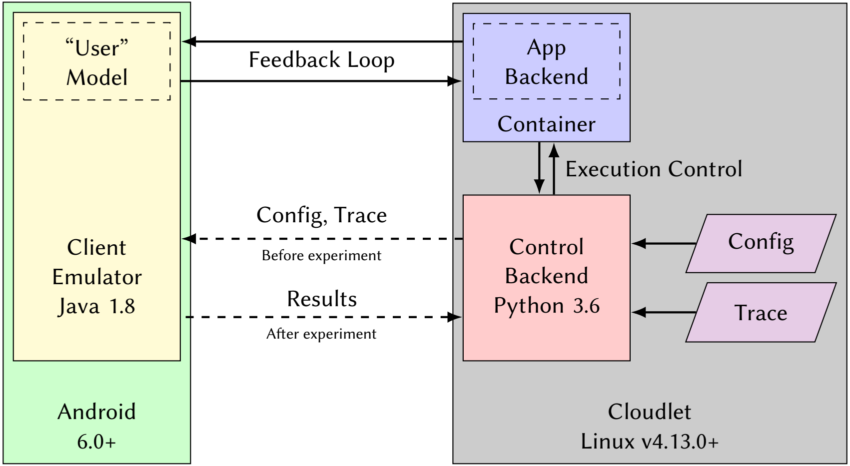
Our Approach

- Segment trace into logical “steps”.
- Controlled replay of steps.



Implementation: EdgeDroid



https://github.com/molguin92/EdgeDroid

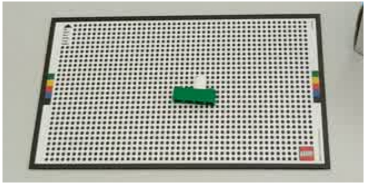
Evaluation

Key purpose:

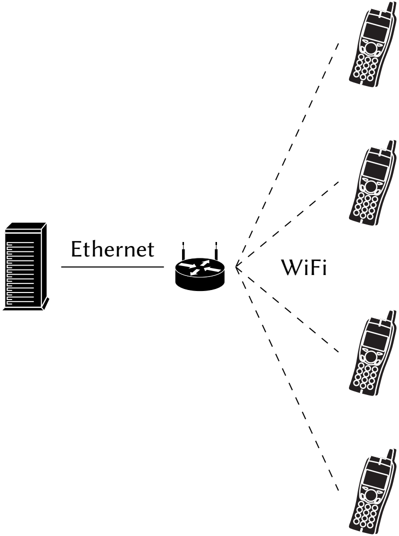
Demonstrate utility of EdgeDroid.

Evaluation: Setup

Application & Scenarios



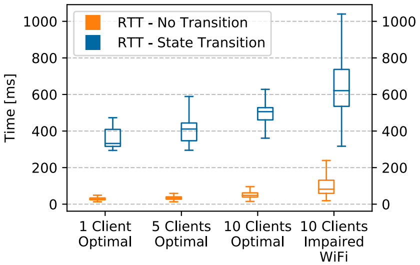
LEGO Assistant



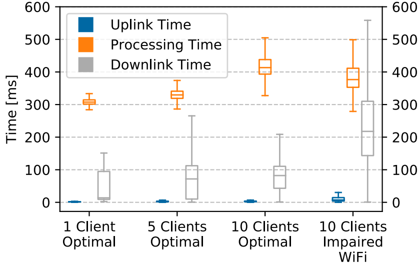
- Three *optimal* scenarios with 1, 5 and 10 devices.
- Weakened wireless link with 10 devices.
- KPI: Round-Trip Time (RTT).

Use Cases

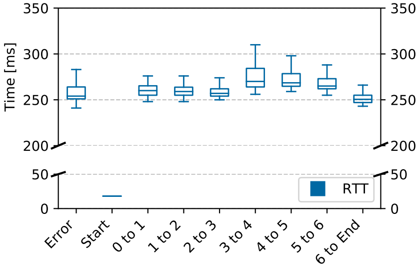
State change vs. no state change.



Times by pipeline segments.



RTT by task step.



Conclusions

Future Work

- User Model.
- Other types of Applications.

Summary

- Need to study the scaling of Human-in-the-Loop applications.
  - Difficult due to human users.
- Methodology + tool suite for benchmarking:
  - **EdgeDroid**
  - Trace based.
  - Model of human behavior.
- Results which show the utility of EdgeDroid.

Thank you.

Contact

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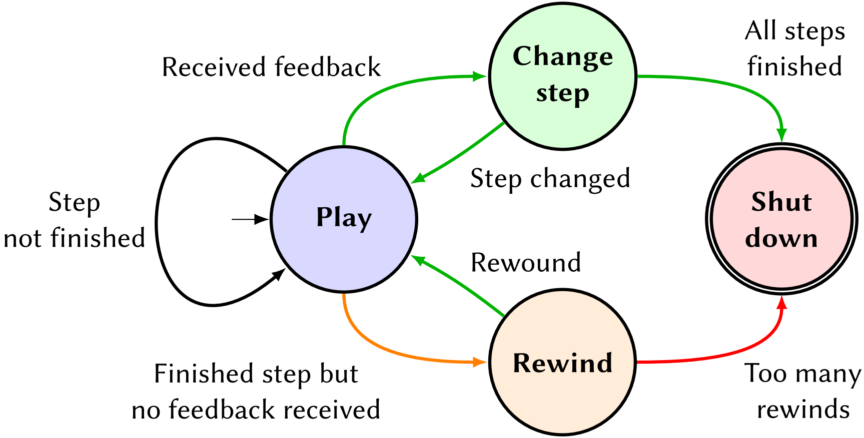
Requirements

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

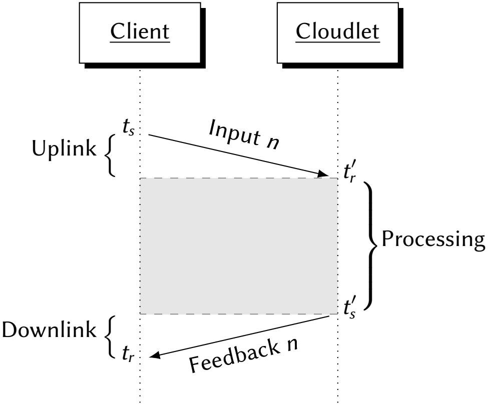
Trace of pre-recorded inputs & a model of user behavior

User Model



Future work: more elaborate models.

Timestamping



Clocks are synchronized previous to the experiment.

Timestamps at key points to obtain:

$$\Delta T_{\text{up}} = t'_r - t_s \tag{1}$$

$$\Delta T_{\text{proc}} = t'_s - t'_r \tag{2}$$

$$\Delta T_{\text{down}} = t_r - t'_s \tag{3}$$

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

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