Genetic Improvement of Software Efficiency: The Curse of Fitness Estimation

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How to measure

Execution time.

1. Test suite time.
   - Test overhead!
2. User time.
3. System time.

Well, this is not complicated!
How to measure

Memory consumption.

1. Overall used/available.
2. Other metrics:
   - Native heap, Dalvik heap, stack …
   - Pss, dirty, clean swappPss …

“Pretty much every time I look at memory usage numbers with other engineers, there is always a long discussion about what they actually mean that only results in a vague conclusion.” ~ Android platform developer [1].

Well, this is complicated!
How to measure Energy.

1. Internal.
2. External.

Well, this *seems not too hard.*
Do we measure and optimise for only one platform?

Yes: go to end of presentation :)
No, stay alert!
Fragmented Ecosystems

Mind the gap – a distributed framework for enabling energy optimisation on modern smart-phones in the presence of noise, drift, and statistical insignificance

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Below: four different phone-OS combinations, orange/blue are two different test loads (but identical across all samples) [2]: 
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Wait, don’t go, it is even worse !!!
Individual runs of Rebound library (original configuration) in two experiments. The device was rebooted and recharged between the two experiments.
How to solve it

1. Run thousands … millions of trials.
How to solve it

1. Run thousands … millions of trials.
2. Use simple models or simulators.
   - Generally, describe the system in one variable (cpu utilisation, bytecode, line of code ...).
   - Noise free.
   - Deterministic.
How to solve it

1. Run thousands … millions of trials.
2. Use simple models or simulator.
   ● Traditional ways of data collection.
   ● Doesn’t capture all system behaviours.
   ● Lucky and unlucky generated solutions.
   ● Might misguide the search process.
   ● One model per device model out of more than 24000 device models.
   ● HW non-linear energy usage [3, 4].

Models are only good on what they were trained for.
How to solve it

In-vivo and offline optimisation of energy use in the presence of small energy signals – A case study on a popular Android library

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They are only good on what they were trained for.
How to solve it

In-vivo and offline optimisation of energy use in the presence of small energy signals – A case study on a popular Android library

They are only good on what they were trained for.
Proposed Solution

- Data collection.
  - Considers different system states.
  - R3-validation approach [6].
Proposed Solution

- Data collection.
- ML for GI.
  - Repeated patterns (background processes).
  - Voltage variations.
  - Garbage Collection (GC) impacts.
Proposed Solution

- Data collection.
- ML for GI.
  - Repeated patterns (background processes).
  - Voltage variations.
  - Garbage Collection (GC) impacts.
  - ....
- ML models + *in-vivo* optimisation (expensive fitness function/surrogate-assisted optimisation [7]).
  - Adaptive models that get re-calibrated as the optimisation proceeds.
  - Select representatives of solutions for the *in-vivo* optimisation.
    - E.g. unseen solutions can trigger new interesting system states (unseen behaviours).
  - *In-vivo* keeps the real behaviour of the system engaged in the search process.
References

[1] Stackoverflow, accessed on July 2020, How do I discover memory usage of my application in Android?


