An Empirical Study on the Impact of Deep Parameters on Mobile App Energy Usage

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Motivition

- Parameter tuning in conventional software is shown to improve the performance
- Mobile apps have hundreds of deep parameters that are scattered around the source code
- Little is known about the energy impacts of deep parameters in mobile apps
- Prior works only studied deep parameters in specific modules or libraries, not systematically

Deep Parameter

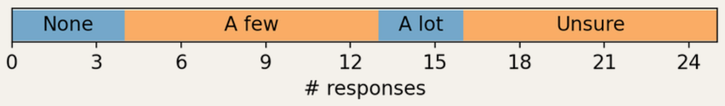
A constant in app source code that can be changed by app developers, while the app still functions properly with minimal impact on user experience.

✓ buffer size, timeout, UI element size, ...
```
sock.setSocketTimeout(0);
```
✗ error code, loop initializer, ...
```
for (int i = 0; ...)
```

Developer Perspectives

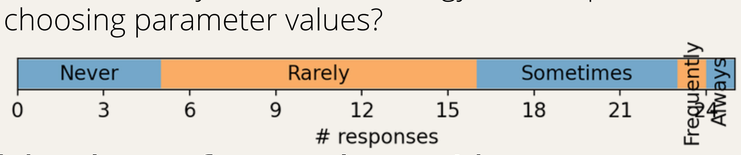
25 Android developers, on average 6–10 years of software development experience, 3–5 years of Android development experience, 19 questions

For what proportion of the parameters in your app are you confident about the energy impact of changing them?



Few developers (12%) are confident about the energy impact of parameters. Possibly due to the lack of handy tools for energy tuning.

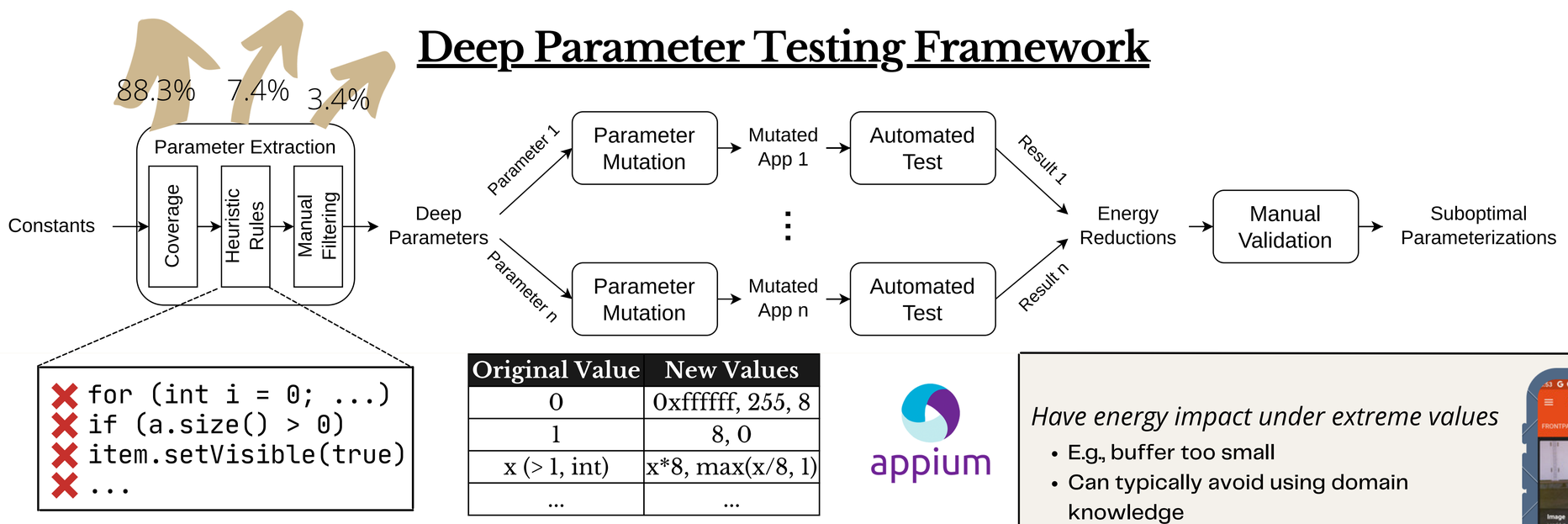
How often do you consider energy consumption while choosing parameter values?



Only 8% of developers frequently consider energy consumption when choosing parameter values.

As developers have limited confidence in parameters' energy impacts, further experiments are needed to validate developers' choices.

Deep Parameter Testing Framework

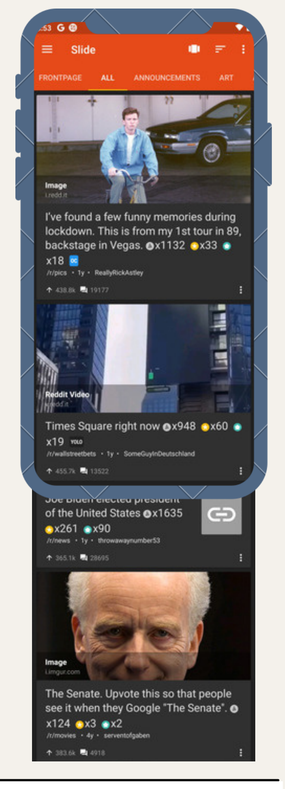


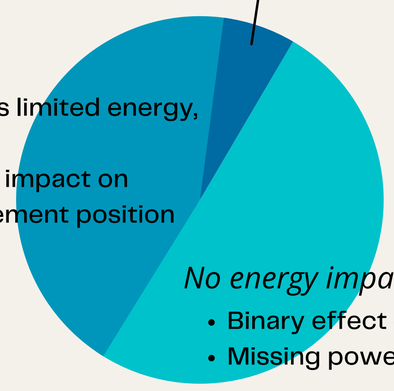
Original Value	New Values
0	0xffffff, 255, 8
1	8, 0
x (> 1, int)	x*8, max(x/8, 1)
...	...

appium

Have energy impact under extreme values

- E.g., buffer too small
- Can typically avoid using domain knowledge





Limited energy impact

- Component consumes limited energy, e.g., logging
- Parameter has limited impact on component, e.g., UI element position

No energy impact

- Binary effect -- success or fail
- Missing power model

Why do deep parameters commonly not affect energy usage?
A manual examination of 143 deep parameters in ConnectBot

Experimental Results

16 popular open-source apps from 16 categories, one 30–60s test scenario for each app

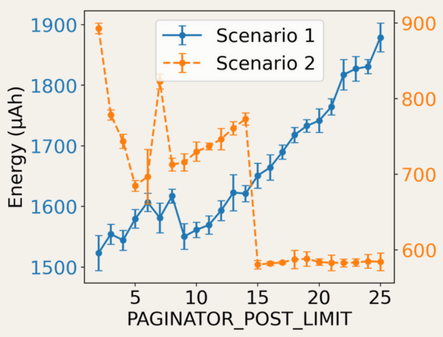
1644 deep parameters tested, 28 observed energy reduction, 2 manually validated to reduce energy drain without breaking app functionality

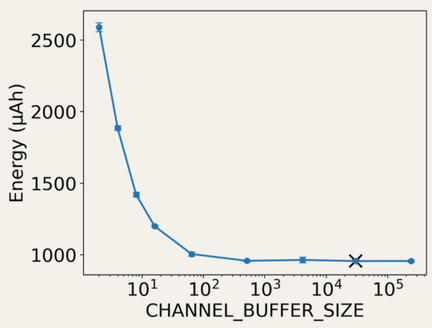
True positives

- Prefetching size in Reddit client, optimal value depends on the scenario
- Ping interval in P2P browser to multiple peers; reducing from every 1s to every 8s saves 12% energy

False Positives

- Broken app functionality (13/26)
- Test stochasticity (12/26)





Conclusion

- **Survey:** developers are uncertain about, and largely ignore the energy impact of deep parameters
- **Experiment:** single-parameter-induced energy inefficiency is uncommon
- **Takeaway:** developers can safely ignore the energy impact when choosing deep parameter values for now
- **Future work:** interactions between deep parameters

Paper: https://arxiv.org/abs/2009.12156
Survey, framework, results: https://doi.org/10.5281/zenodo.5823364