Lukewarm Serverless Functions: Characterization and Optimization

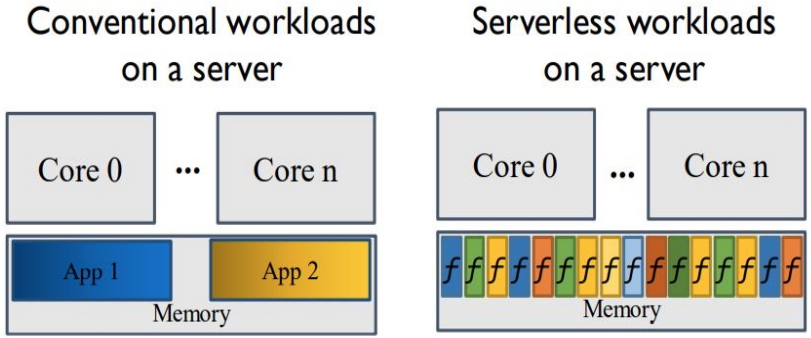
CS422 Project PPT: Group 1

(Nibir Baruah , Manish, Sarthak Rout)

Serverless Function Characteristics

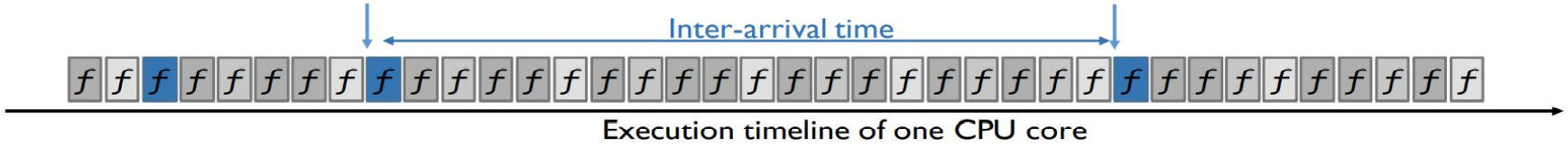
Unique characteristics:

- Short function execution times: a few ms or less
- Contrast: Linux scheduling quantum: 10-20ms
- Small memory footprint: tens of MB
- Sporadically invoked (seconds or minutes)

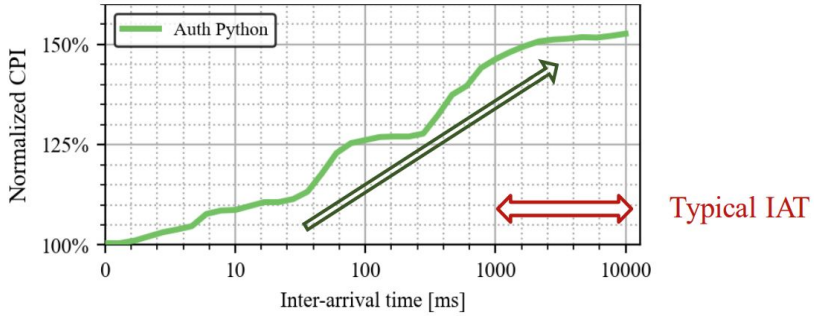


Implications:

- Extreme multi-tenancy: Thousands of functions resident on a server
- Huge degree of interleaving between two invocations of the same function



Effect of Interleaving



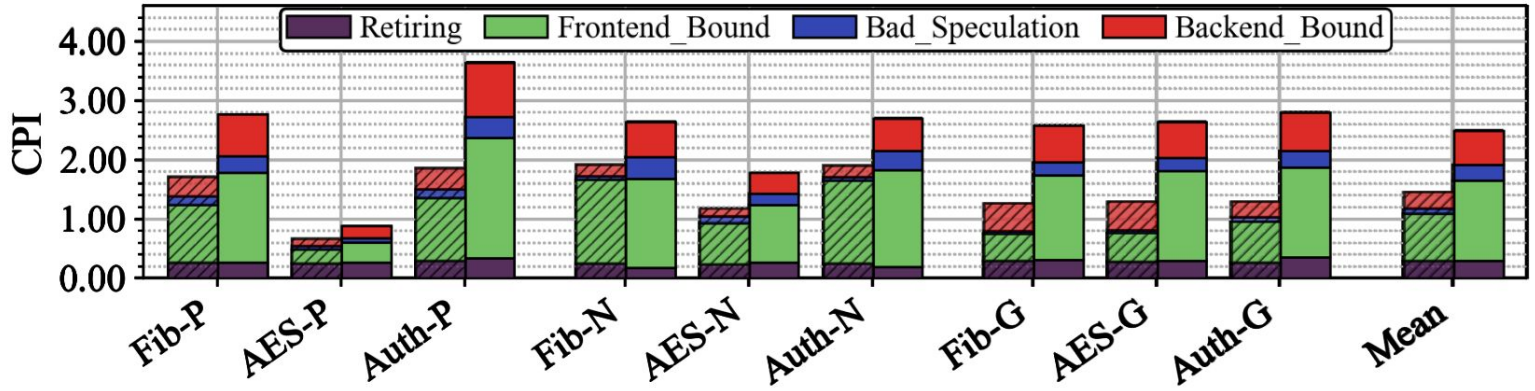
Longer inter-arrival times

- Higher degree of interleaving
- Higher CPI

Drastic increase in CPI for typical inter-arrival times (IATs)

- Up to 170% CPI increase for IAT > 1s

Why Instruction Misses?

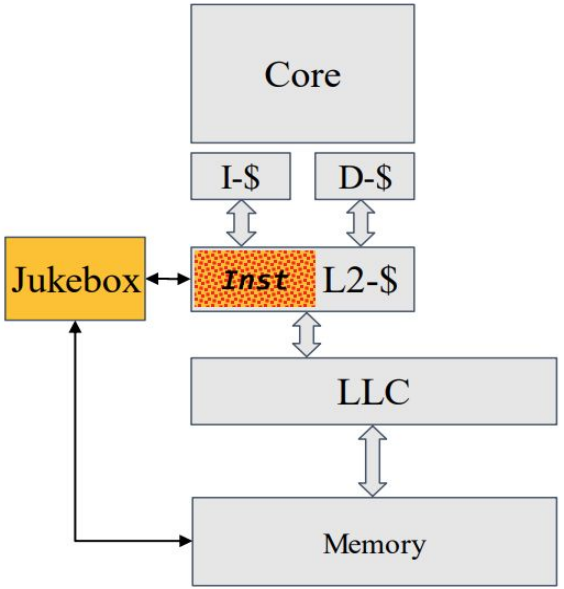


- Front-end stalls is the largest source of stalls
- **56%** of additional stall cycles in interleaved execution come from fetch latency

Jukebox Architecture

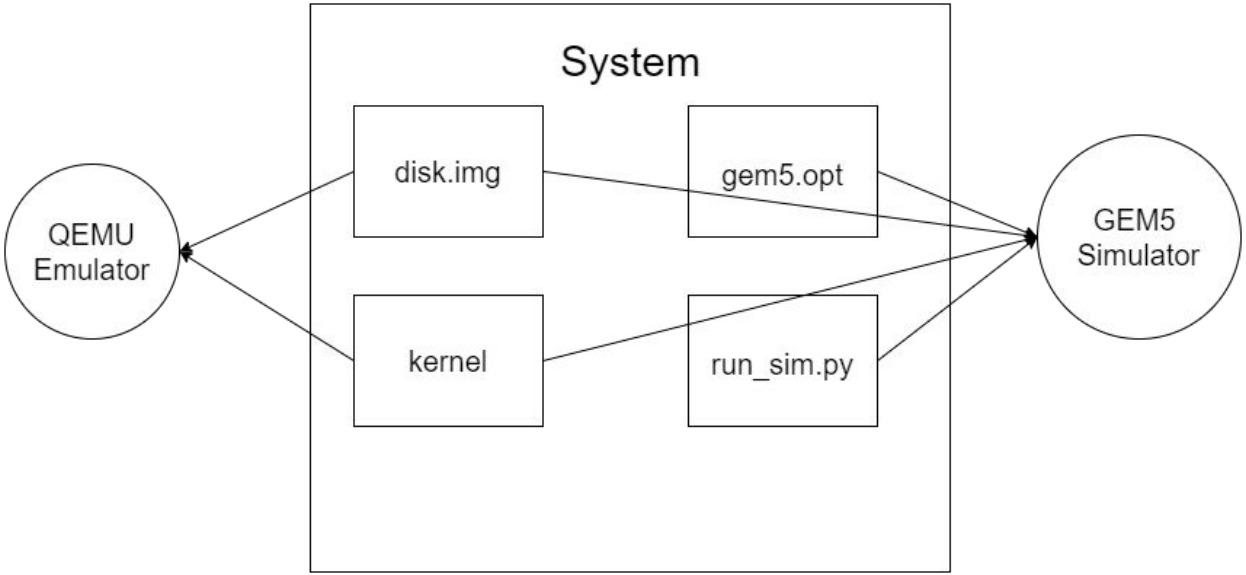
Jukebox: record-and-replay instruction prefetcher for lukewarm serverless function invocations

- Record: L2 misses using a spatio-temporal encoding
- Stores records in main memory
- Replay: prefetch the recorded addresses into the L2
- Fully decoupled from the core
- Triggered by function invocation
- Operates on virtual addresses
- Not affected by page re-allocation
- Prefetching prepopulates TLB

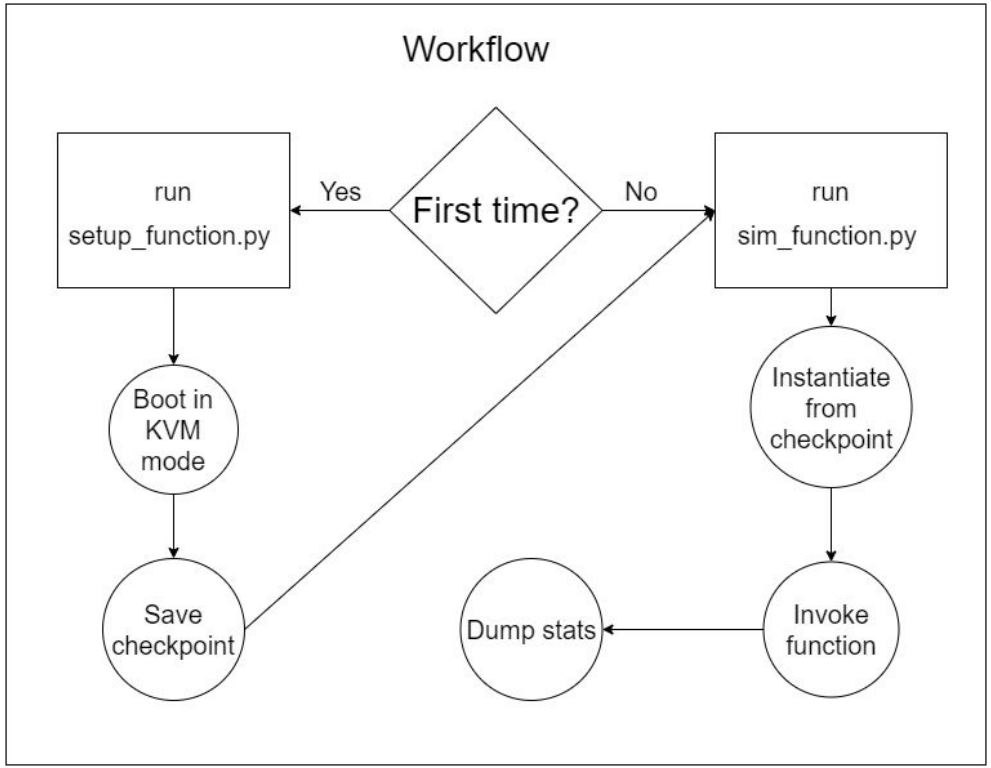


Implementation

Setup : System



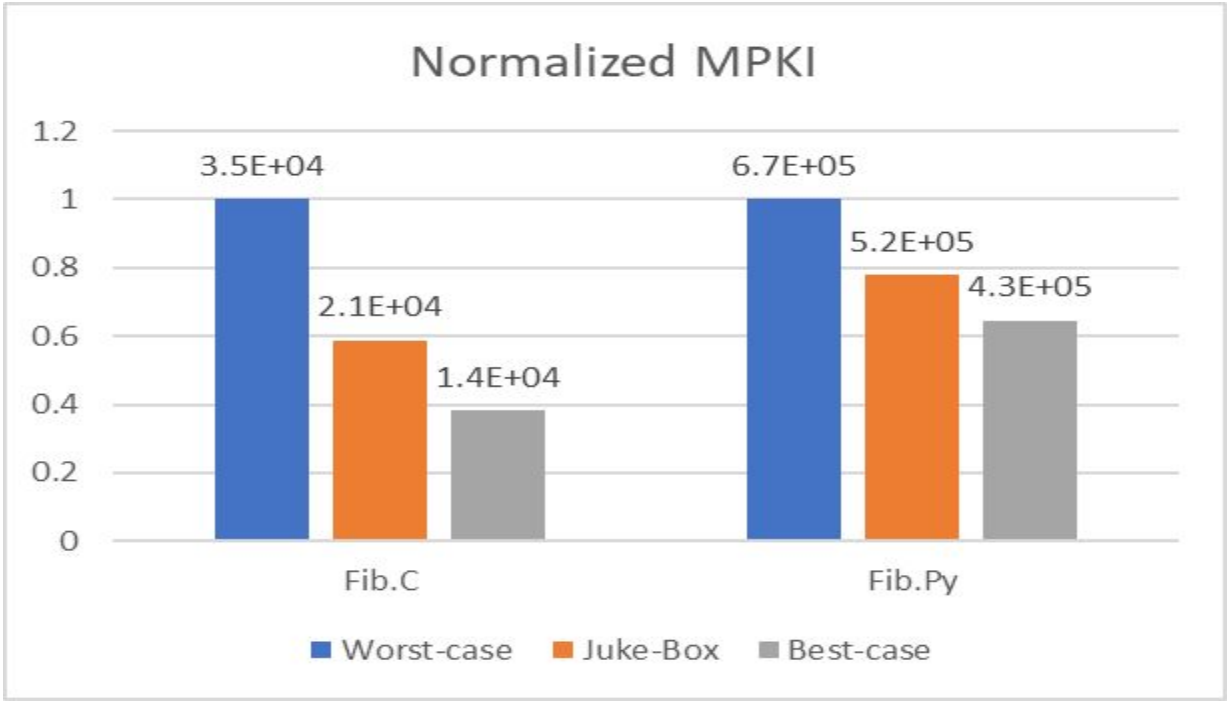
Setup : Workflow



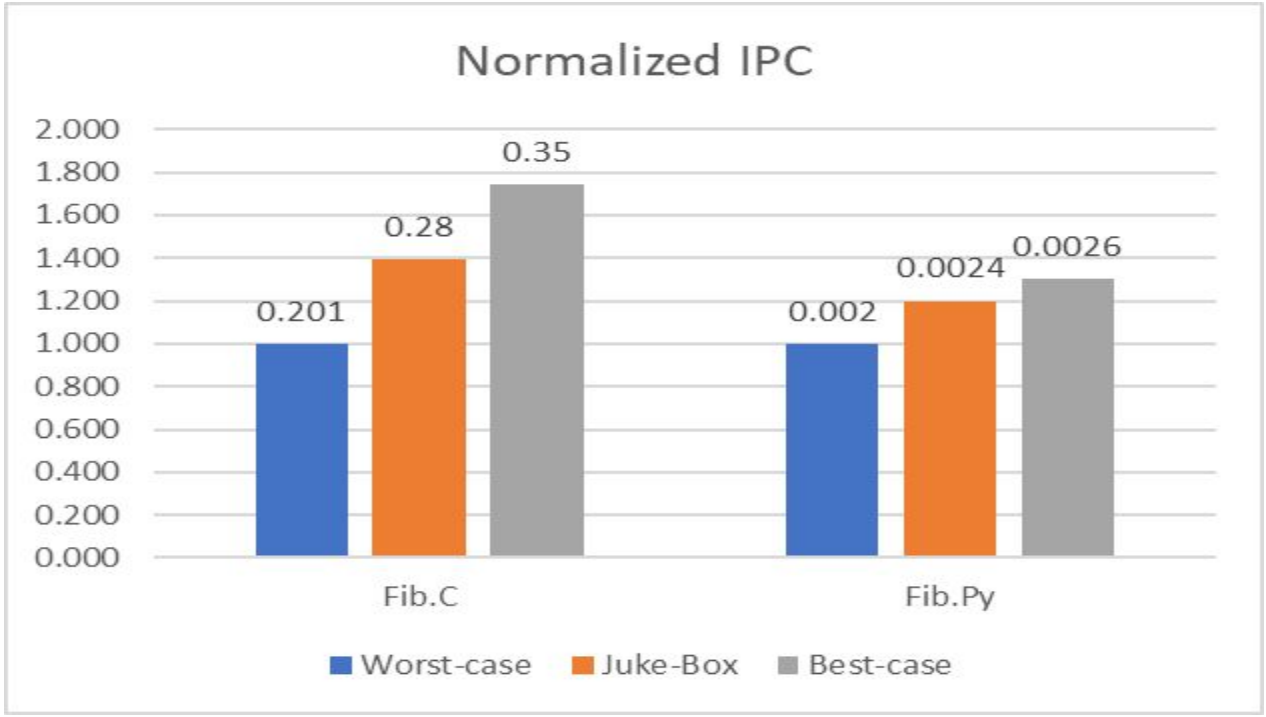
Implementation Details

- Added record logic in Cache
- Added replay logic in Prefetcher
- Added MSRs
- Saved and restored registers during context switch
- Modified run_sim.py

Results


Normalized MPKI
1.2
1
0.8
0.6
0.4
0.2
0
3.5E+04
2.1E+04
1.4E+04
6.7E+05
5.2E+05
4.3E+05
Fib.C
Fib.Py
Worst-case
Juke-Box
Best-case

Results



*Results are updated in reports as recommended in presentation

Contribution

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Acknowledgement

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Thank You!

References

- Lukewarm Serverless Functions: Characterization and Optimization (acm.org)
- PowerPoint Presentation (iscaconf.org)
- here (mail-archive.com) (Gem5 Mailing List)
- Linux Kernel Module Cheat (cirosantilli.com)
- GitHub - fearful-symmetry/gomsr: Read / write Intel MSRs in go