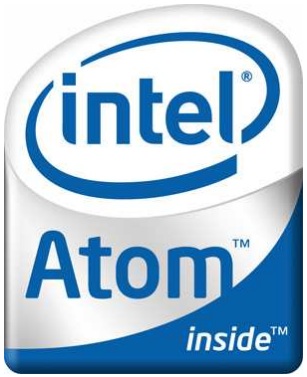
A Genetic Algorithm to Improve Linux Kernel Performance on Resource-Constrained Devices

James T. Kukunas, Robert D. Cupper, and
Gregory M. Kapfhammer

Department of Computer Science
Allegheny College, Pennsylvania, USA

Late Breaking Abstracts
The Genetic and Evolutionary Computation Conference
(GECCO), July 2010

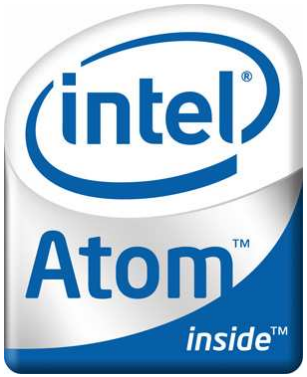
What is a Resource-Constrained Device?



A Resource-Constrained Device Is . . .

- Any Device In Which Resources Are *Intentionally* Constrained

What is a Resource-Constrained Device?



A Resource-Constrained Device Is . . .

- Any Device In Which Resources Are *Intentionally* Constrained

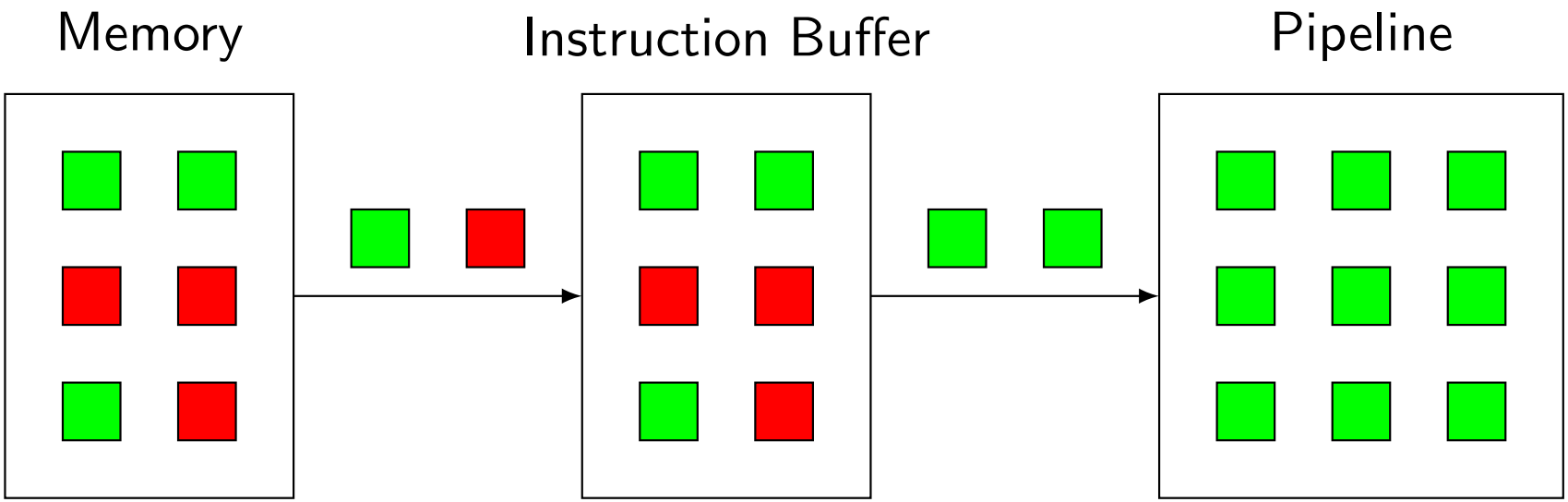
Why Do We Intentionally Constrain Resources?

VS

The Goal of This Research is to ...

- Achieve BMW Performance With A Honda Motor While Keeping Honda Benefits

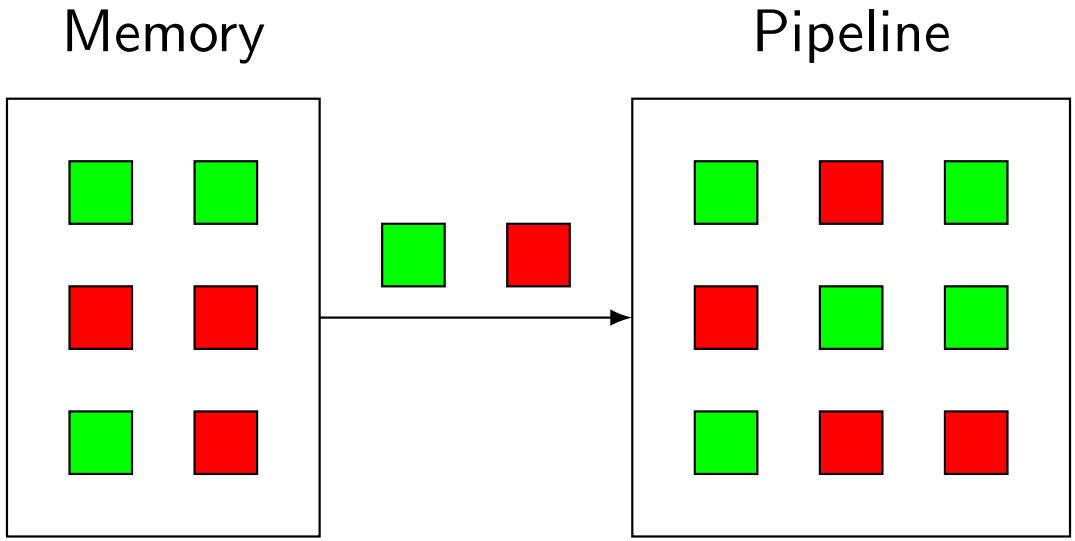
Intel Atom Specifics: In-Order Execution



Out-of-Order Instruction Execution

- Hardware Dynamically Reorders Instructions to Reduce Dependency Stalls in the Pipeline

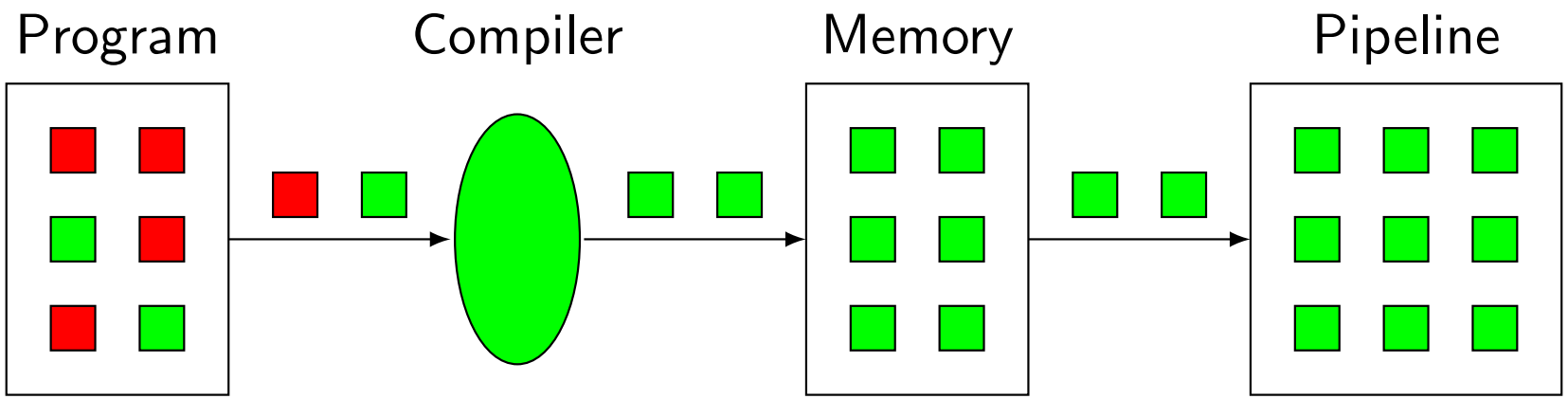
Intel Atom Specifics: In-Order Execution



In-Order Instruction Execution

- Pipeline Sensitive to Depedency Stalls

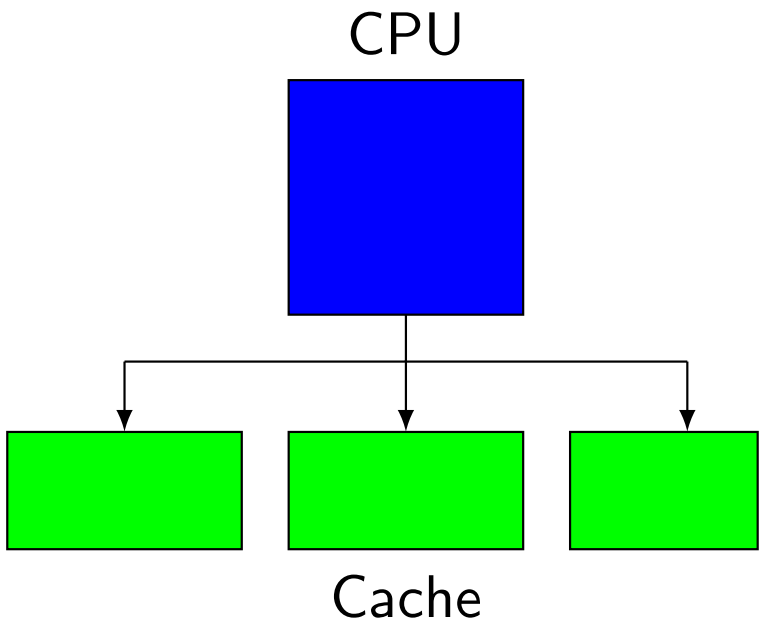
Intel Atom Specifics: In-Order Execution



Pipeline Modeling . . .

- At Compile-Time Reduces Dependency Stalls

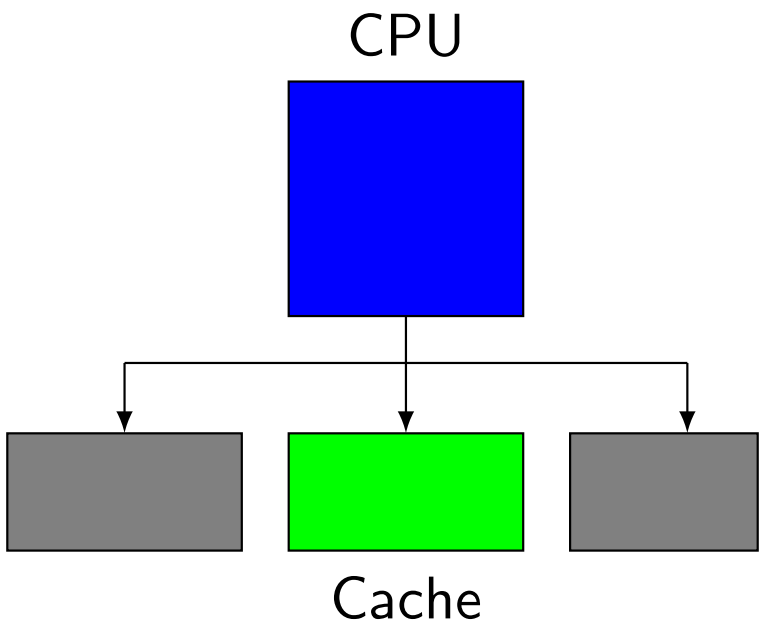
Intel Atom Specifics: Power-Aware Cache



At Higher Processor Power States ...

- All Caches Blocks are Enabled

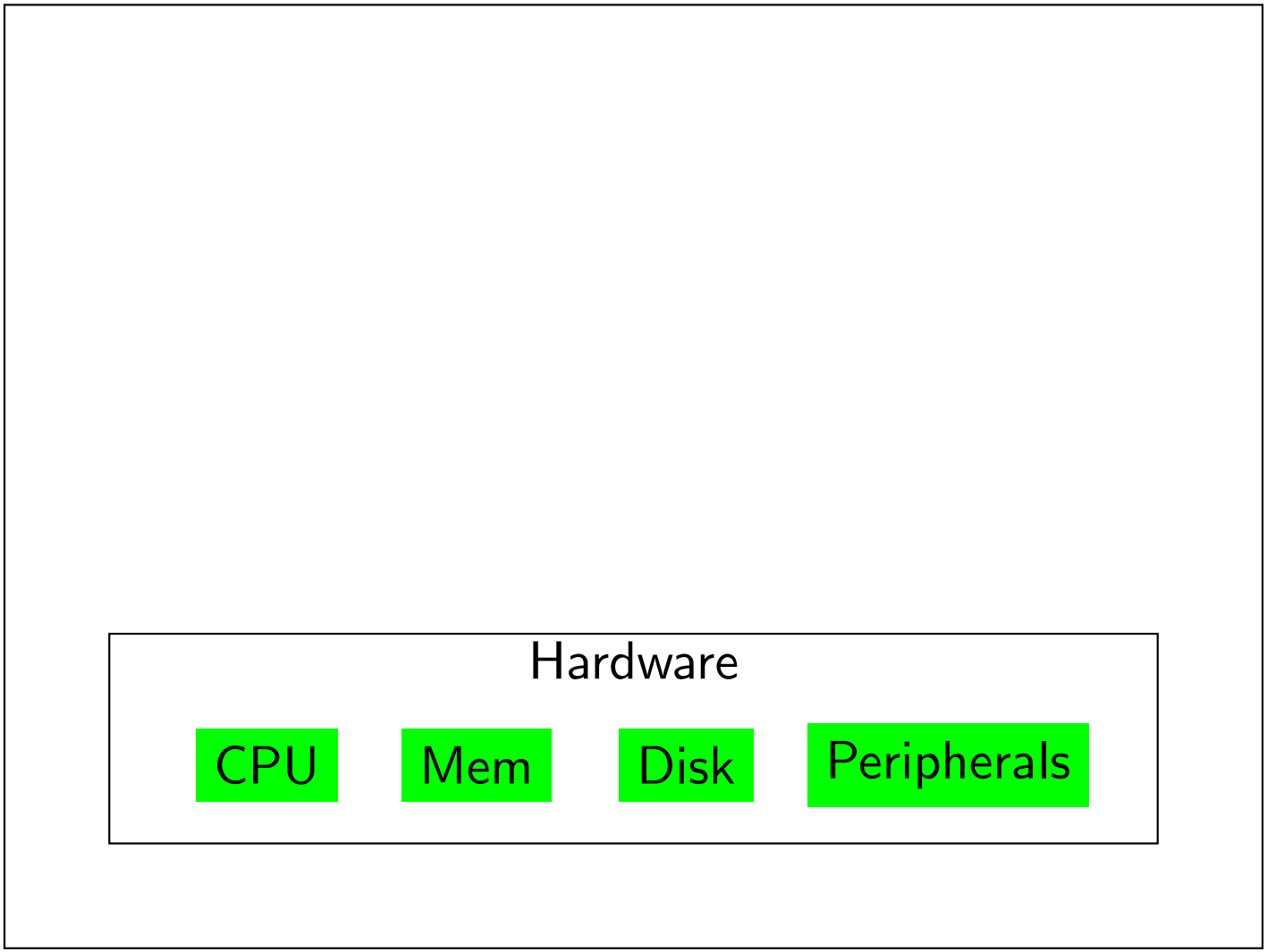
Intel Atom Specifics: Power-Aware Cache



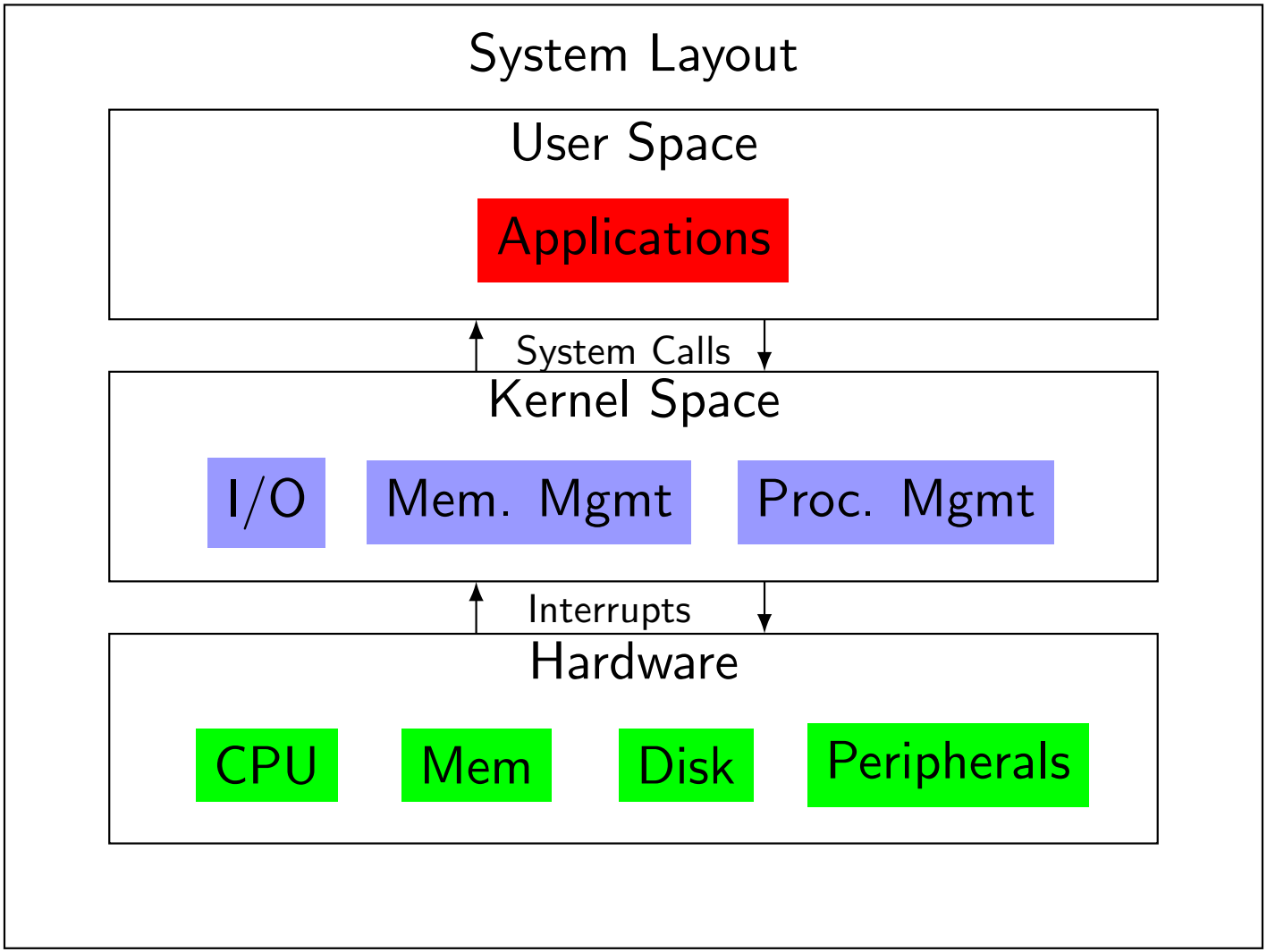
At Lower Processor Power States . . .

- Cache Blocks are Disabled to Conserve Power

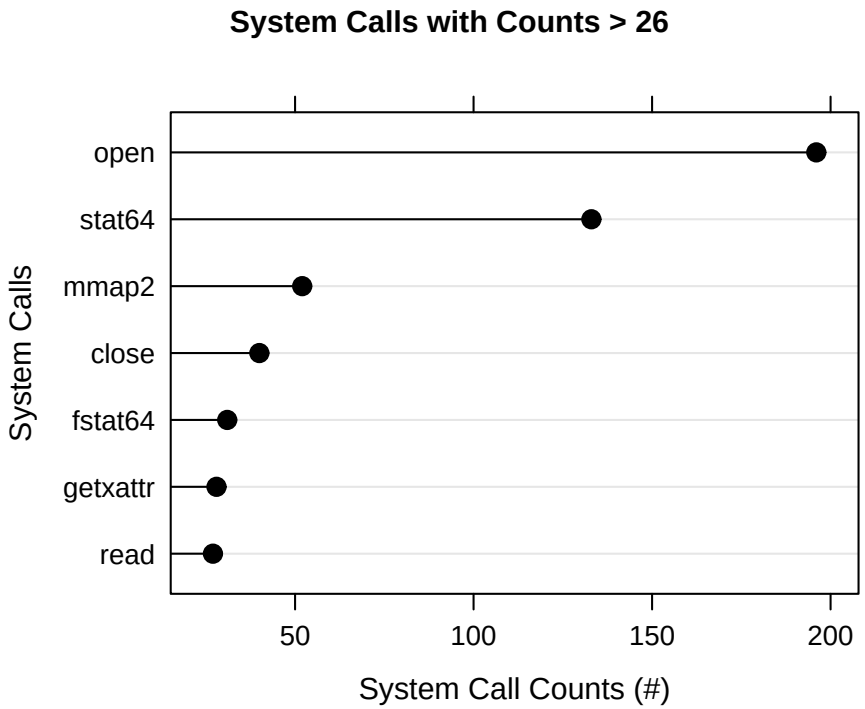
What is the Linux Kernel?



What is the Linux Kernel?



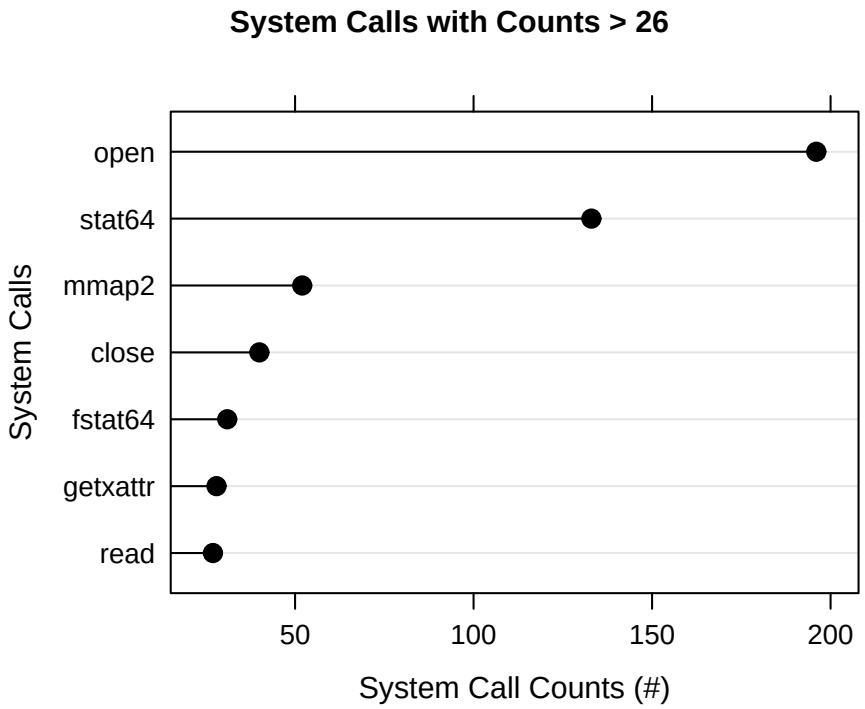
Precise Fitness Metric



Fitness Metric

- System Calls Model User/Kernel Space Interaction

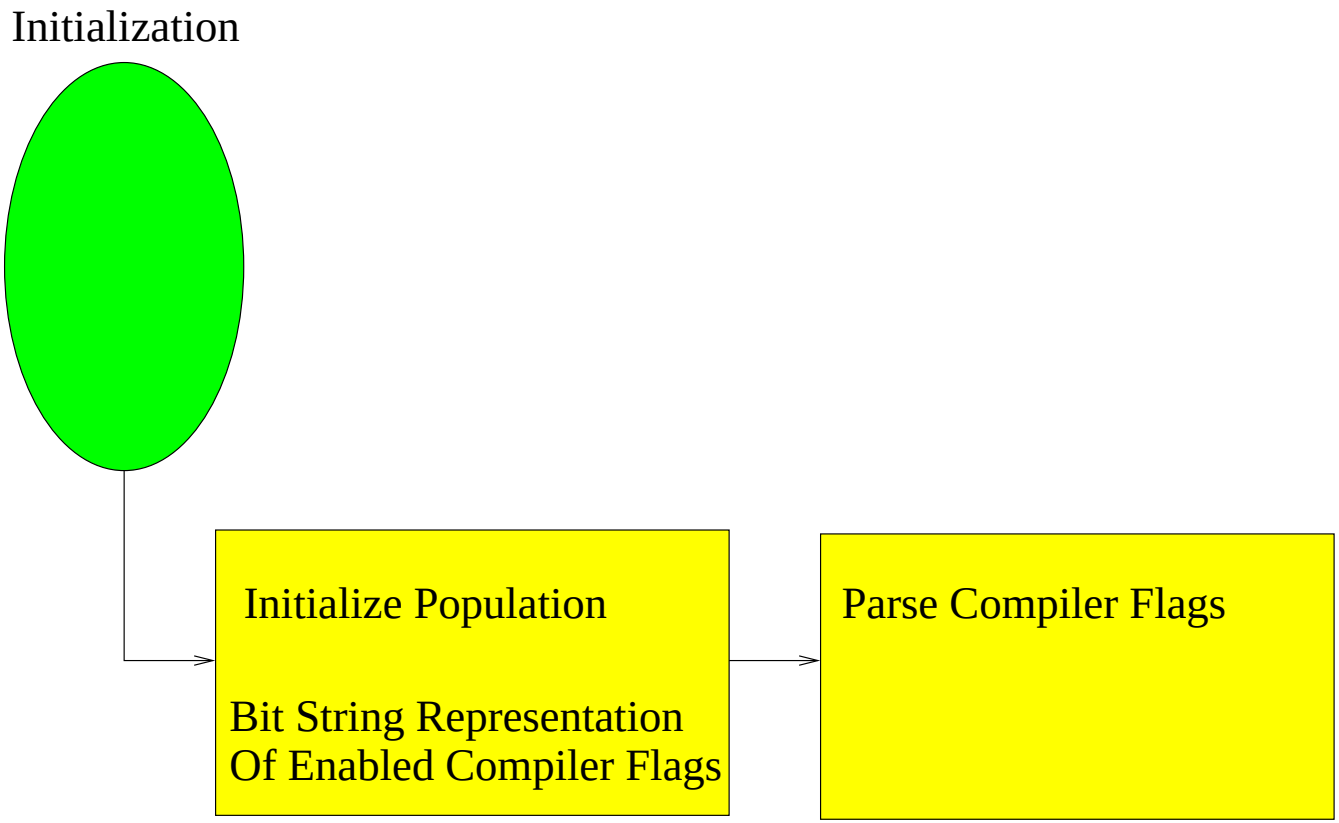
Precise Fitness Metric



Fitness Metric

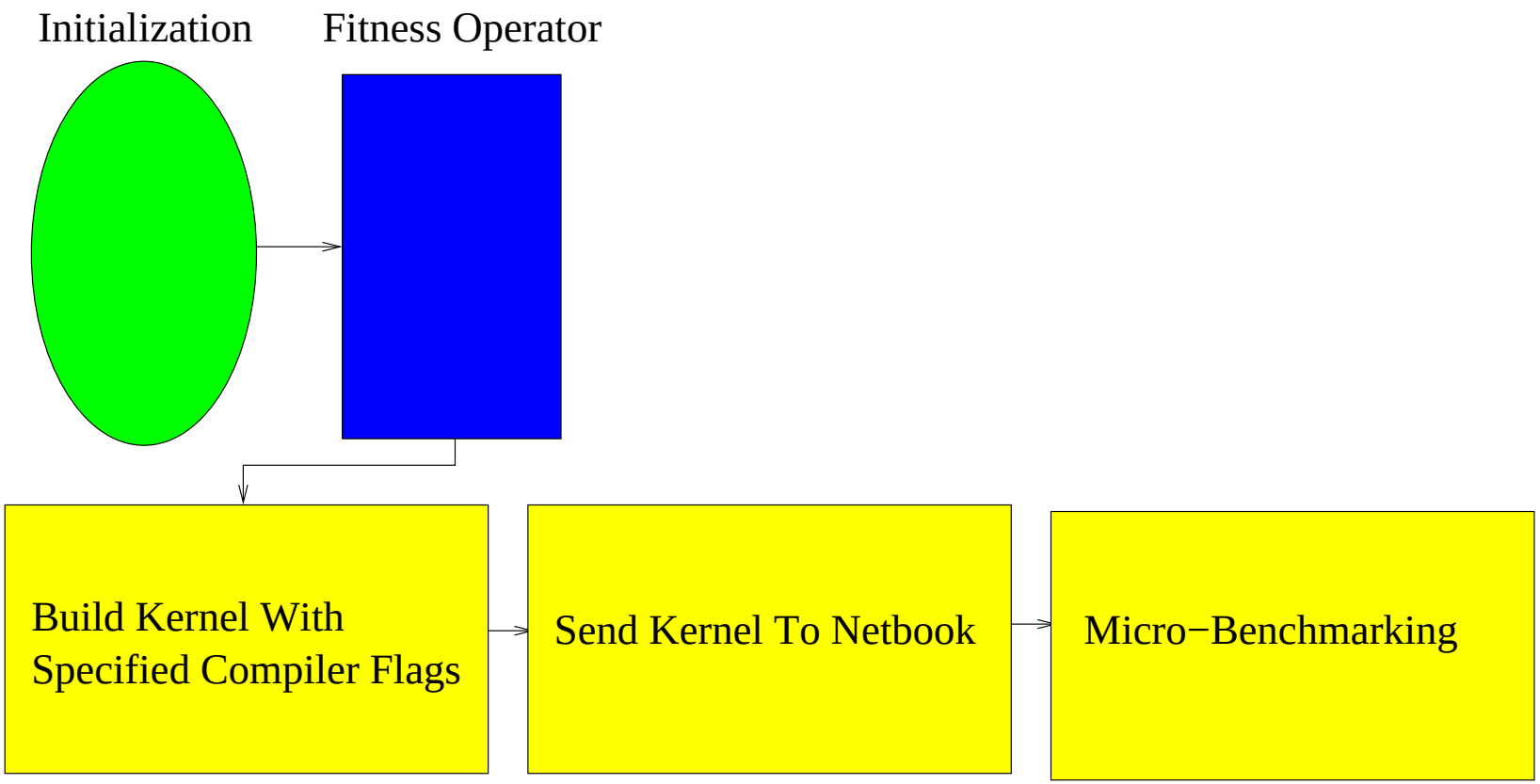
- Only 10% of System Calls had Non-Zero Counts

Genetic Algorithm



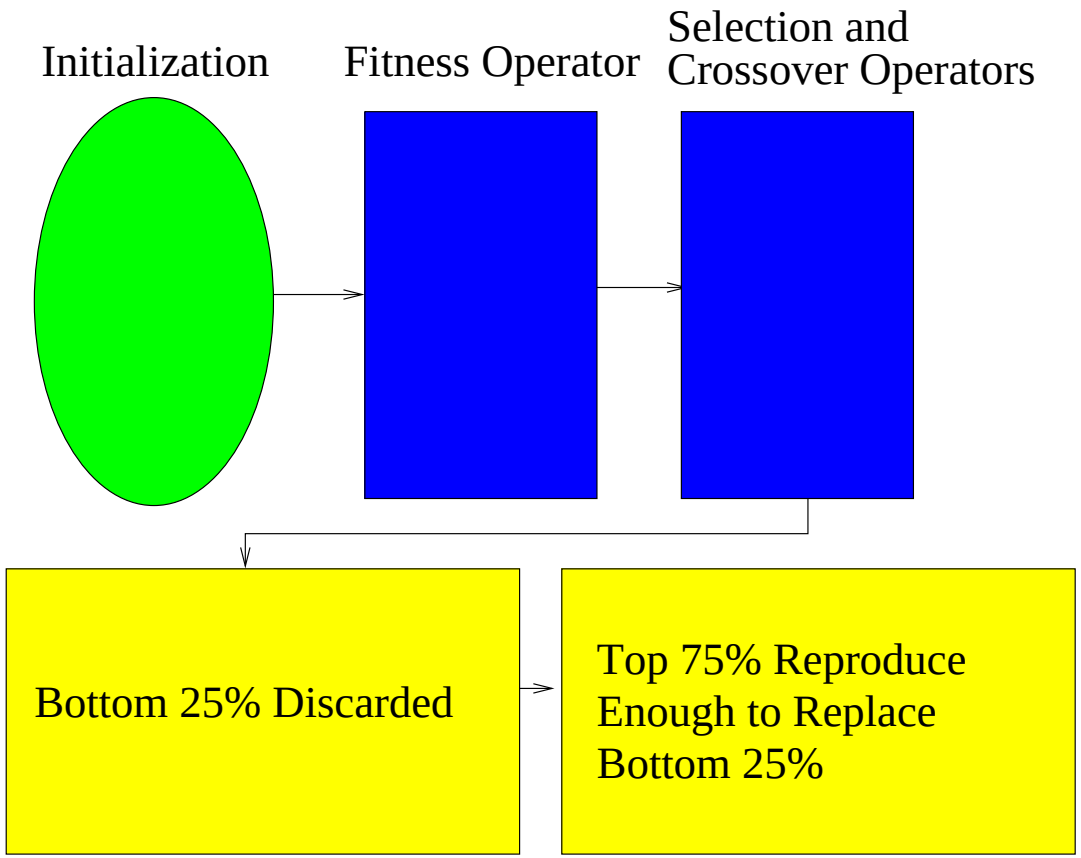
- *Initialization:* Individual Represents Enabled Compiler Options

Genetic Algorithm



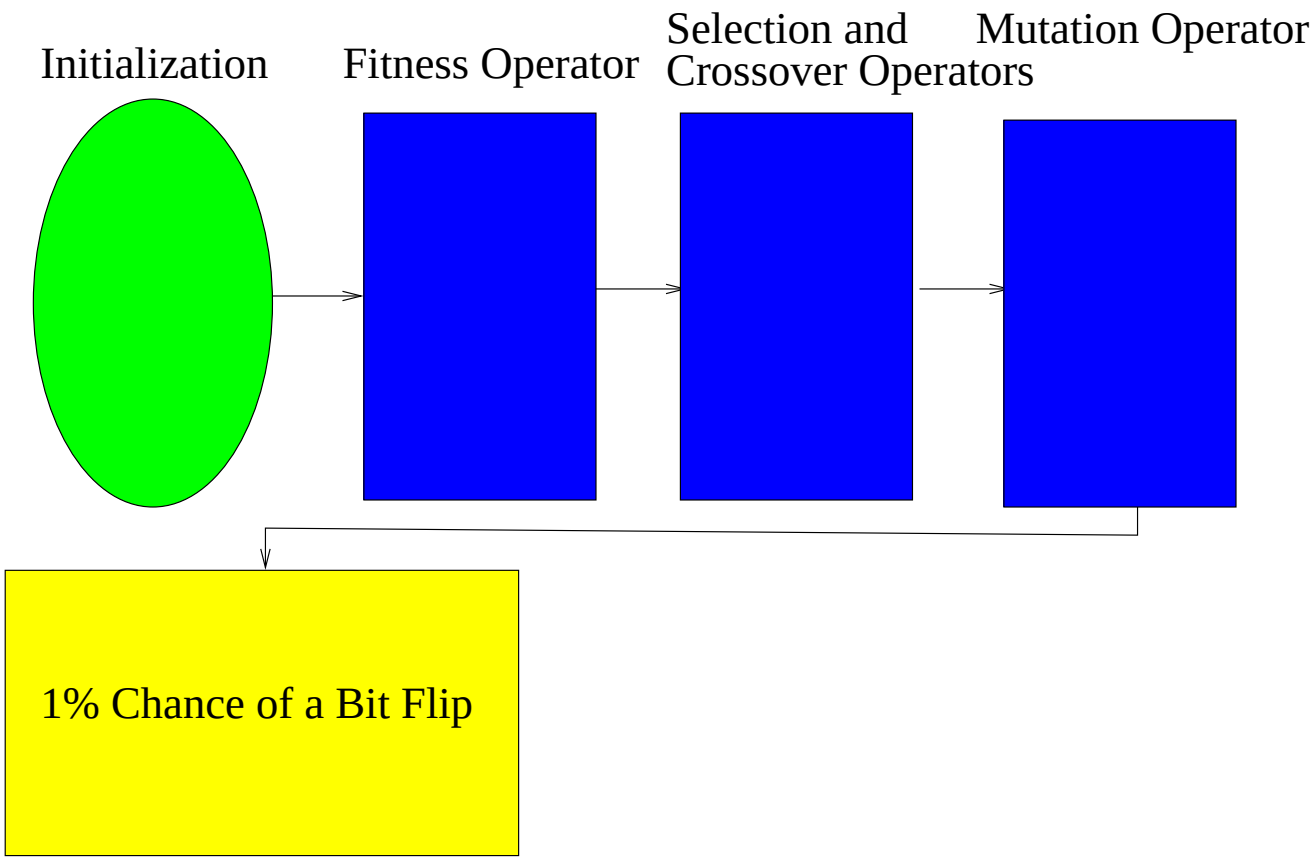
- *Fitness Operator:* System Call Micro-Benchmarking

Genetic Algorithm



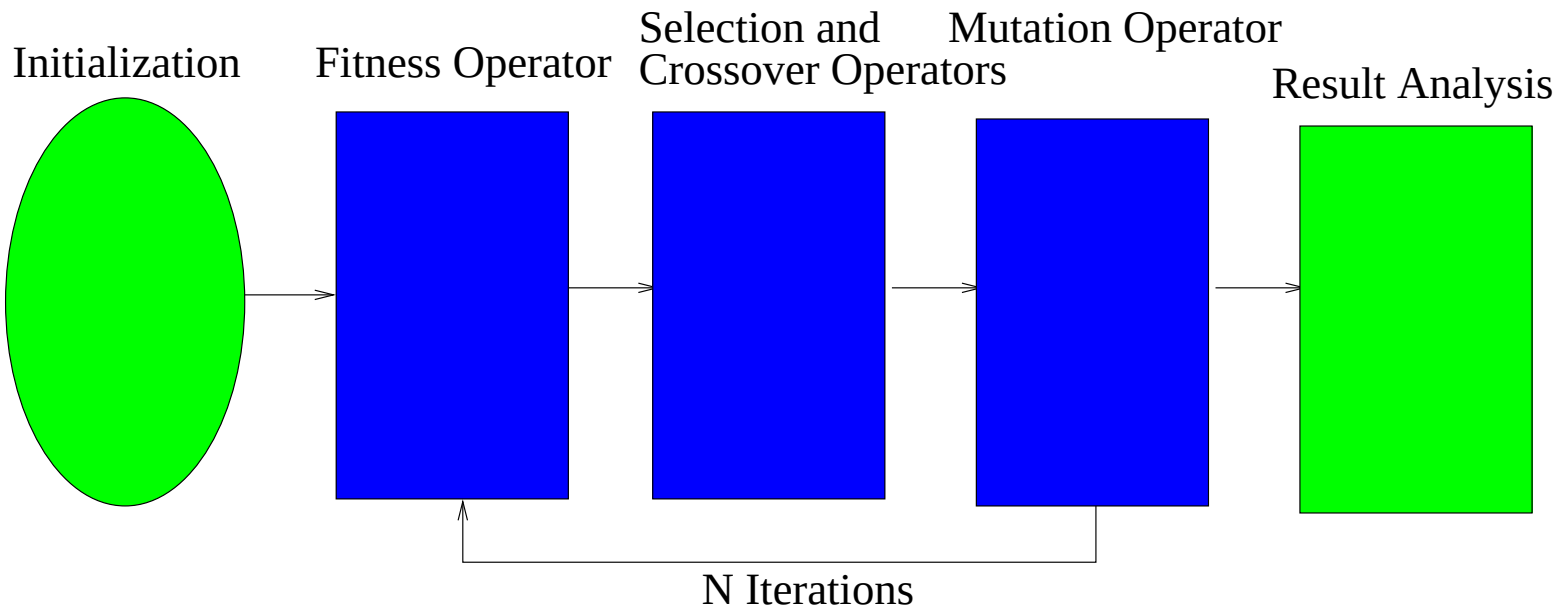
- *Selection Operator:* Enforces Strong Elitism

Genetic Algorithm



- *Mutation Operator:* Too Much Mutation Masks Evolution

Genetic Algorithm



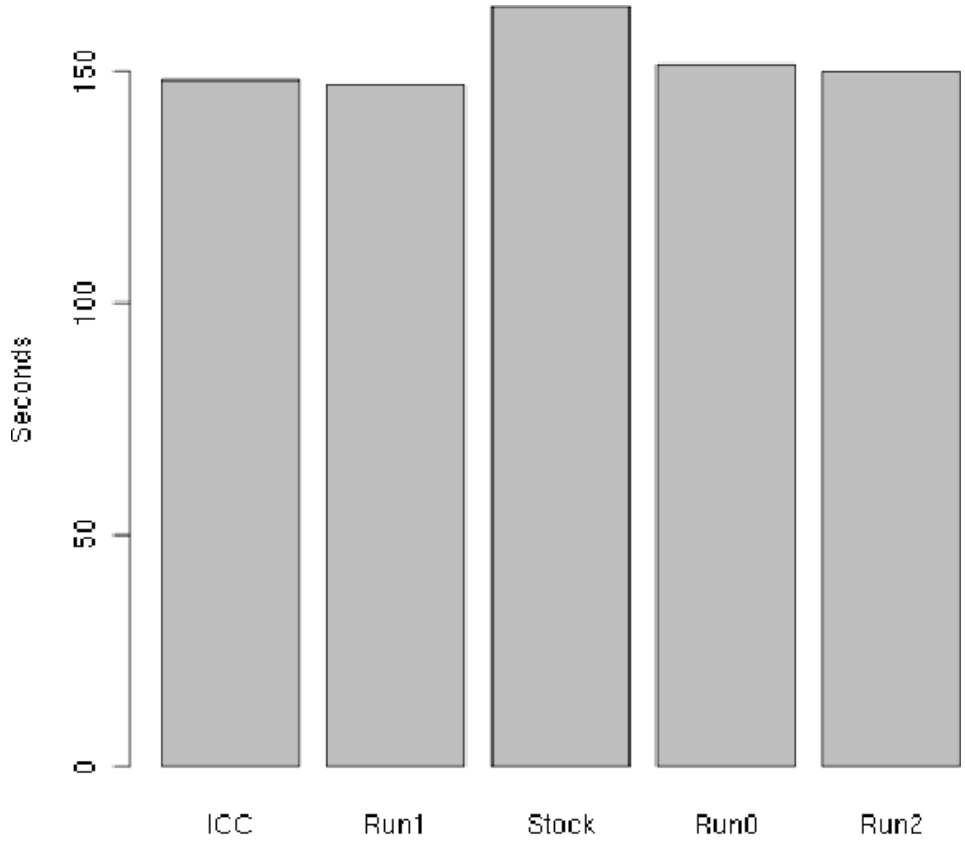
- *Termination Condition:* Predefined Generation Count

Results Analysis

Results Analysis Technique

- Phoronix Test Suite
- Suite to emulate netbook workload
  - SQLLite
  - GnuPG
  - Ogg
  - CRay
  - SciMark
  - 7Zip
  - GTKPerf

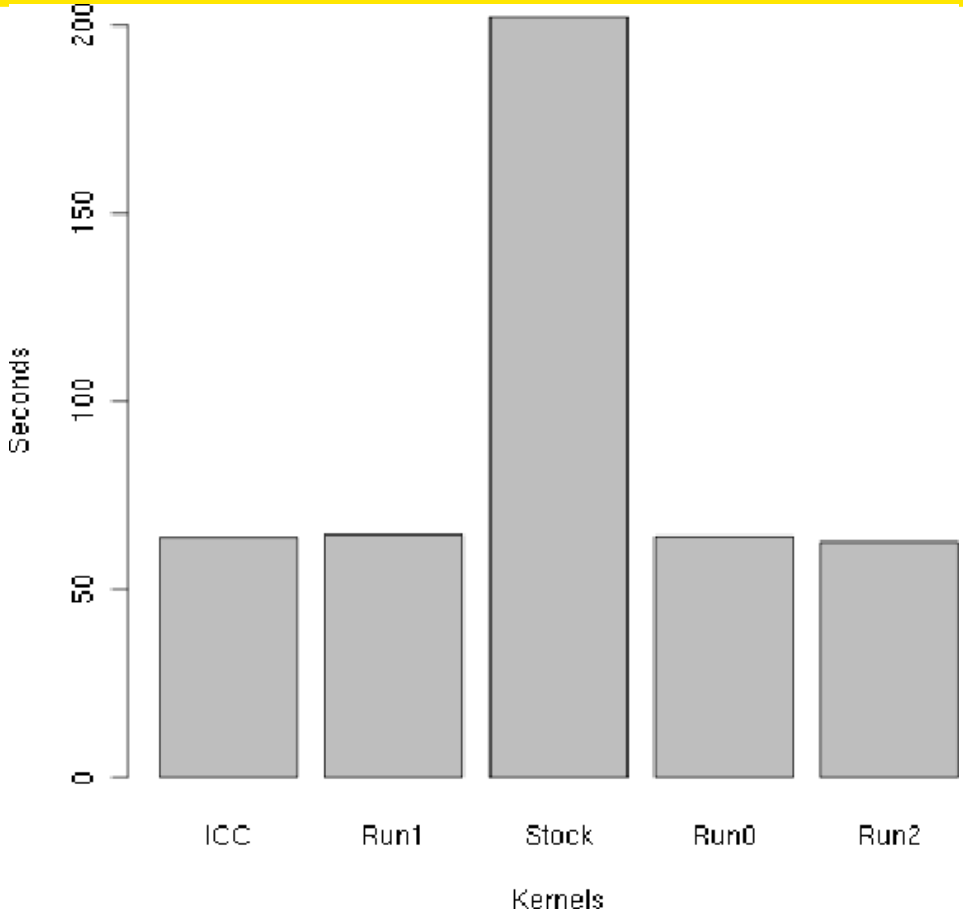
GTK Results



The Fastest Evolved Kernel . . .

- is About 20 Seconds Faster

SQLLite



The Fasted Evolved Kernel . . .

- is About 140 Seconds Faster

Conclusions and Future Work

Conclusions

- Evolved Kernels Outperformed Stock Fedora Kernel
- Genetic Algorithm Excels at Finding Correlations Between Optimizations

Future Work

- More Platforms
- More Compilers
- More GA Options

Conclusions and Future Work

More Information at ...

- Jim Kukunas <jkukunas@acm.org>
- `http://member.acm.org/~treak007`