iPhone Application Programming
Lecture 8: Instruments

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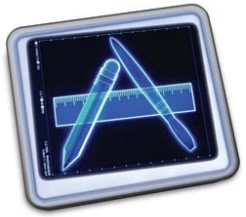
http://hci.rwth-aachen.de/iphone



Instruments

Where is the problem?

```
int main(int argc, const char * argv[])
{
    @autoreleasepool
    {
        for(int i = 0; i < HUGE_VAL; i++)
        {
            NSArray *array = @[];
            [[array retain] autorelease];
        }
    }
    return 0;
}
```


Analyzing Runtime Behavior

- Memory
  - How much is used?
  - When is it allocated / freed?
- CPU Time
  - Where is it spent?
  - How is it distributed between multiple CPUs?

→ How is my algorithm doing things?
Not: Is it doing them correctly?

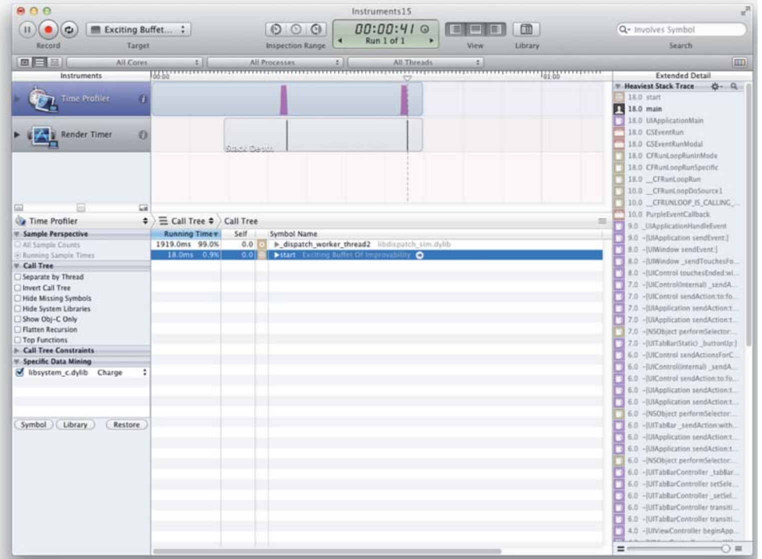
Instruments UI

Track view

Data view

Extended details

Strategies



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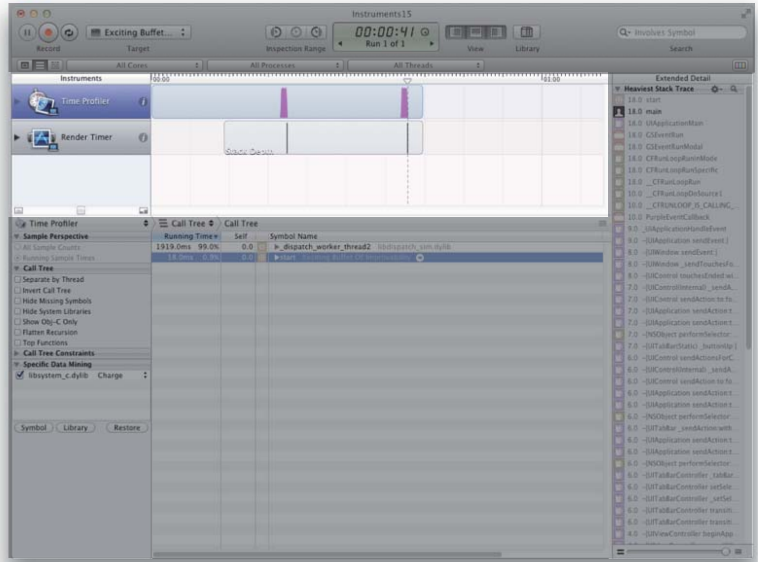

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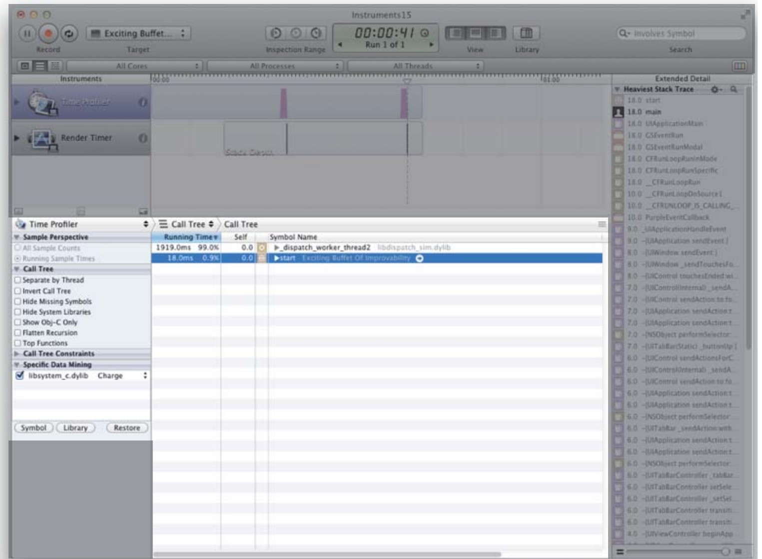

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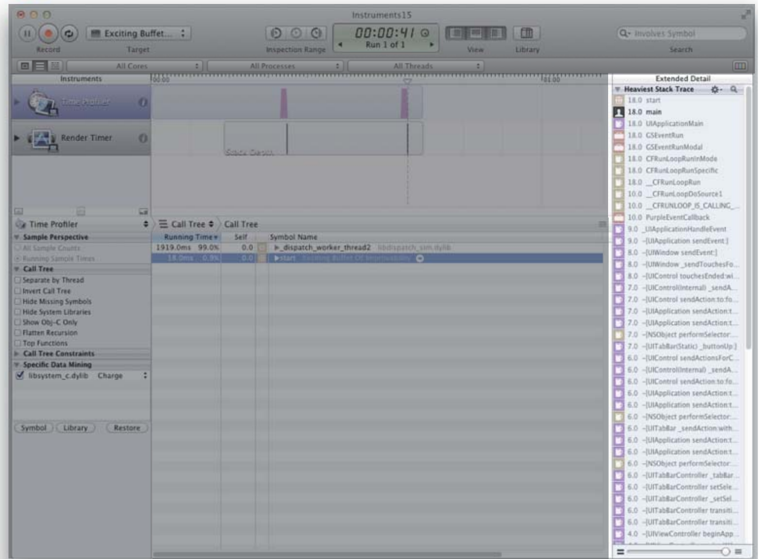

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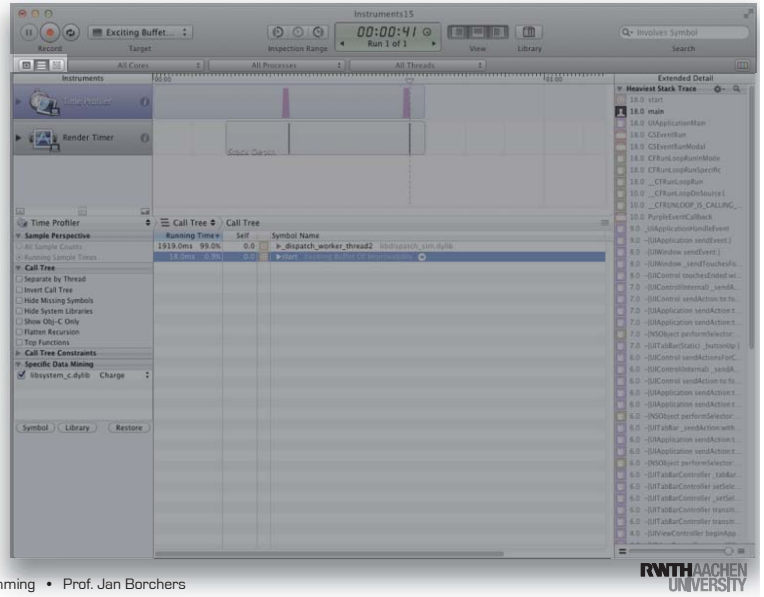

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Strategies (Example)

- Instruments

- Threads

- CPUs

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Demo Project

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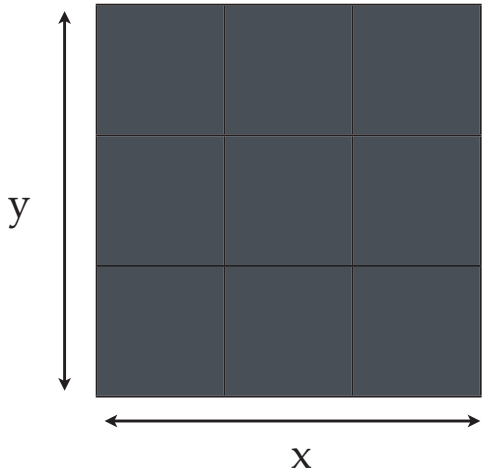
$$f(x) = x$$



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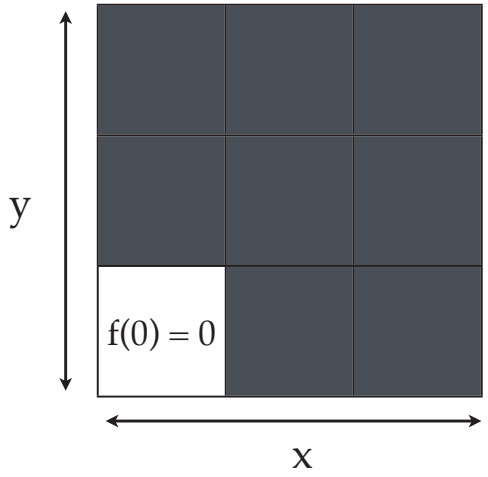

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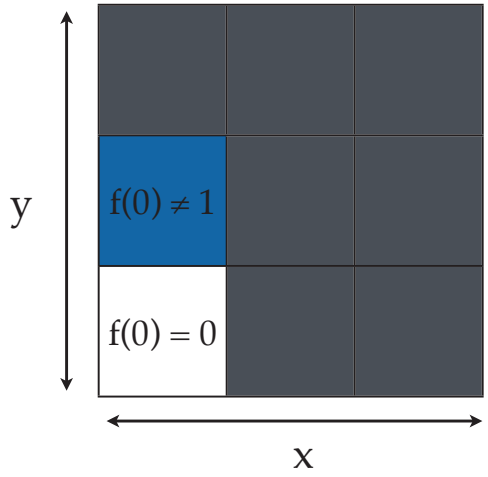

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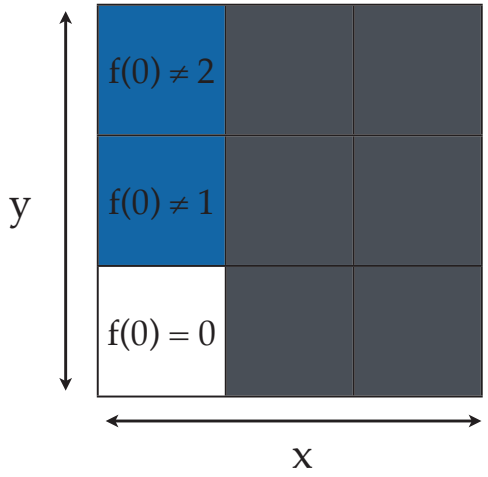

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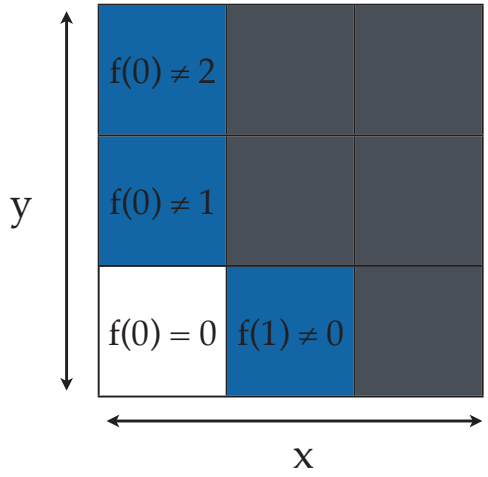

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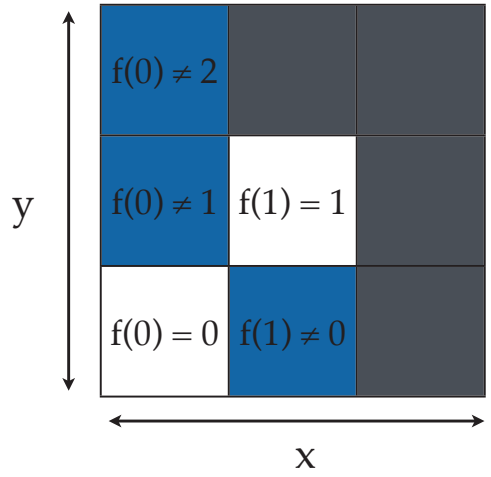

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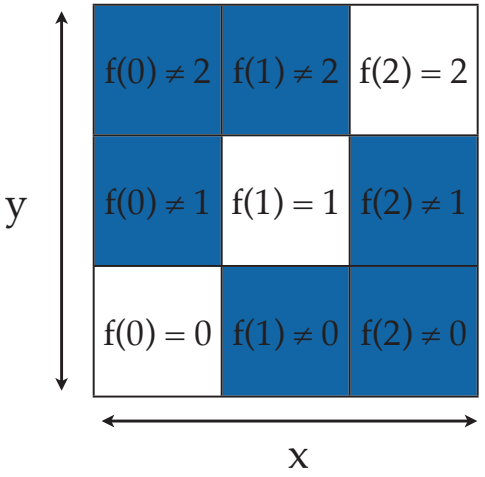

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Simple Optimization Demo

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Memory Analysis

- Allocation
  - Monitors memory allocation and reference counting
- Leaks
  - Checks for inaccessible memory
  - Finds retain cycles
- Zombies
  - Checks for freed memory being accessed

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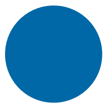
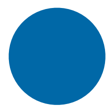
Leaks



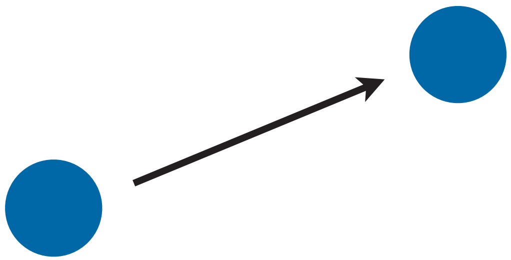
Leaks

Leaks

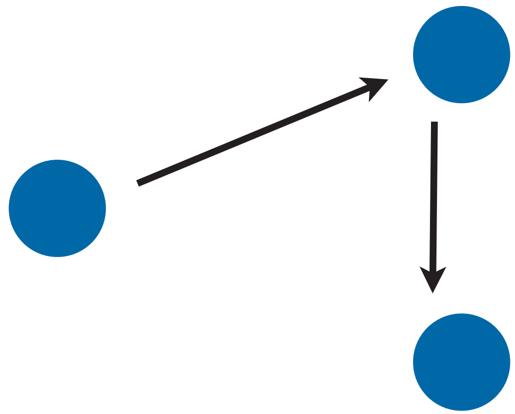
Retain Cycles



Retain Cycles



Retain Cycles



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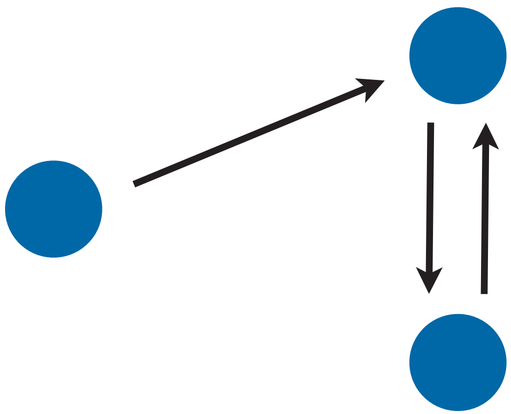

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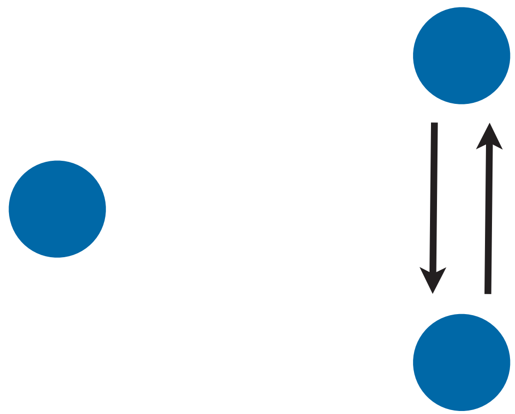


Allocations & Leaks Demo

Zombies

Freed memory being accessed

- "Good" Zombies
  - Obvious crashes
  - You release, system reuses, you try to access
  - Crash (usually EXC_BAD_ACCESS)
- Bad Zombies
  - No crash, or crash at strange location
  - You release, you allocate something, you try to access
  - Weird side-effects

Zombies Demo

Using Memory Instruments

- When you are done with a task: Leaks
- Whenever you get strange crashes or inexplicable values: Zombies
- You can use the simulator

Profiling

- Check in regular intervals what the CPU is doing
- Time Profiling
  - Where does the CPU spend time?
  - Distribution of work between threads / CPUs
- System Trace
  - What is the system doing?
    - Thread scheduling
    - Paging
    - System calls

Time Profiling Demo

Using Time Profiling

- When your app seems too slow
  - Identify hotspots
  - Identify opportunities for parallelization
  - Identify parallelization issues (e.g. forced serial execution)
- Use on iOS Device

System Trace Demo

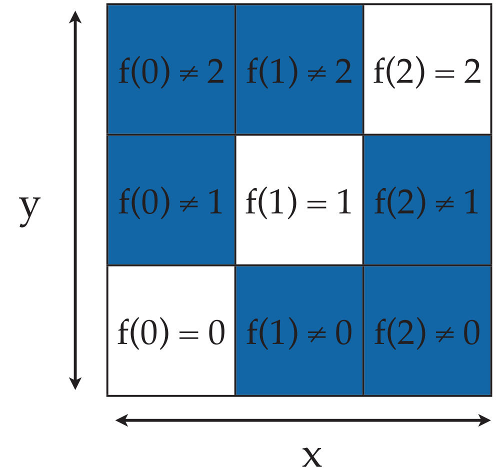
Using System Trace

- When results of Time Profiling are insufficient
  - Excessive context switching
  - Paging issues
  - Find opportunities to group system calls
- Use on iOS Device

$f(x) = x$

Layout in Memory

Order of Drawing



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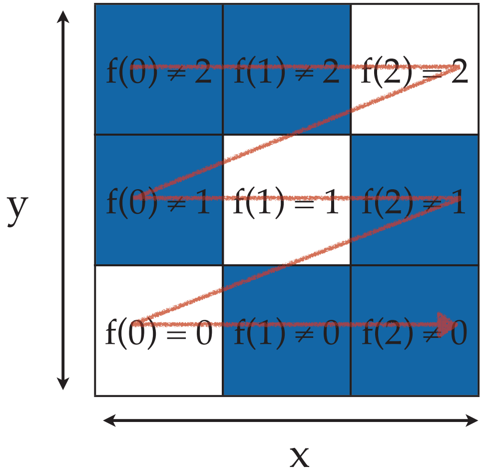

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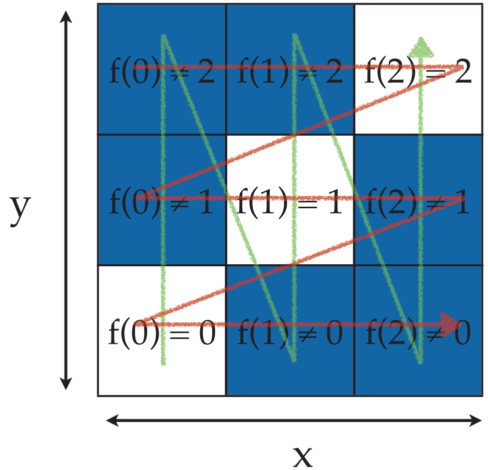

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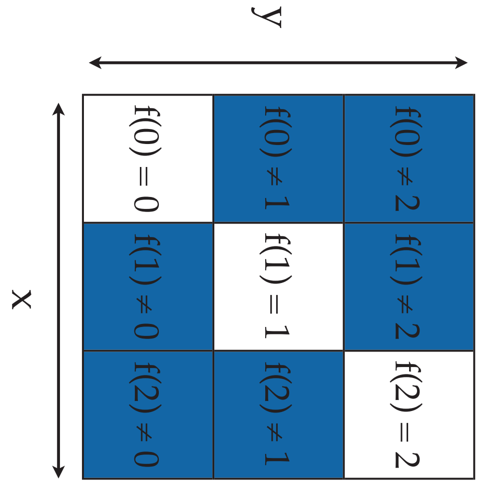

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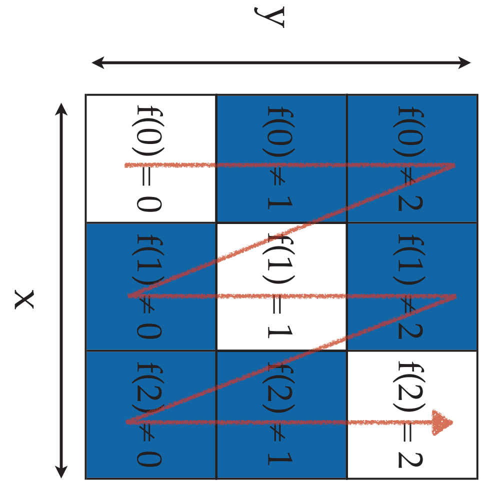

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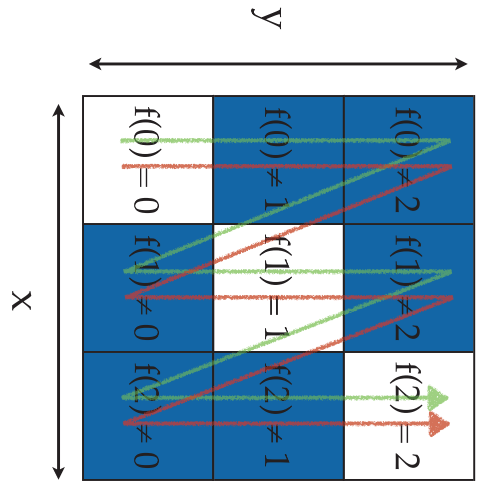

Other Instruments

- Energy Diagnostic
- Core Animation
- OpenGL ES
- System Usage
- UI Automation

Summary

- General
  - Find bugs at runtime
  - Increase algorithmic efficiency
- Profiling
  - Identify bottlenecks
  - Parallelization
- Memory Instruments
  - Sanity checks to find leaks and zombies
  - Increase memory efficiency