Savina –
An Actor Benchmark Suite

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Introduction

- Multicore processors are now ubiquitous
- Parallelism is the future of computing
- Actor Model regained popularity
  - Erlang – flagship language
- Many actor libraries out there for various languages

Motivation

- Benchmarks help motivate language implementers to
  - Improve their implementations
  - Calibrate competitive advantages of their approach
- Currently rely on micro-benchmarks
  - Rarely reflect behavior of real world applications
- Need a benchmark suite that goes beyond micro-benchmarks

Goals

- Savina, a benchmark suite for actor-oriented programs
- Cover a wide range of diverse and realistic use-cases
  - Enable apple-to-apples comparisons
- Implementations available as open source
  - Provide implementations of benchmarks in various actor libraries
  - Encourage researchers to contribute their implementations

Outline

- Benchmarks breakdown
- Micro-benchmarks
- Concurrency Benchmarks
- Parallelism Benchmarks
- Experimental Results
- Availability and Summary

Benchmarks Diversity

- Focuses on computationally intensive applications
- Display commonly used parallel patterns
- Covers wide range of domains
  - Common concurrency problems
  - Graph and Tree Traversal
  - Linear Algebra

Benchmarks Breakdown

- 7 Micro-benchmarks
- 8 Classical Concurrency benchmarks
- 14 Parallelism benchmarks

Micro-benchmarks (I)

- Ping Pong
  - Message delivery overhead
- Counting Actor
  - Message passing overhead
- Fork Join (throughput)
  - Messaging throughput
- Fork Join (actor creation)
  - Actor creation and destruction

Micro-benchmarks (II)

- Thread Ring
  - Message sending; Context switching between actors
- Chameneos
  - Contention on mailbox; Many-to-one message passing
- Big
  - Contention on mailbox; Many-to-Many message passing

Concurrency benchmarks (I)

- Concurrent Dictionary
  - Reader-Writer concurrency; Constant-time data structure
- Concurrent Sorted Linked-List
  - Reader-Writer concurrency; Linear-time data structure
- Producer-Consumer with Bounded Buffer
  - Multiple message patterns based on Join calculus
- Dining Philosophers
  - Inter-process communication; Resource allocation

Concurrency benchmarks (II)

- Sleeping Barber
  - Inter-process communication; State synchronization
- Cigarette Smokers
  - Inter-process communication; Deadlock prevention
- Logistic Map Series
  - Synchronous Request-Response with non-interfering transactions
- Bank Transaction
  - Synchronous Request-Response with interfering transactions

Parallelism benchmarks (I)

- All-Pairs Shortest Path
  - Graph exploration; Phased computation
- A-Star Search
  - Graph exploration; Message priority
- NQueens first K solutions
  - Divide-and-conquer style parallelism; Message priority
- Recursive Matrix Multiplication
  - Divide-and-conquer style parallelism; Uniform load
- Quicksort
  - Divide-and-conquer style parallelism; Non-uniform load

Parallelism benchmarks (II)

- Radix Sort
  - Static Pipeline; Message batching
- Filter Bank
  - Static Pipeline; Split-Join Pattern
- Bitonic Sort
  - Static Pipeline; Round-robin message forwarding and reception
- Sieve of Eratosthenes
  - Dynamic Pipeline; Non-uniform load

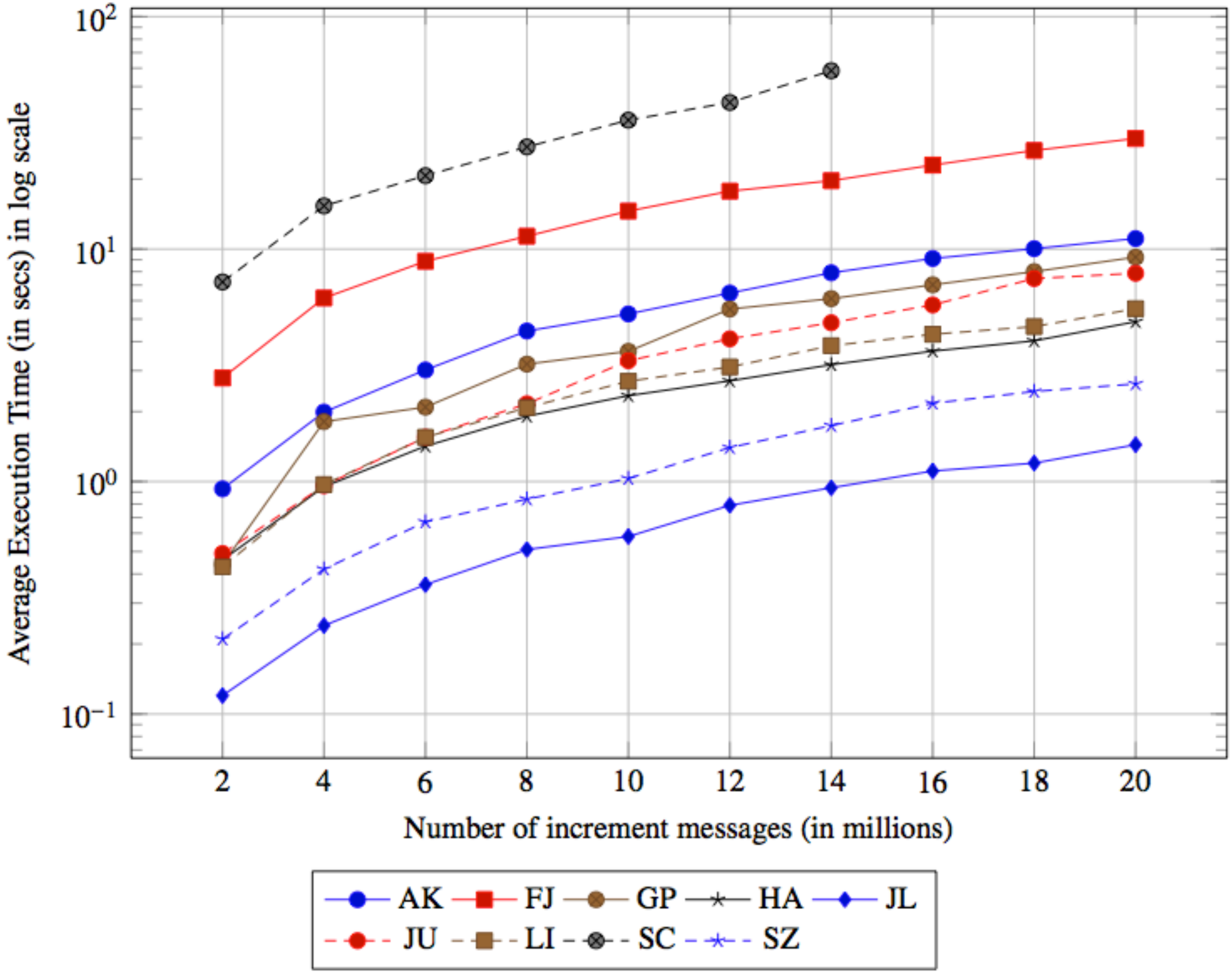
Parallelism benchmarks (III)

- Unbalanced Cobwebbed Tree
    - Tree exploration; Non-uniform load
- Online Facility Location
    - Dynamic Tree generation and navigation
- Trapezoidal Approximation
    - Master-Worker; Static load-balancing
- Precise Pi Computation
    - Master-Worker; Dynamic load-balancing
- Successive Over-Relaxation
    - 4-point stencil computation

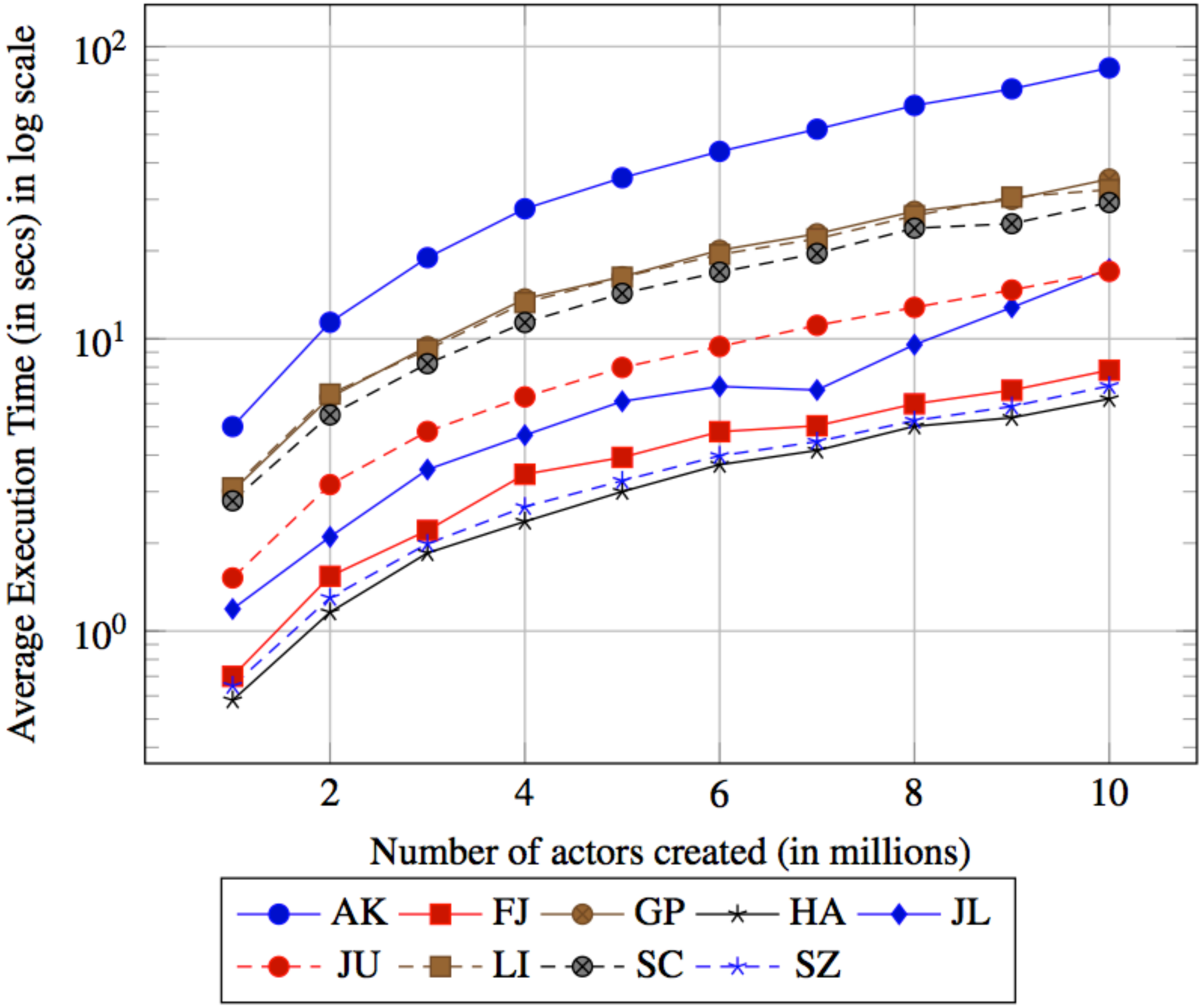
Experimental Results

- 12-core (two hex-cores) 2.8 GHz Intel Westmere SMP node
- Java Hotspot JDK 1.8.0
- Nine Actor libraries:
  - Akka 2.3.2
  - Functional-Java 4.1
  - GPars 1.2.1
  - Habanero-Java library 0.1.3
  - Jetlang 0.2.12
  - Jumi 0.1.196
  - Lift 2.6-M4
  - Scala 2.11.0
  - Scalaz 7.1.0-M6

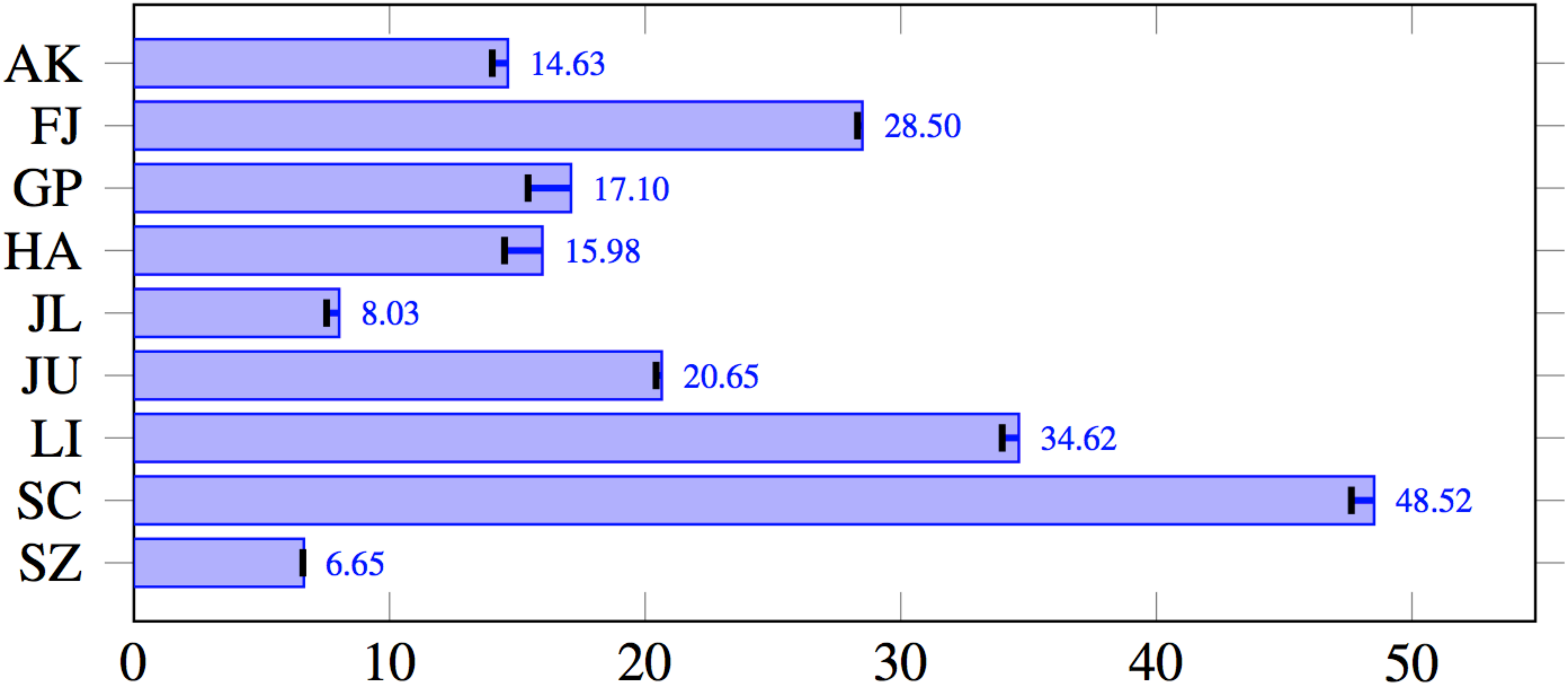
Counting Micro-benchmark



ForkJoin Creation Micro-benchmark

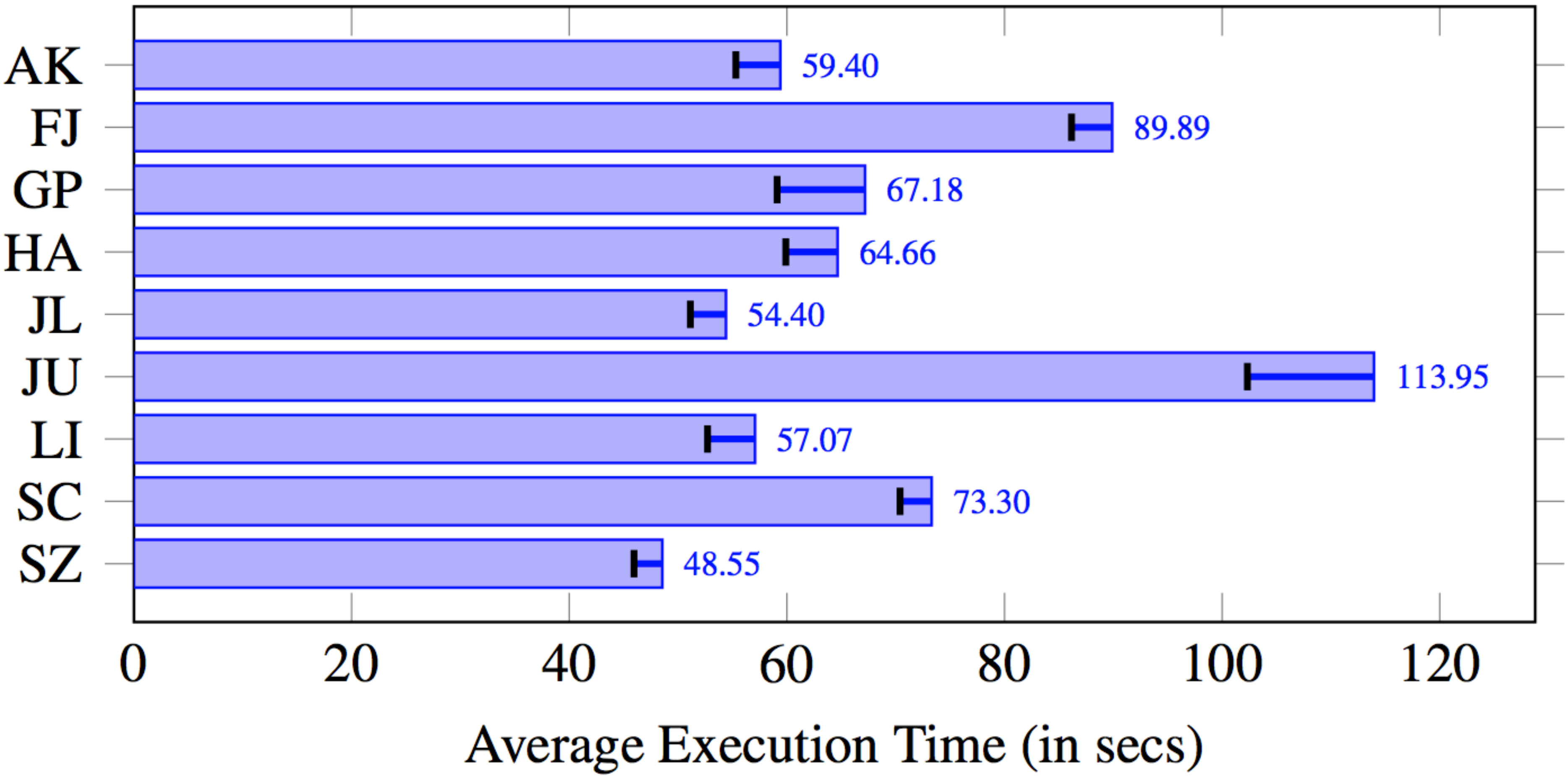


Producer-Consumer with Bounded Buffer benchmark



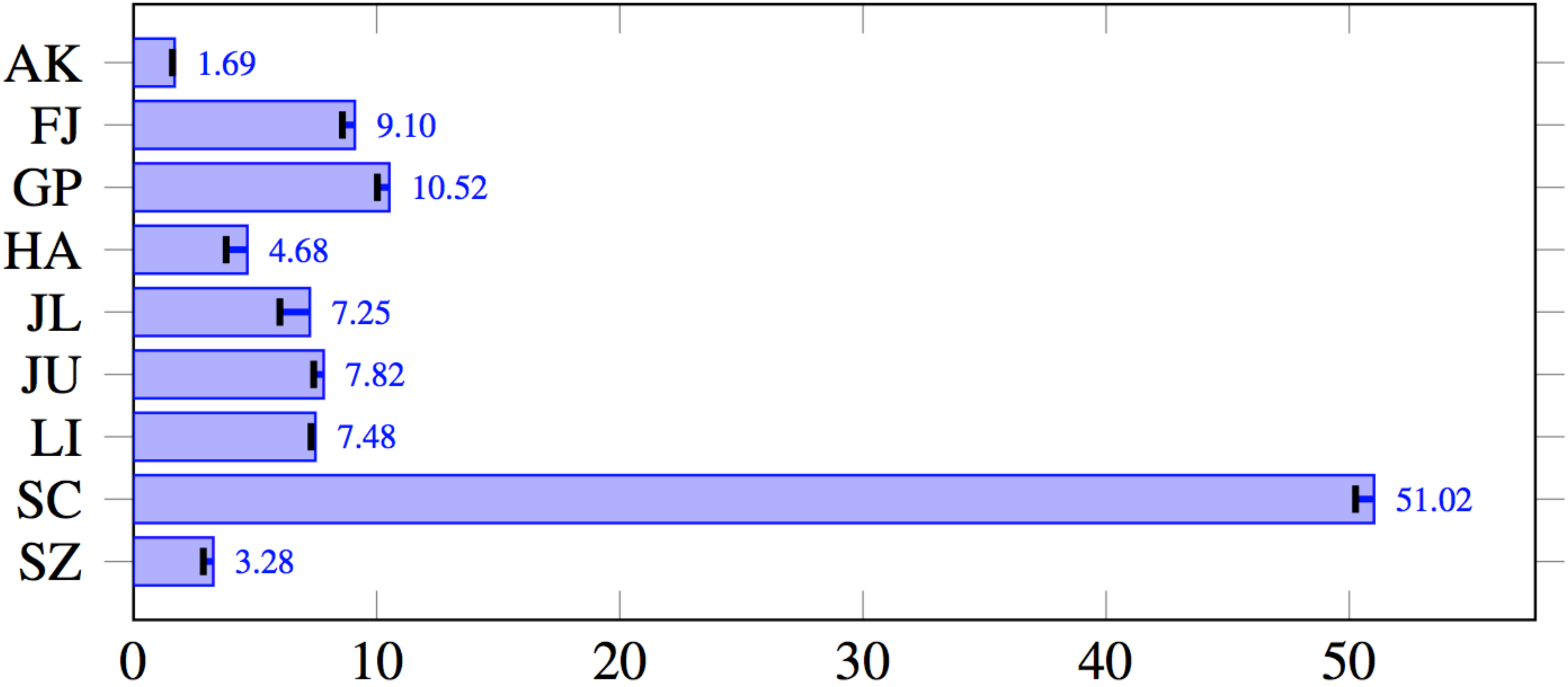
- Buffer size of 6000
- 5000 producer actors each producing up to 1000 messages
- 2000 consumer actors

Filter Bank benchmark



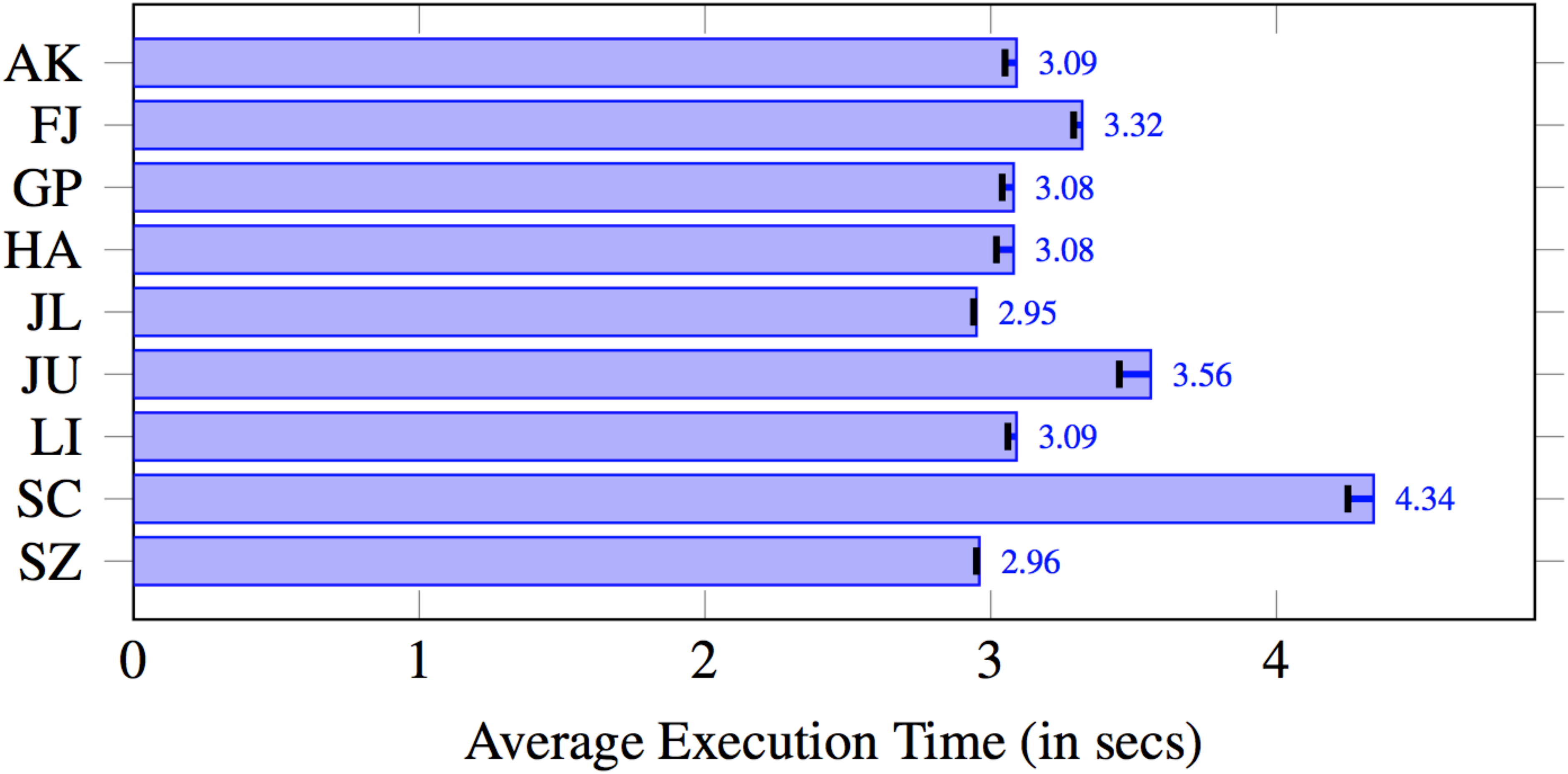
- 8-way join branches
- 300,000 data items and 131,072 columns

Bitonic Sort benchmark



- 32,768 data items

Sieve of Eratosthenes benchmark



- Find primes smaller than 100,000

Related Work

- Cardoso et al at AGERE last year
  - Compare actor and agent languages
  - Focus on micro-benchmarks (Thread Ring, Chameneos, Fibonacci)
- bencherl: Scalability benchmark suite for Erlang applications
- Theron C++ concurrency library: Five actor micro-benchmarks
- nofib suite: Haskell programs
- Computer Language Benchmarks Game:
  - compares over 20 programming languages on a set of 13 micro-benchmarks

Future Work

- Bug fixes and improved implementations
- Java versions of benchmarks
  - Save on pattern matching overheads
- Discover and add diverse benchmarks
- Other runtime implementations
  - Perform inter-language comparisons
- Compare solutions for elegance

Availability

- Implementation available in github

  https://github.com/shamsmahmood/savina

- Open source release allows
  - Verifying what is actually being tested
  - Porting the benchmarks to other actor languages and runtimes
  - Comparison of solutions for syntax and elegance
  - Analysis of benchmarks to further study impact of different features
- Encourage community to submit solutions
  - Improve existing ones
  - Add new libraries or runtimes

Summary

- Introduced Savina, Actor Benchmark Suite
- Described benchmark breakdown
- Open source release
  - Nine actor libraries compared
  - Expect contributions for other libraries

Comments

- Introduced Savina, Actor Benchmark Suite
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```
import agere.audience.Feedback
```

Backup-Slides