

# Computer Systems Performance Analysis and Benchmarking (37-235)

## Analytic Modeling Simulation Measurements / Benchmarking

### Lecture by:

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### Assignments/Projects:

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### Textbook:

Raj Jain, "The Art of Computer Systems Performance Analysis", 1991 Wiley & Sons, New York

### Topic of Today:

- **Self Scaling Benchmarks**  
SIGMETRICS Paper 1993 by P.Chen
- **Performance Modeling & Prediction**  
SUPERCOMPUTING Paper 1998 by M.Taufer

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## What's wrong w. I/O benchmarks

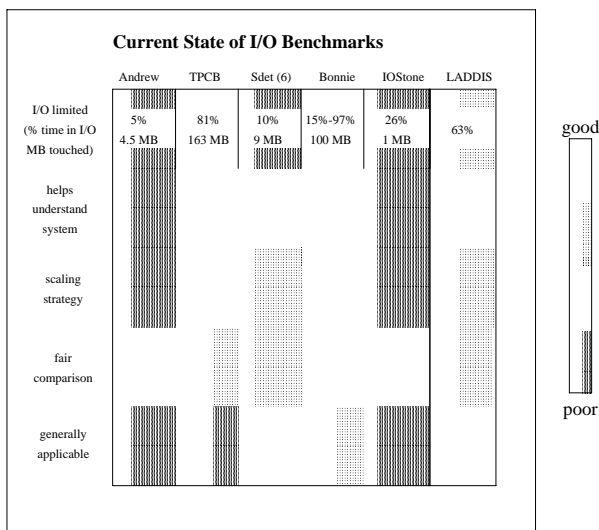
- Become quickly obsolete  
i.e. Have no scaling strategy
- Do not stress the I/O system
- Do not help to understand IO
- Comparison for one workload only  
i.e. don't allow conclusions about relative performance.
- Narrow application range  
i.e. TPC-B is only debit/credit

### Look at

- IO Percentage
- Maximal Working Set
- Scaling strategy
- Insight into system
- Suitability for comparison

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## Current State of Art (1993)



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## Workload Model

- uniqueBytes
  - working set
- sizeMean
  - size of I/O request
  - normal distribution with C.O.V of 1
- readFrac
  - percentage of reads vs. writes
- seqFrac
  - probability that next request follows the prior request
- processNum
  - multithreading, number of processes issuing I/O.

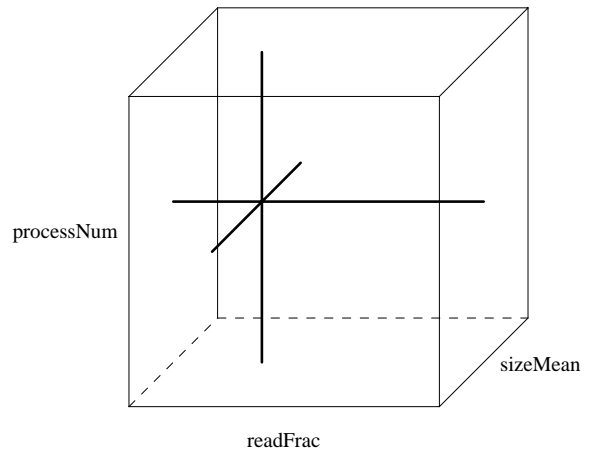
## How accurately can we model real workloads?

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## Representativeness of workload

Application	Throughput	Read Response Time	Write Response Time	Average Response Time
Sort	.20 MB/s	19.7 ms	1.6 ms	11.7 ms
Workload Model	.20 MB/s	20.0 ms	1.9 ms	11.0 ms
TPC-B	.13 MB/s	25.6 ms	1.3 ms	14.0 ms
Workload Model	.13 MB/s	22.1 ms	1.6 ms	12.3 ms

## The Parameter Space



## Terms

- Single Parameter Graphs
- Focal Point
- Focal Vector

### Example

- uniqueBytes= 21MB
- sizeMean= 10 KB
- readFrac= 0
- processNum= 1
- sequFrac= 0

### Full Fractional Design

- $6^5 = 8000$  points @ 10min = 2 Months

### Reduced Design

- 30 points @ 10 min = 5 hours

## Basic Version of Benchmark

- Take focal point somewhere at 75% of maximal performance of each factor

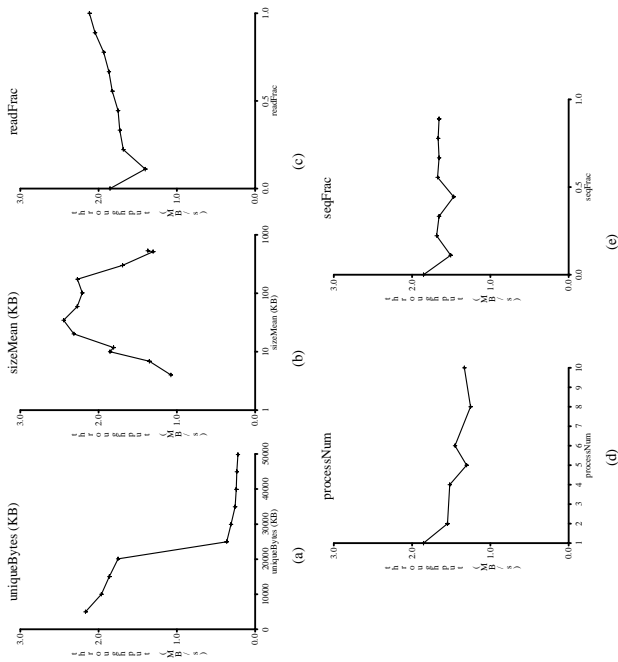
### Problems:

- Focal points at outer limits
- Focal points set arbitrarily
- Focal point in an unstable area
- Not aware of plateaus

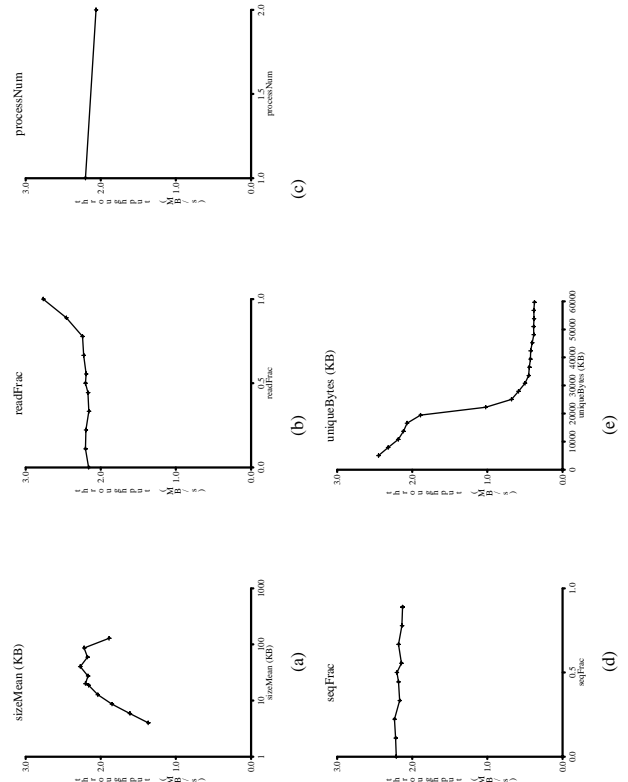
### Improved Version of Benchmark

- Aware of plateaus
- multiple focal points for uniqueBytes
- Focal points midway e.g. 0.5 for [0..1]

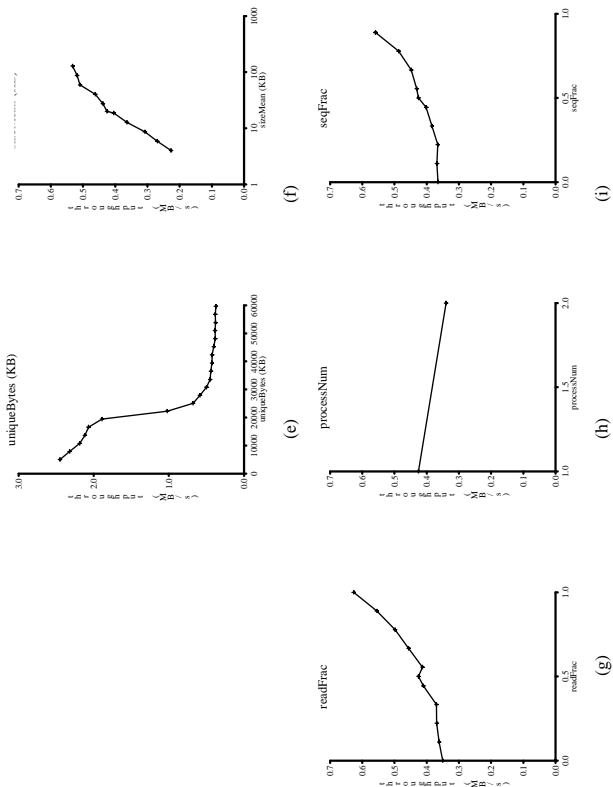
# Scaling all Parameters [Sparc1]



# Plateau 1 [Sparc1]



# Plateau 2 [Sparc1]



# How to allow for comparisons?

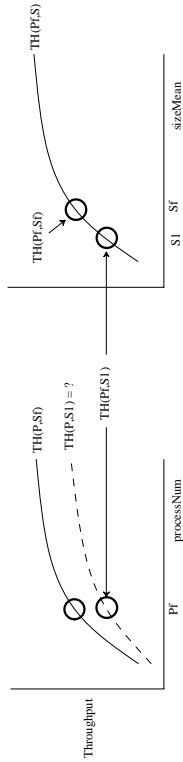
Simple prediction component for any workload assumed

Big assumption

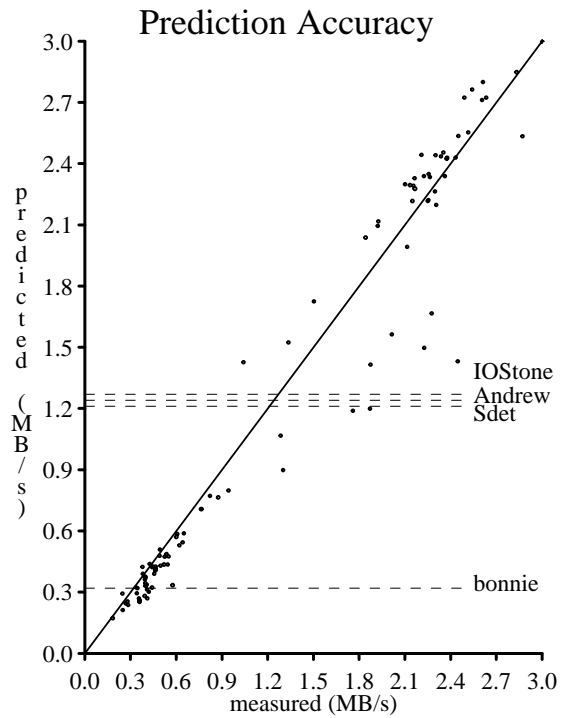
- Shape of single parameter curve does not change with focal point.
- Simple linear interpolation
- Multiplicative linear interpolation for multiple parameters

Clean evaluation of the error in the paper.

# Predicting Performance

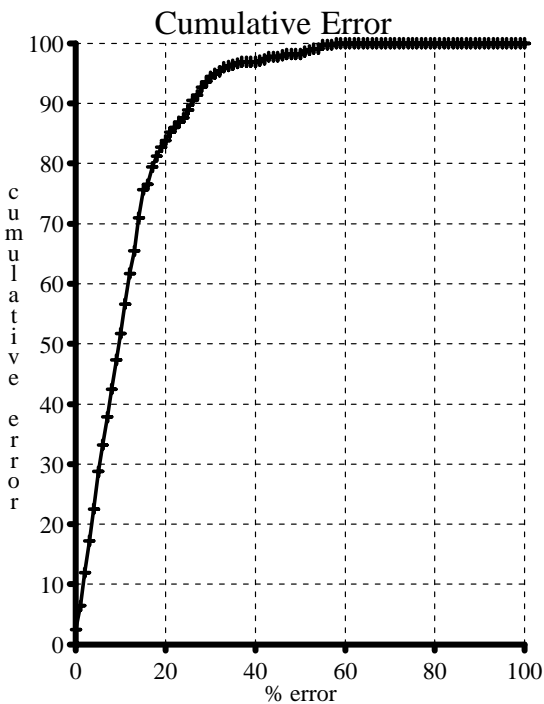


# Accuracy of Prediction [Sparc1]



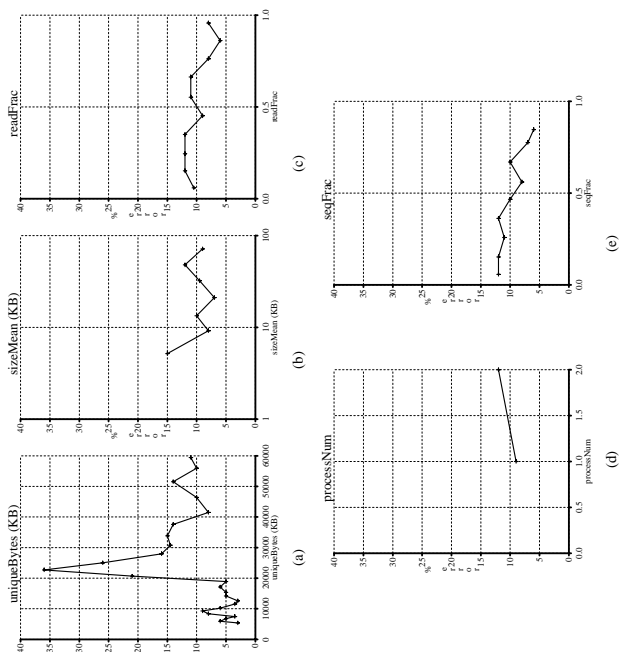
(a)

# Error of Prediction [Sparc1]



(b)

# Parameters with error



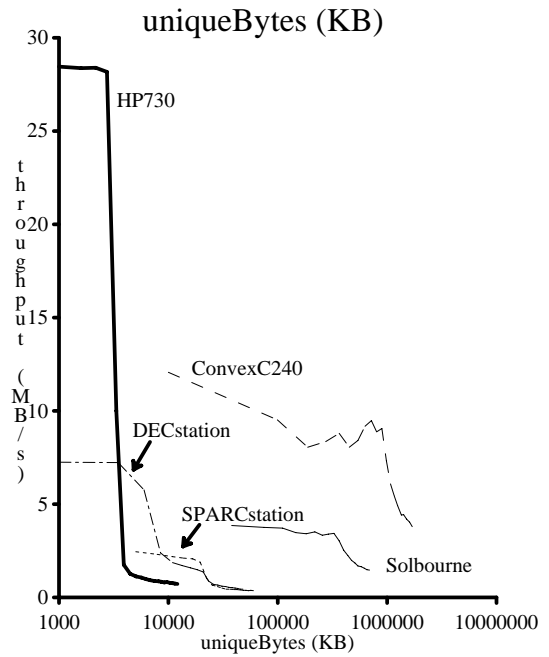
# Discussion of Machines

System Name	SPARCstation 1+	DECstation 5000/200	HP 730
Year Released	1989	1990	1991
CPU	SPARC 8.3	MIPS R3000	PA-RISC 76.8
SPECmarks	CDC Wren IV	3 disk (Wren) RAID 0	HP I350SX
Disk System	SCSI-I	100 MB/s	Fast SCSI-II
I/O Bus	28 MB	32 MB	32 MB
Mem. Bus Peak Speed	SunOS 4.1	Sprite LFS	HP/UX 8.07
Memory Size			
Operating System			

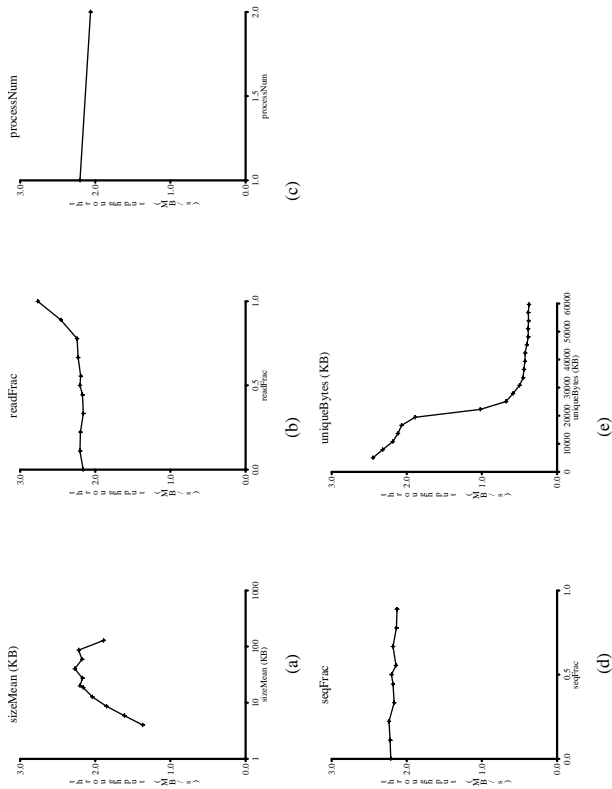
  

System Name	Convex C240	Solbourne SE/905
Year Released	1990 (???)	???
CPU	C2 (4 processors)	SPARC (???) processors
Speed	220 MIPS	???
Disk System	4 DKD-502 RAID 5	4 IPI
I/O Bus	IPI-2	128 MB/s ??
Memory Bus Peak Speed	200 MB/s	384 MB
Memory Size	1024 MB	SunOS 4.1A.2 (revised)
Operating System	ConvexOS 10.1 (BSD derived)	

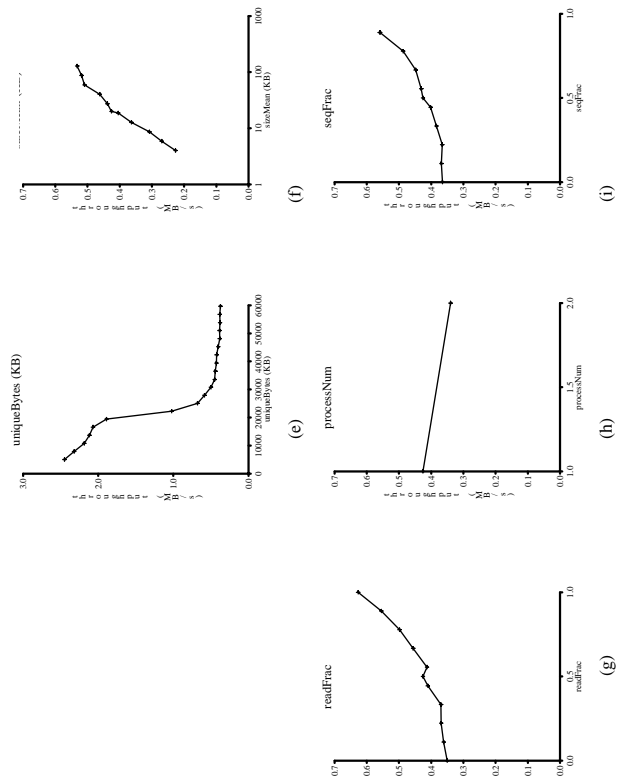
# Storage Hierarchies



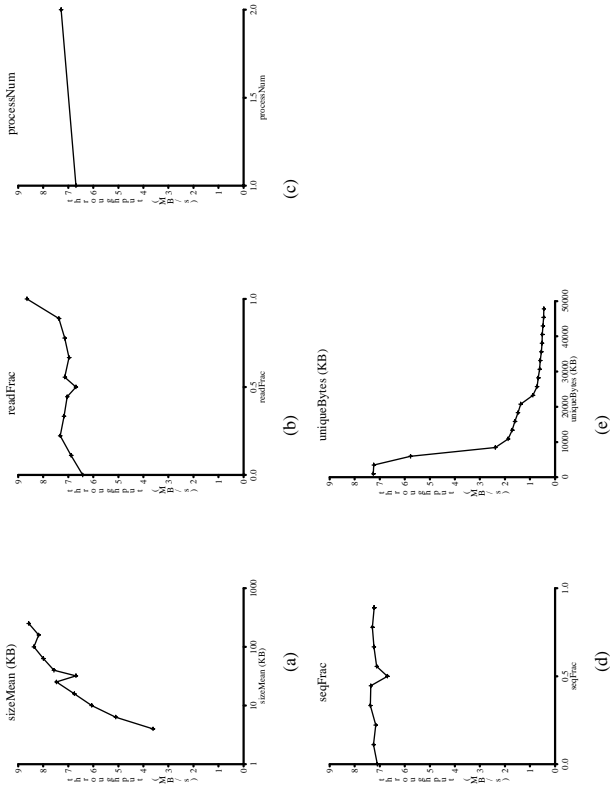
## Plateau 1 [Sparc1]



## Plateau 2 [Sparc1]

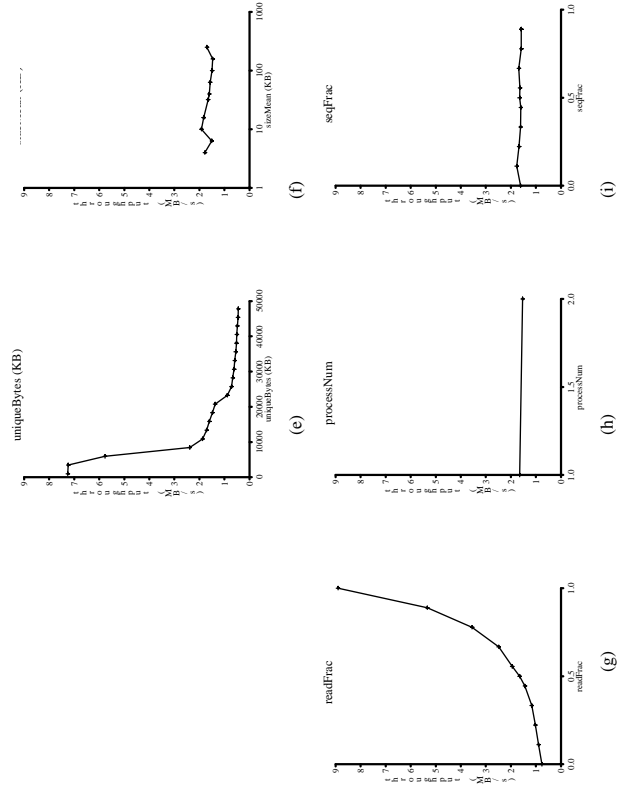


## Plateau 1 [DEC 5000]



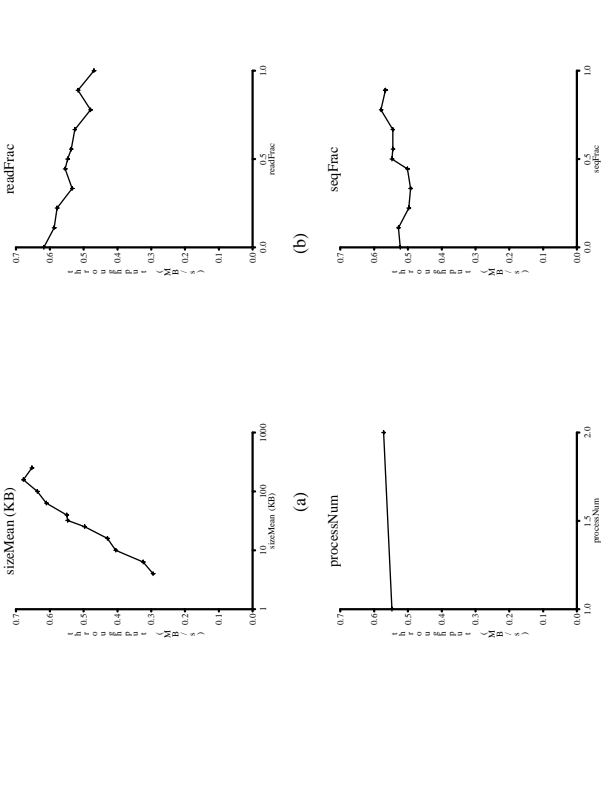
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## Plateau 2 [DEC 5000]



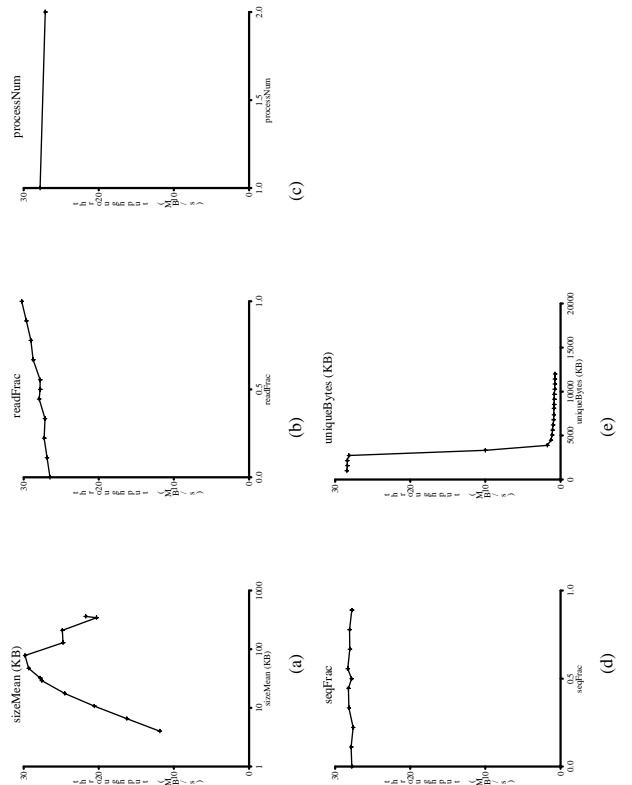
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## Plateau 3 [DEC 5000]



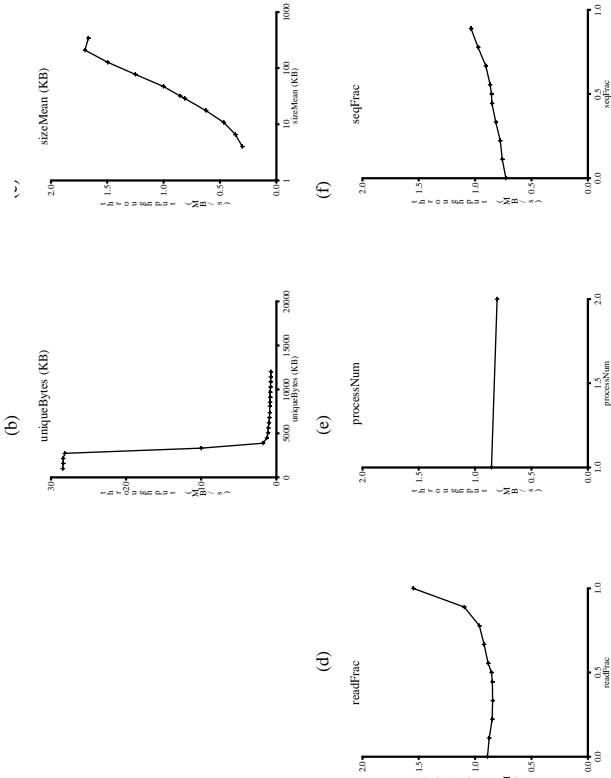
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## Plateau 1 [HP 730]



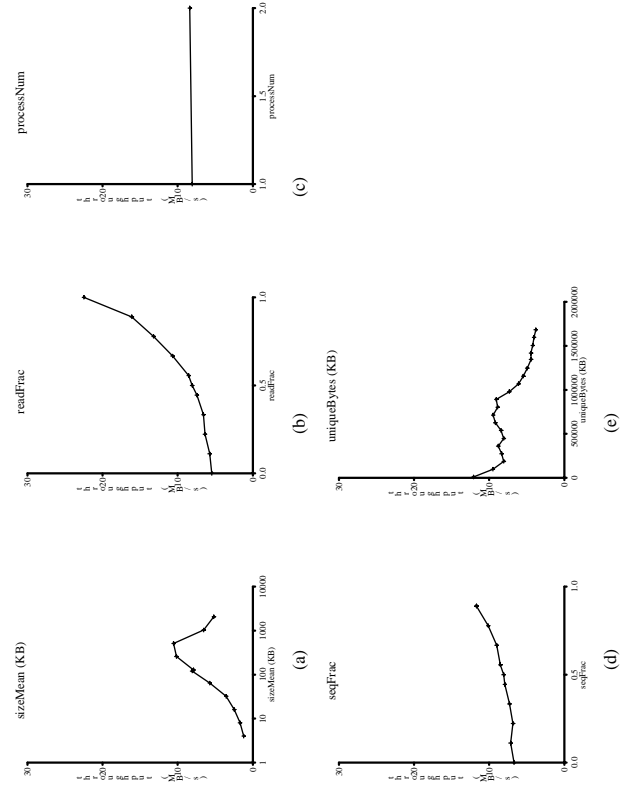
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## Plateau 2 [HP 730]



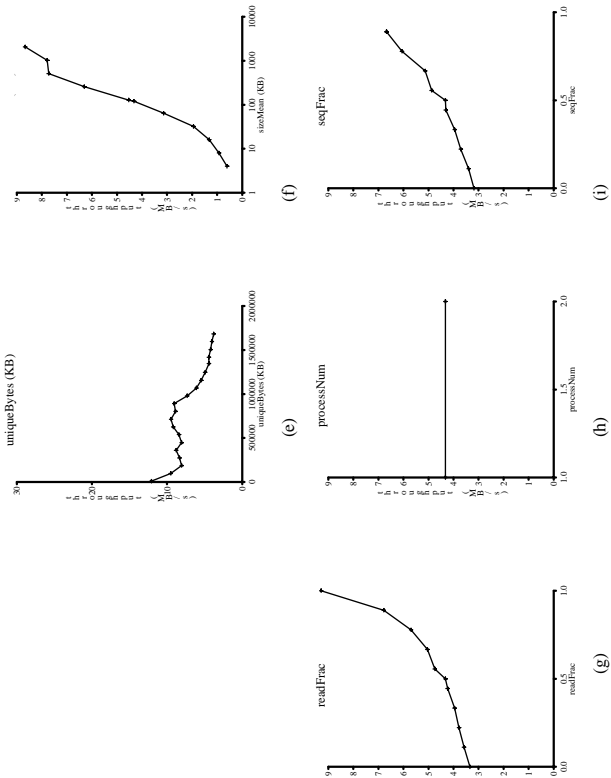
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## Plateau 1 [Convex C240]



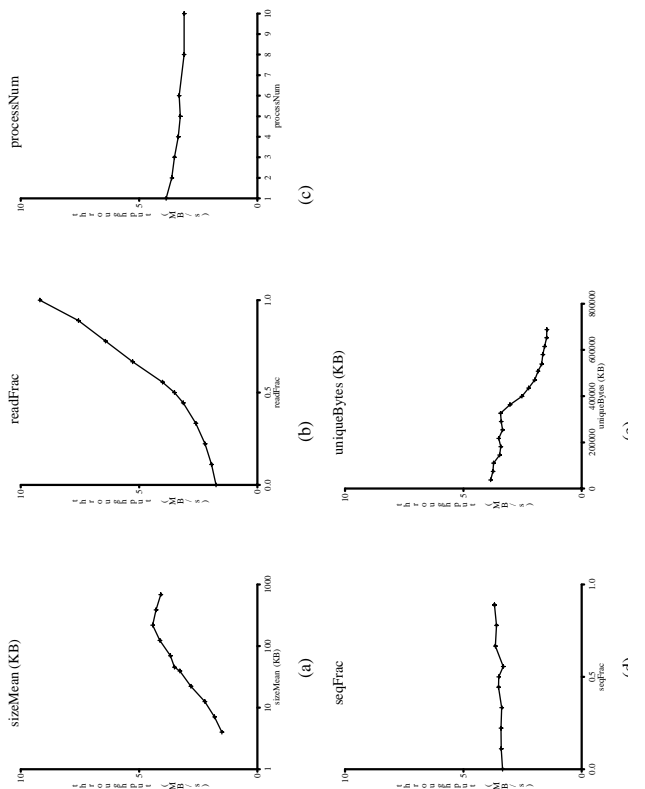
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## Plateau 2 [Convex C240]



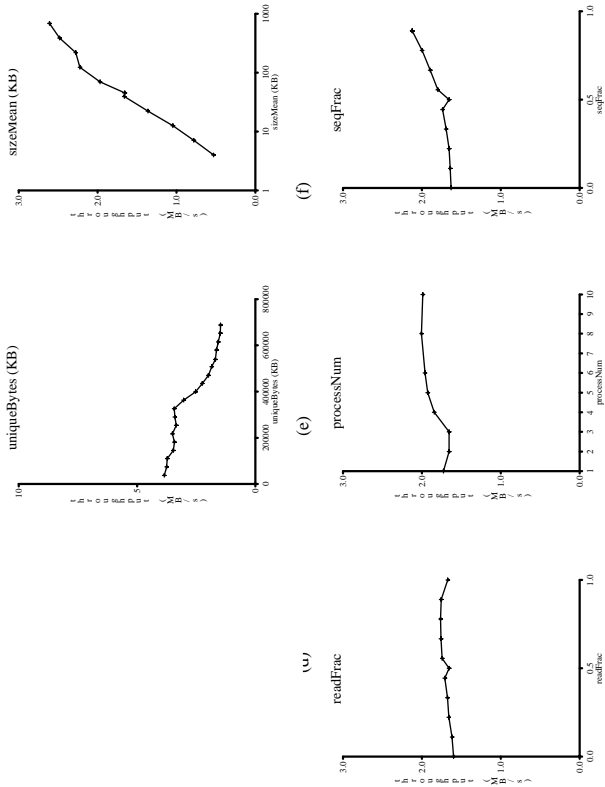
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## Plateau 1 [Solbourne]



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# Plateau 2 [Solbourne]



# Prediction Accuracy

