Jamie L. Zimmerman

Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts

Using Statistical Distributions to Generate Random Test Data

Jamie L. Zimmerman

Robert D. Clark Honors College
Department of Computer and Information Science
University of Oregon

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Overview

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Introduction
Proposed Argument
Architecture
Results
Concluding Thoughts

1 Introduction
2 Proposed Argument
3 Architecture
4 Results
5 Concluding Thoughts

What is Software Testing?

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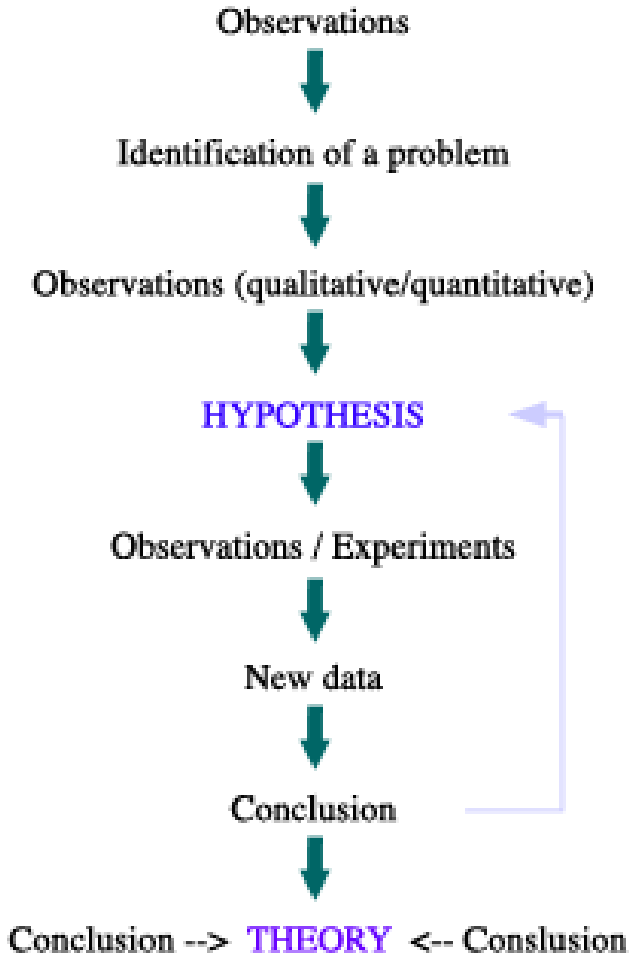
Introduction
Proposed Argument
Architecture
Results
Concluding Thoughts



Why is it so hard?

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Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts

```
files/xoklpenyj/xvrr/xmnyjnm/rrm.exe
files/xoklpenyj/xvrr/xmnyjnm/vvfpm.c
files/xoklpenyj/xvrr/xmnyjnm/vvfpm.h
files/xoklpenyj/xvrr/xmnyjnm/vvfpm.o
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files/xoklpenyj/xvrr/xmnyjnm/xhqyi.h
files/xoklpenyj/xvrr/xmnyjnm/xhqyi.o
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files/xoklpenyj/xvrr/xn/dcwhu.h
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files/xoklpenyj/xvrr/xn/dmqcv.h
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files/xoklpenyj/xvrr/xn/isolg.h
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files/xoklpenyj/yj/witop.o
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files/xqftrpq/cru/wtmyn.c
files/xqftrpq/cru/wtmyn.h
files/xqftrpq/cru/wtmyn.o
files/xqftrpq/fay.tgz
files/xqftrpq/gcq.tgz
files/xqftrpq/vs/lpfqt.h
files/xqftrpq/vs/qywyn.c
files/xqftrpq/vs/qywyn.h
```

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Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts

cis415-2 [Running]

Applications | Terminal - cis415@cis41... | 15:37 | cis415

Terminal - cis415@cis415-arch:~/uoregon-cis415/project2

File Edit View Terminal Tabs Help

```
Info: application 7 has queued write to sector 3592 (blocking)
Info: application 8 has acquired a sector descriptor.
Info: application 8 is queueing write to sector 3987
Info: application 8 has queued write to sector 3987 (blocking)
Info: application 1 has acquired a sector descriptor.
Info: application 1 is queueing write to sector 1175
Info: application 1 has queued write to sector 1175 (nonblocking)
[Device> sector 4004 successfully written by process 2
Info: application 9 has acquired a sector descriptor.
Info: application 9 is queueing read of sector 3854
Info: application 9 has queued read of sector 3854 (blocking)
Info: application 5 has acquired a sector descriptor.
Info: application 5 is queueing write to sector 1111
Info: application 5 has queued write to sector 1111 (nonblocking)
Info: application 3 has acquired a sector descriptor.
Info: application 3 is queueing read of sector 1537
Info: application 3 has queued read of sector 1537 (nonblocking)
Info: application 9 has acquired a sector descriptor.
Info: application 9 is queueing write to sector 3402
Info: application 9 has queued write to sector 3402 (blocking)
Info: application 8 has acquired a sector descriptor.
Info: application 8 is queueing read of sector 3175
Info: application 8 has queued read of sector 3175 (blocking)
Info: application 3 (writer) write to sector 2192 was successful
[Device> sector 1091 successfully written by process 10
Info: application 5 (reader) read from sector 1477 was successful
Info: application 5 (reader) has released a sector descriptor.
Info: application 6 has acquired a sector descriptor.
Info: application 6 is queueing read of sector 821
Info: application 6 has queued read of sector 821 (nonblocking)
Info: application 2 (writer) write to sector 4004 was successful
[Device> sector 3592 successfully written by process 7
Info: application 10 (reader) read from sector 1331 was successful
Info: application 10 (reader) has released a sector descriptor.
Info: application 2 has acquired a sector descriptor.
Info: application 2 is queueing read of sector 117
Info: application 2 has queued read of sector 117 (nonblocking)
[Device> sector 3854 successfully read by process 9
[Device> sector 1537 successfully read by process 3
[Device> sector 3987 successfully written by process 8
Info: application 7 (writer) write to sector 3592 was successful
```

Left ⌘

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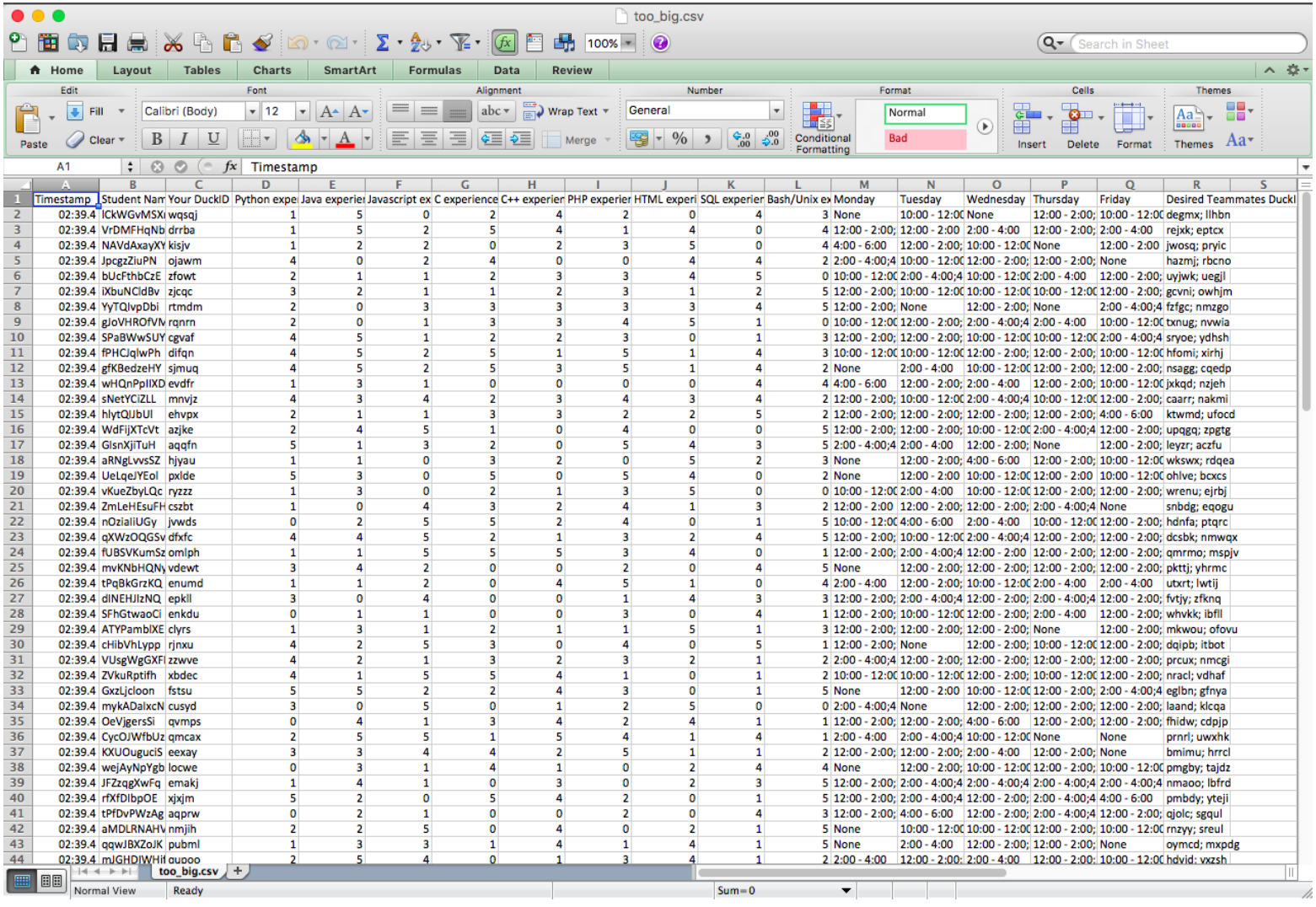
Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts



Timestamp	Student Nam	Your DuckID	Python expe	Java experier	Javascript ex	C experience	C++ experier	PHP experier	HTML experi	SQL experier	Bash/Unix ex	Monday	Tuesday	Wednesday	Thursday	Friday	Desired Teammates Duckl
02:39.4	lCkWGvMSXi	wqsqj	1	5	0	2	4	2	0	4	3	None	10:00 - 12:0	None	12:00 - 2:00;	10:00 - 12:0	degmx; llhbn
02:39.4	VrDMFHqNb	drrba	1	5	2	5	4	1	4	0	4	12:00 - 2:00;	12:00 - 2:00	2:00 - 4:00	12:00 - 2:00;	2:00 - 4:00	rejxk; eptcx
02:39.4	NAVdAxayXY	kisjv	1	2	2	0	2	3	5	0	4	4:00 - 6:00	12:00 - 2:00;	10:00 - 12:0	None	12:00 - 2:00	jwosq; pryic
02:39.4	JpcgzZiuPN	ojawm	4	0	2	4	0	0	4	4	2	2:00 - 4:00;4	10:00 - 12:0	12:00 - 2:00;	12:00 - 2:00;	None	hazmj; rbcno
02:39.4	bUcFthbCzE	zfowt	2	1	1	2	3	3	4	5	0	10:00 - 12:0	2:00 - 4:00;4	10:00 - 12:0	2:00 - 4:00	12:00 - 2:00;	uyjwk; uegjl
02:39.4	iXbuNCldBv	zjcqc	3	2	1	1	2	3	1	2	5	12:00 - 2:00;	10:00 - 12:0	10:00 - 12:0	10:00 - 12:0	12:00 - 2:00;	gcvni; owhjm
02:39.4	YyTQlvpDbi	rtmdm	2	0	3	3	3	3	3	4	5	12:00 - 2:00;	None	12:00 - 2:00;	None	2:00 - 4:00;4	fzfgc; nmzgo
02:39.4	gJoVHROfVM	rqnrn	2	0	1	3	3	4	5	1	0	10:00 - 12:0	12:00 - 2:00;	2:00 - 4:00;4	2:00 - 4:00	10:00 - 12:0	txnug; nvwia
02:39.4	SPaBWwSUY	cgvaf	4	5	1	2	2	3	0	1	3	12:00 - 2:00;	12:00 - 2:00;	10:00 - 12:0	10:00 - 12:0	2:00 - 4:00;4	sryoe; ydhsh
02:39.4	fPHCJqlwPh	difqn	4	5	2	5	1	5	1	4	3	10:00 - 12:0	10:00 - 12:0	12:00 - 2:00;	12:00 - 2:00;	10:00 - 12:0	hfomi; xirhj
02:39.4	gfKBedzeHY	sjmuq	4	5	2	5	3	5	1	4	2	None	2:00 - 4:00	10:00 - 12:0	12:00 - 2:00;	12:00 - 2:00;	nsagg; cqedp
02:39.4	wHQnPpIIXD	evdfr	1	3	1	0	0	0	0	4	4	4:00 - 6:00	12:00 - 2:00;	2:00 - 4:00	12:00 - 2:00;	10:00 - 12:0	jxkqd; nzjeh
02:39.4	sNetYCiZLL	mnvjz	4	3	4	2	3	4	3	4	2	12:00 - 2:00;	10:00 - 12:0	2:00 - 4:00;4	10:00 - 12:0	12:00 - 2:00;	caarr; nakmi
02:39.4	hlytQlJbUl	ehvpx	2	1	1	3	3	2	2	5	2	12:00 - 2:00;	12:00 - 2:00;	12:00 - 2:00;	12:00 - 2:00;	4:00 - 6:00	ktwmd; ufocd
02:39.4	WdFijXTcVt	azjke	2	4	5	1	0	4	0	0	5	12:00 - 2:00;	12:00 - 2:00;	10:00 - 12:0	2:00 - 4:00;4	12:00 - 2:00;	upqgq; zpgtg
02:39.4	GlsnXjiTuH	aqqfn	5	1	3	2	0	5	4	3	5	2:00 - 4:00;4	2:00 - 4:00	12:00 - 2:00;	None	12:00 - 2:00;	leyzr; aczfu
02:39.4	aRNgLvvsSZ	hjyau	1	1	0	3	2	0	5	2	3	None	12:00 - 2:00;	4:00 - 6:00	12:00 - 2:00;	10:00 - 12:0	wkswx; rdqea
02:39.4	UeLqeJYEol	pxlde	5	3	0	5	0	5	4	0	2	None	12:00 - 2:00	10:00 - 12:0	12:00 - 2:00	10:00 - 12:0	ohlve; bcxcs
02:39.4	vKueZbyLQc	ryzzz	1	3	0	2	1	3	5	0	0	10:00 - 12:0	2:00 - 4:00	10:00 - 12:0	12:00 - 2:00;	12:00 - 2:00;	wrenu; ejrbj
02:39.4	ZmLeHEsuFH	cszbt	1	0	4	3	2	4	1	3	2	12:00 - 2:00	12:00 - 2:00;	12:00 - 2:00;	2:00 - 4:00;4	None	snbdg; eqogu
02:39.4	nOzialiUGy	jvwds	0	2	5	5	2	4	0	1	5	10:00 - 12:0	4:00 - 6:00	2:00 - 4:00	10:00 - 12:0	12:00 - 2:00;	hdnfa; ptqrc
02:39.4	qXWzOQGSv	dfxfc	4	4	5	2	1	3	2	4	5	12:00 - 2:00;	10:00 - 12:0	2:00 - 4:00;4	12:00 - 2:00;	12:00 - 2:00;	dcsbk; nmwqx
02:39.4	fUBSVKumSz	omlph	1	1	5	5	5	3	4	0	1	12:00 - 2:00;	2:00 - 4:00;4	12:00 - 2:00	12:00 - 2:00;	12:00 - 2:00;	qmrmo; mspjv
02:39.4	mvKNbHQNy	vdewt	3	4	2	0	0	2	0	4	5	None	12:00 - 2:00;	12:00 - 2:00;	12:00 - 2:00;	12:00 - 2:00;	pkttj; yhrmc
02:39.4	tPqBkGrzKQ	enumd	1	1	2	0	4	5	1	0	4	2:00 - 4:00	12:00 - 2:00;	10:00 - 12:0	2:00 - 4:00	2:00 - 4:00	utxrt; lwtij
02:39.4	dlNEHJIzNQ	epkll	3	0	4	0	0	1	4	3	3	12:00 - 2:00;	2:00 - 4:00;4	12:00 - 2:00;	2:00 - 4:00;4	12:00 - 2:00;	fvtjy; zfknq
02:39.4	SFhGtwaoCi	enkdu	0	1	1	0	0	3	0	4	1	12:00 - 2:00;	10:00 - 12:0	12:00 - 2:00;	2:00 - 4:00	12:00 - 2:00;	whvkk; ibfll
02:39.4	ATYPamblXE	clyrs	1	3	1	2	1	1	5	1	3	12:00 - 2:00;	12:00 - 2:00;	12:00 - 2:00;	None	12:00 - 2:00;	mkwou; ofovu
02:39.4	cHibVhLypp	rjnxu	4	2	5	3	0	4	0	5	1	12:00 - 2:00;	None	12:00 - 2:00;	10:00 - 12:0	12:00 - 2:00;	dqipb; itbot
02:39.4	VUsgWgGXFl	zzwve	4	2	1	3	2	3	2	1	2	2:00 - 4:00;4	12:00 - 2:00;	12:00 - 2:00;	12:00 - 2:00;	12:00 - 2:00;	prcux; nmcgi
02:39.4	ZVkuRptifh	xbdec	4	1	5	5	4	1	0	1	2	10:00 - 12:0	10:00 - 12:0	12:00 - 2:00;	10:00 - 12:0	12:00 - 2:00;	nracl; vdhaf
02:39.4	GxzLjcloon	fstsu	5	5	2	2	4	3	0	1	5	None	12:00 - 2:00	10:00 - 12:0	12:00 - 2:00;	2:00 - 4:00;4	eglbn; gfnya
02:39.4	mykADaIxcN	cusyd	3	0	5	0	1	2	5	0	0	2:00 - 4:00;4	None	12:00 - 2:00;	12:00 - 2:00;	12:00 - 2:00;	laand; klcqa
02:39.4	OeVjgersSi	qvmps	0	4	1	3	4	2	4	1	1	12:00 - 2:00;	12:00 - 2:00;	4:00 - 6:00	12:00 - 2:00;	12:00 - 2:00;	fhidw; cdpjp
02:39.4	CycOJWfbUz	qmcax	2	5	5	1	5	4	1	4	1	2:00 - 4:00	2:00 - 4:00;4	10:00 - 12:0	None	None	prnrl; uwxhk
02:39.4	KXUOuguciS	eexay	3	3	4	4	2	5	1	1	2	12:00 - 2:00;	12:00 - 2:00;	2:00 - 4:00	12:00 - 2:00;	None	bmimu; hrrcl
02:39.4	wejAyNpYgb	locwe	0	3	1	4	1	0	2	4	4	None	12:00 - 2:00;	10:00 - 12:0	12:00 - 2:00;	10:00 - 12:0	pmgby; tajdz
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02:39.4	rfXfDlbpOE	xjxjm	5	2	0	5	4	2	0	1	5	12:00 - 2:00;	2:00 - 4:00;4	12:00 - 2:00;	2:00 - 4:00;4	4:00 - 6:00	pmbdy; yteji
02:39.4	tPfDvPWzAg	aqprw	0	2	1	0	0	2	0	4	3	12:00 - 2:00;	4:00 - 6:00	12:00 - 2:00;	2:00 - 4:00;4	12:00 - 2:00;	qjolc; sgqul
02:39.4	aMDLRNAHv	nmjih	2	2	5	0	4	0	2	1	5	None	10:00 - 12:0	10:00 - 12:0	12:00 - 2:00;	10:00 - 12:0	rnzyy; sreul
02:39.4	qqwJBXZoJK	pubml	1	3	3	1	4	1	4	1	5	None	2:00 - 4:00	12:00 - 2:00;	12:00 - 2:00;	None	oymcd; mxpdg
02:39.4	mJGHDlWHif	qupoo	2	5	4	0	1	3	4	1	2	2:00 - 4:00	12:00 - 2:00;	2:00 - 4:00	12:00 - 2:00;	10:00 - 12:0	hdvid; vxzsh

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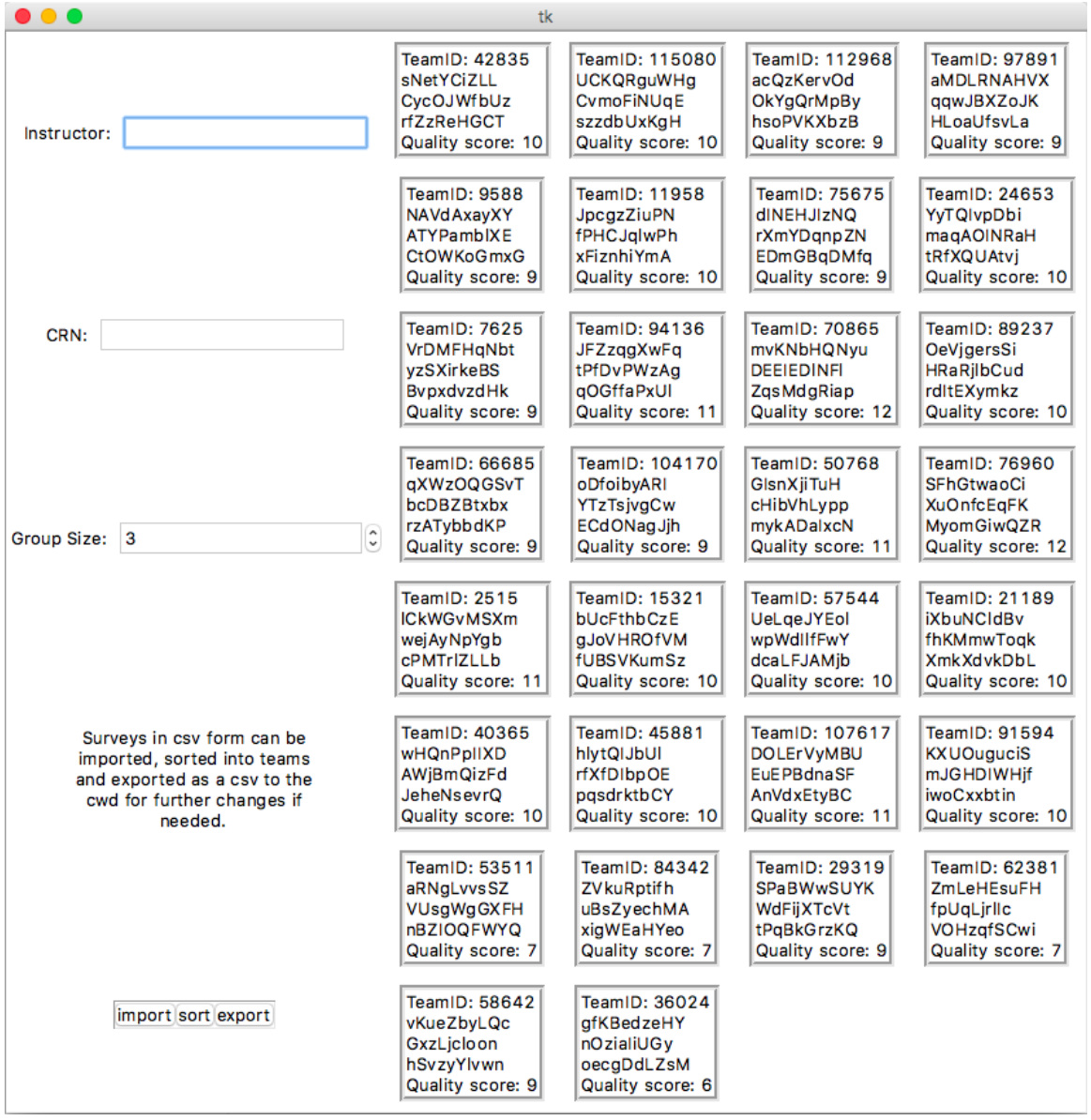
Introduction

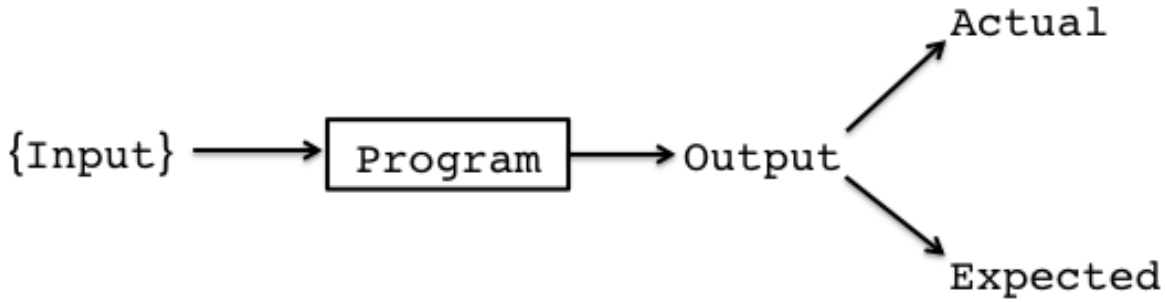
Proposed Argument

Architecture

Results

Concluding Thoughts




{Input}
Program
Output
Actual
Expected

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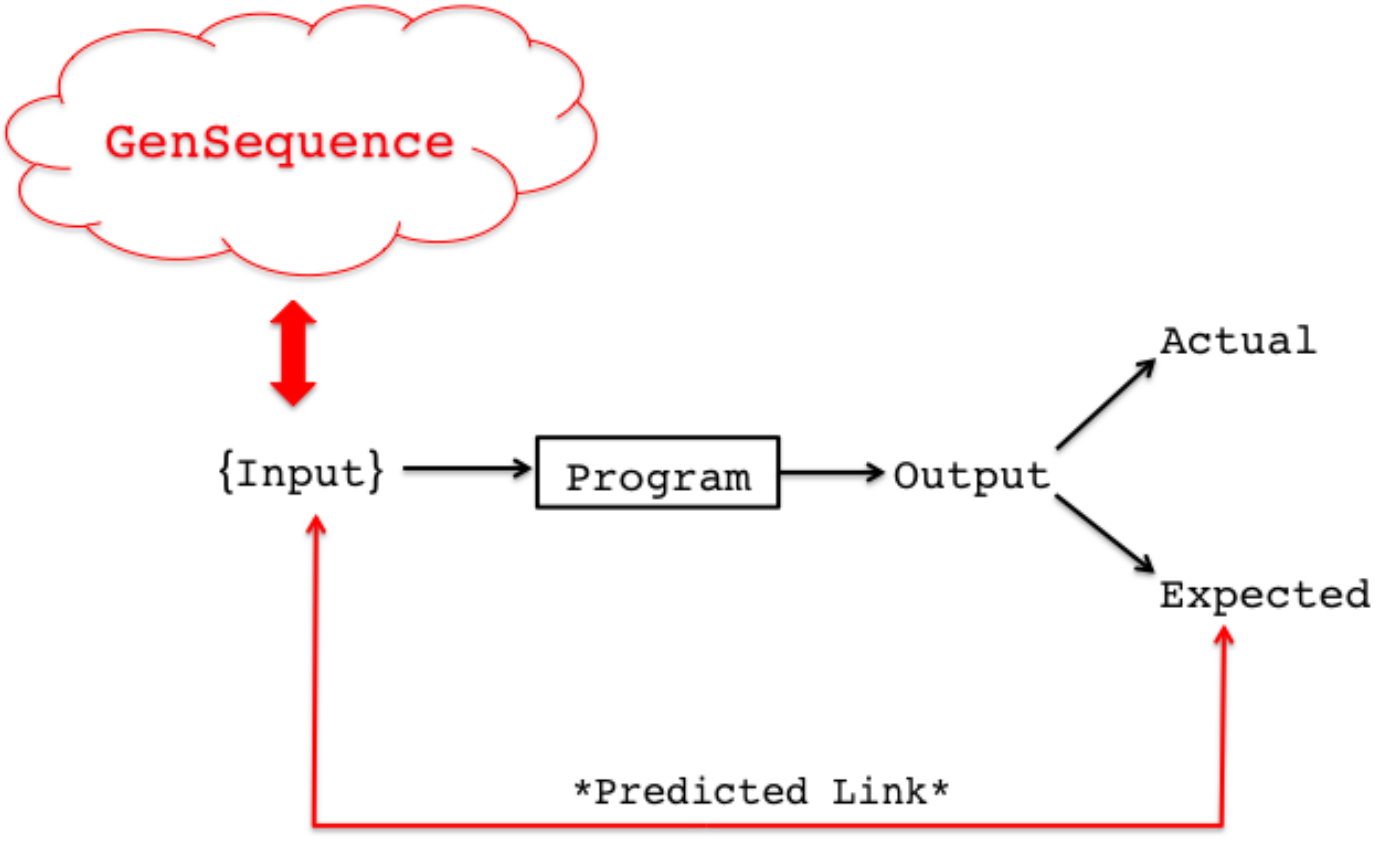
Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts



Well if it's so hard why bother?

5

An Investigation of the Therac-25 Accidents

Nancy G. Leveson, University of Washington
Clark S. Turner, University of California, Irvine

Computers are increasingly being introduced into safety-critical systems and, as a consequence, have been involved in accidents. Some of the most widely cited software-related accidents in safety-critical systems involved a computerized radiation therapy machine called the Therac-25. Between June 1985 and January 1987, six known accidents involved massive overdoses by the Therac-25 — with resultant deaths and serious injuries. They have been described as the worst series of radiation accidents in the 35-year history of medical accelerators.[1]

Overview

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Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts

1 Introduction

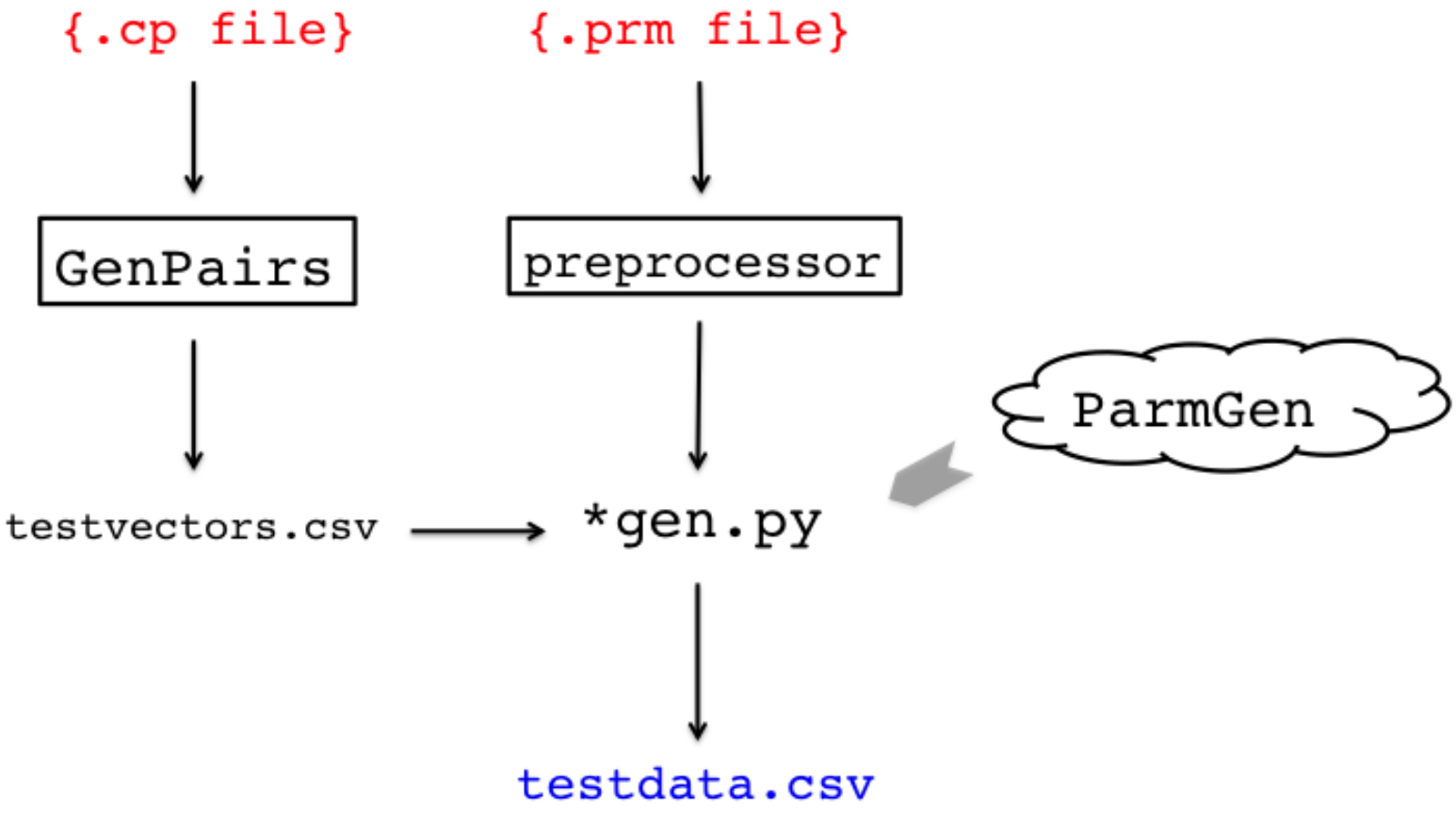
2 Proposed Argument

3 Architecture

4 Results

5 Concluding Thoughts

GenSequence



Goals

- Ease of use - as much end-to-end automation as possible
- Insight into what the input looks like

Overview

1 Introduction

2 Proposed Argument

3 Architecture

4 Results

5 Concluding Thoughts

Pairwise Testing

NEC
Empowered by Innovation

Pairwise Testing

University of Waterloo

- The total number of all-combination test cases is $2 \times 2 \times 2 = 8$
- However, a subset of four test cases, as shown in Table 9.5, covers all pairwise combinations

Test Case Id	Input X	Input Y	Input Z
TC_1	$True$	0	Q
TC_2	$True$	5	R
TC_3	$False$	0	Q
TC_4	$False$	5	R

Table 9.5: Pairwise test cases for system S.

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Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts

Constrained Randomness

100 points

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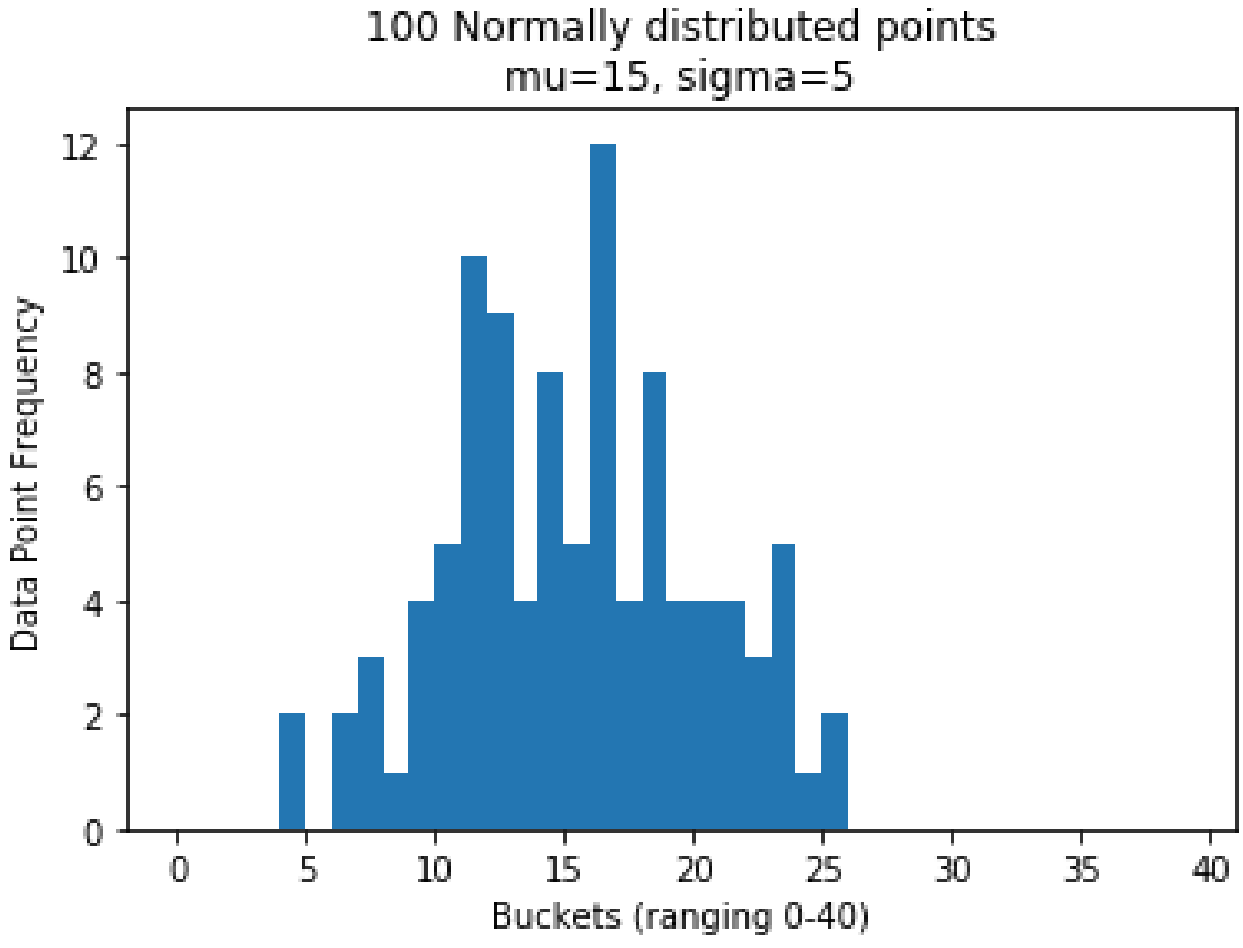
Introduction
Proposed Argument
Architecture
Results
Concluding Thoughts



Law of Large Numbers

- Bernoulli's Principle
- Selection Scheme

10,000 points

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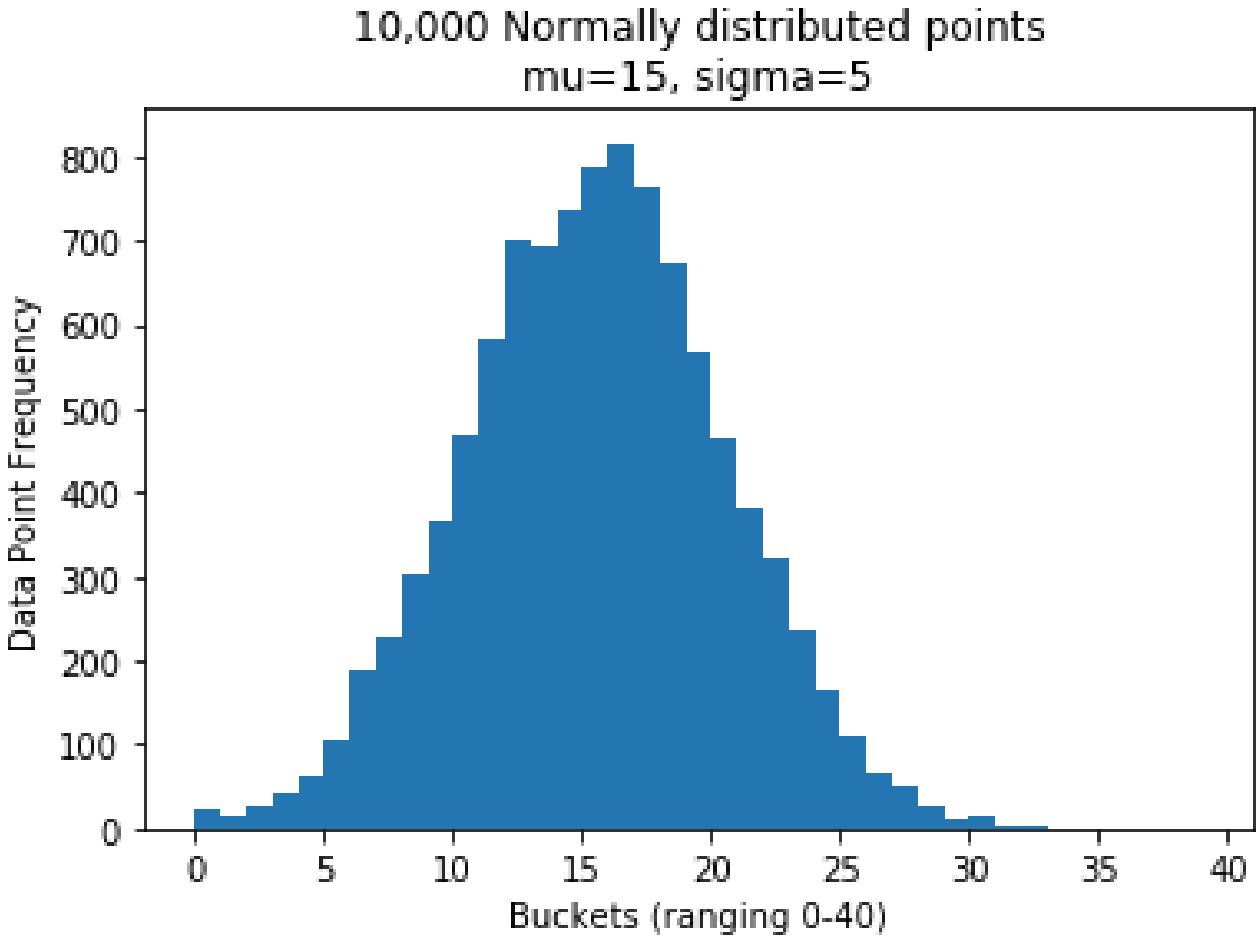
Introduction
Proposed Argument
Architecture
Results
Concluding Thoughts



300 points

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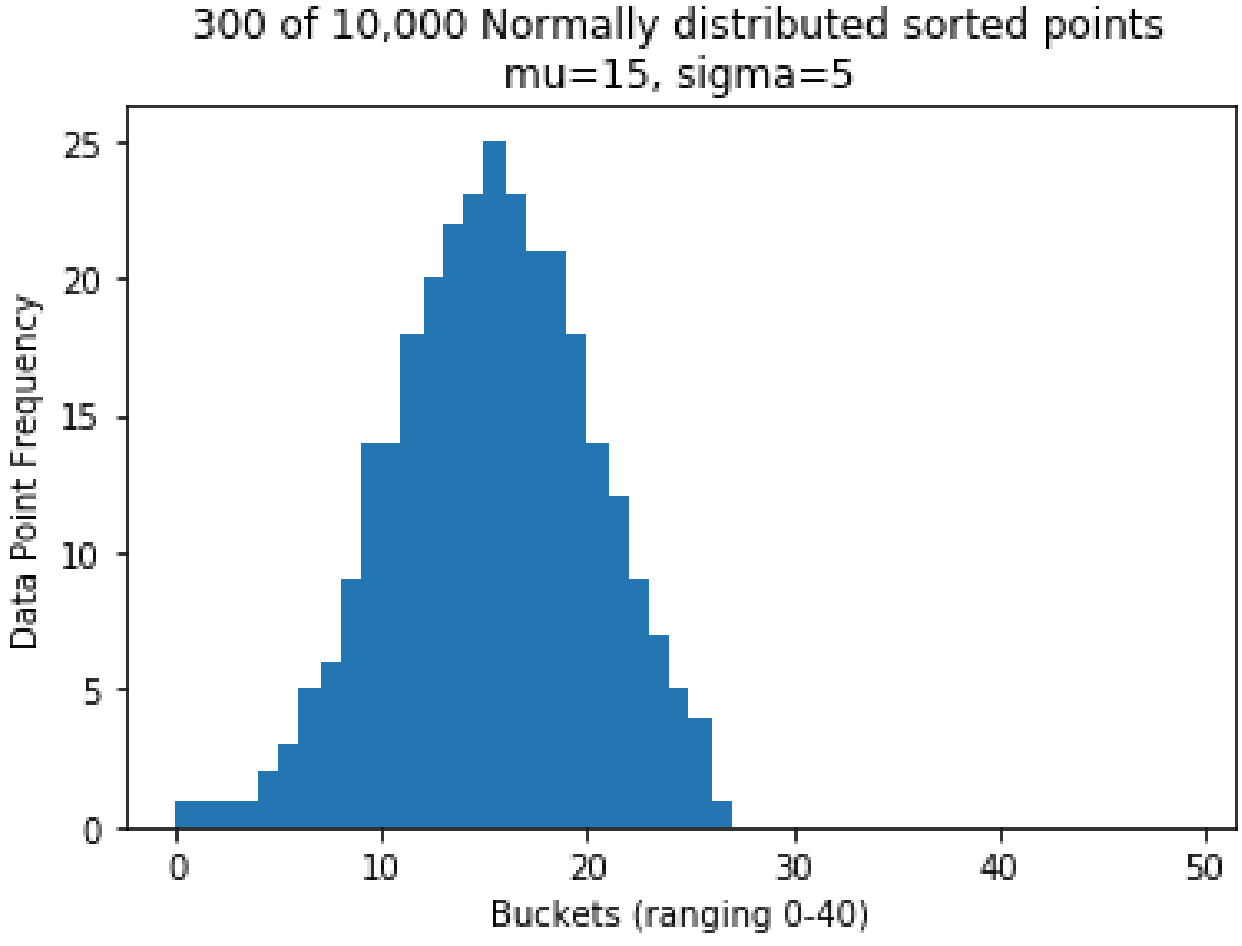
Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts



Cardioids

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Introduction

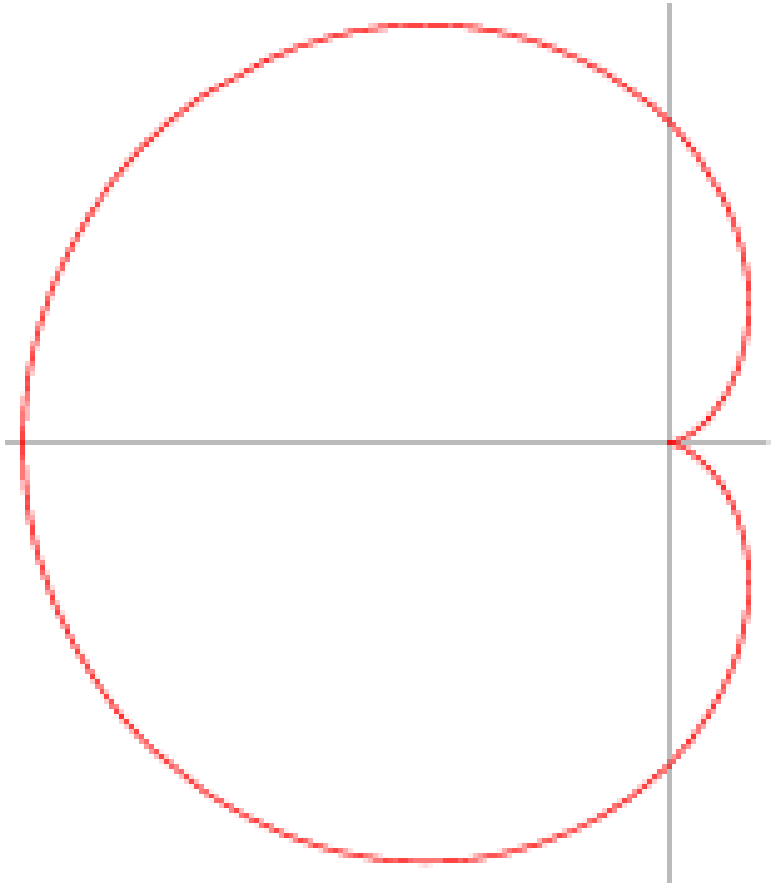
Proposed Argument

Architecture

Results

Concluding Thoughts

$$r = \alpha \pm \alpha cos\theta$$



Overview

1 Introduction

2 Proposed Argument

3 Architecture

4 Results

5 Concluding Thoughts

Orbits Simulation

13-70-mass|right_slanted-position|right_slanted-velocity|uniform-diameter|left_slanted.csv

- Case 13
- 70 bodies
- Mass - right-slant
- Position - right-slant
- Velocity - uniform
- Diameter - left-slant

Starting Orbits

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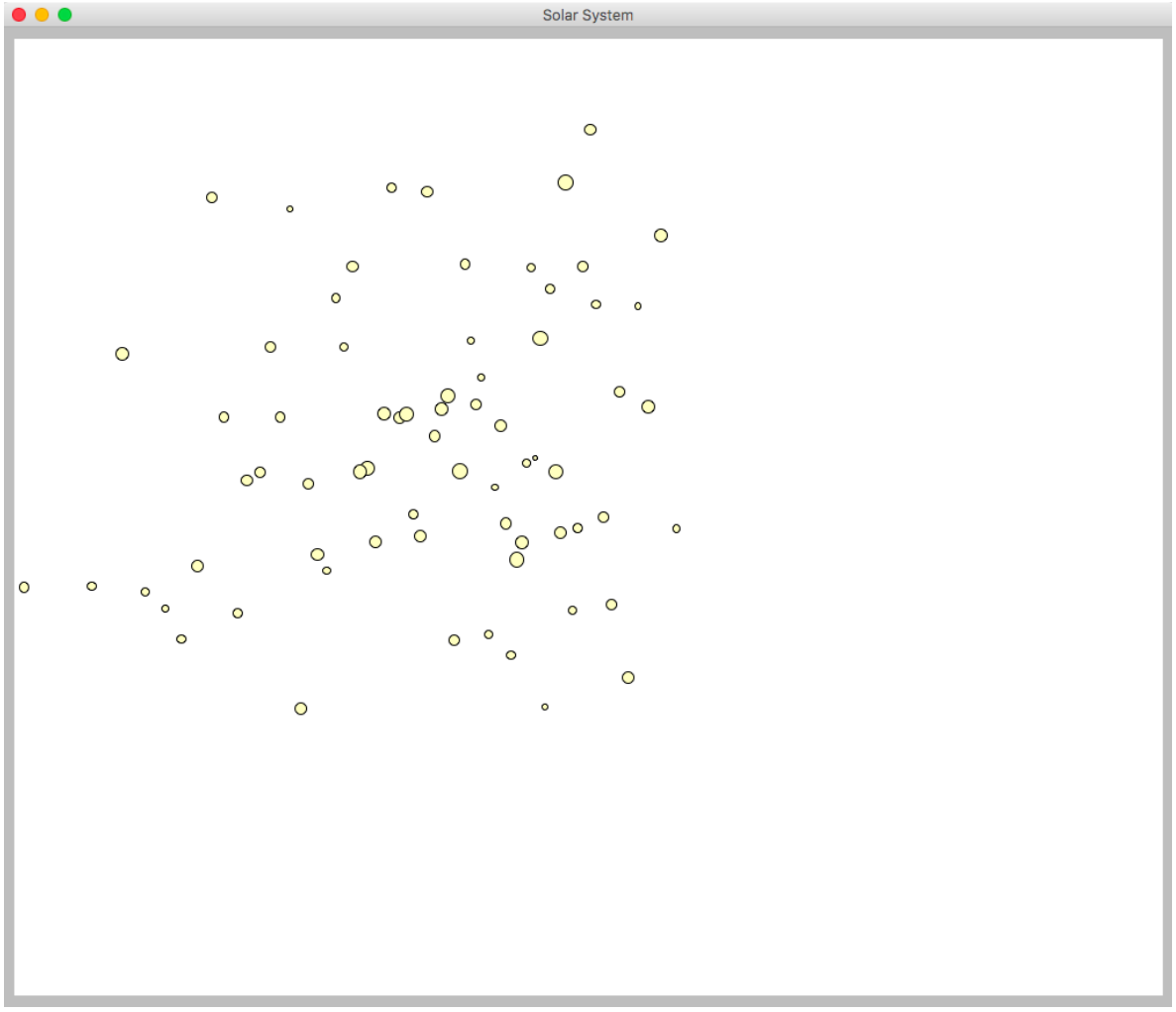
Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts



Starting Observations

- Sizes are mostly small-medium (from left-slant distribution)
- Locations are clustered (from right-slant distribution)

Ending Orbits

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Introduction

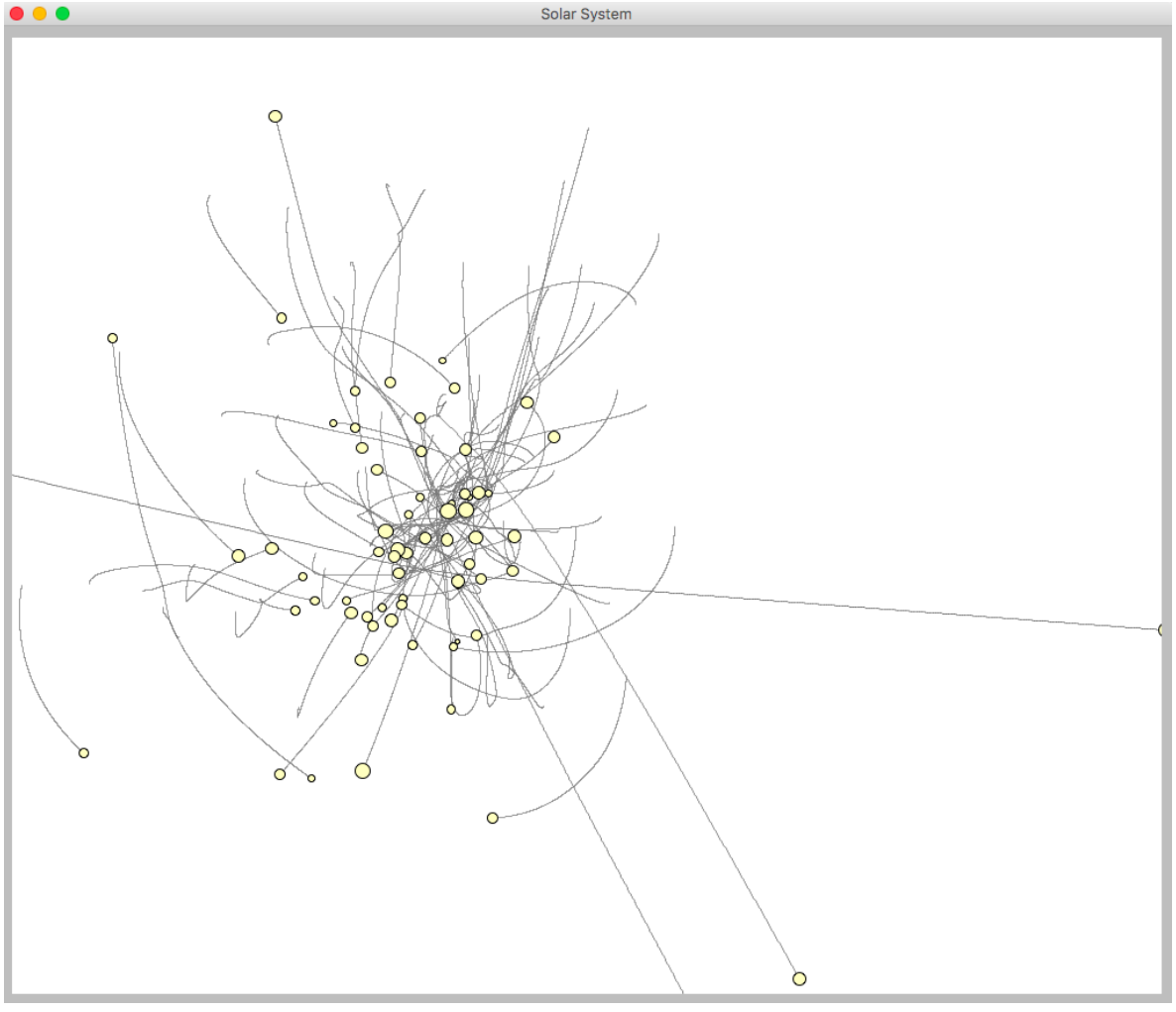
Proposed Argument

Architecture

Results

Concluding Thoughts

665 time steps



Ending Observations

- Behavior of gravity
- Path lengths are all different (from uniform velocity)

Earthquake Analysis

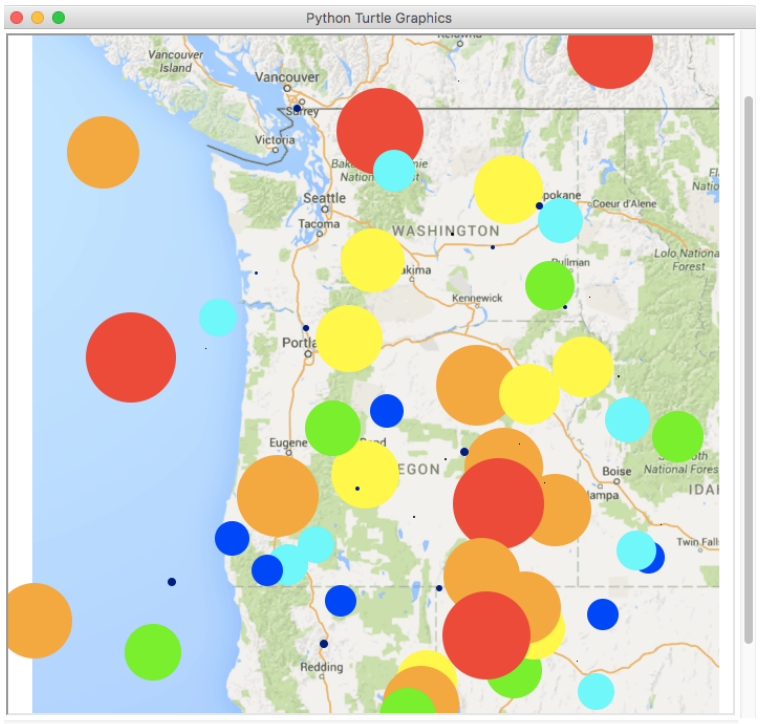
6-70-magnitudes|cardioid-latitudes|left_slanted-longitudes|right_slanted-depths|cardioid.csv

- Case 6
- 70 quake events
- Magnitude & Depth - Cardioid relationship
- Trend: High Magnitude $\rightarrow$ High Depth
- Low Magnitude $\rightarrow$ Low Depth
- Latitudes - left-slant
- Longitudes - right-slant

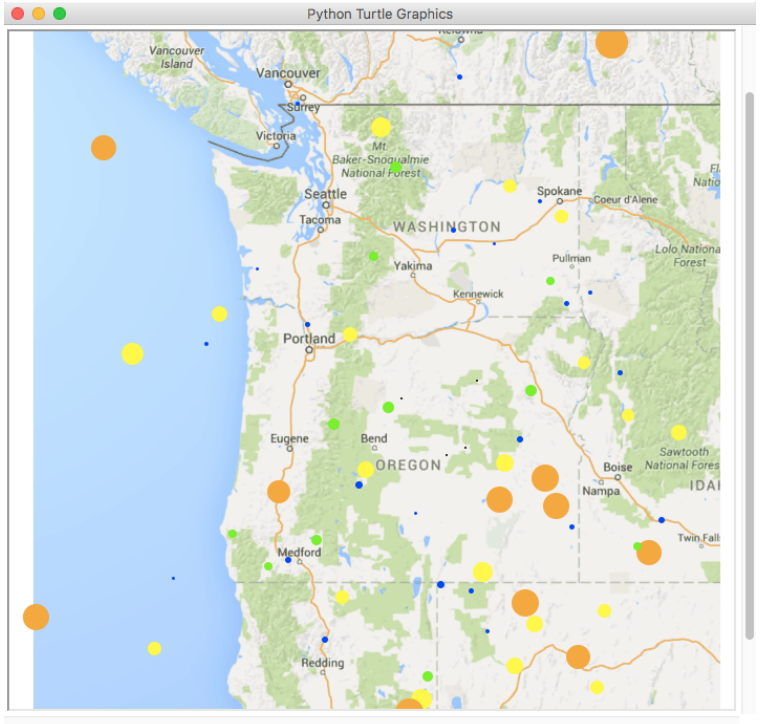
Magnitudes & Depths

Jamie L. Zimmerman

Introduction
Proposed Argument
Architecture
Results
Concluding Thoughts



(a) Magnitudes



(b) Depths

Observations

- Mostly predicted events?
- Any outliers?

Predict

- North - Up
- West - Left
- East - Right
- South - Down
- right-slanted is high numbers
- left-slanted is low numbers
- right-leaning longitudes
- left-leaning latitudes
- Quakes drift towards lower-right corner

Latitudes & Longitudes

Jamie L. Zimmerman

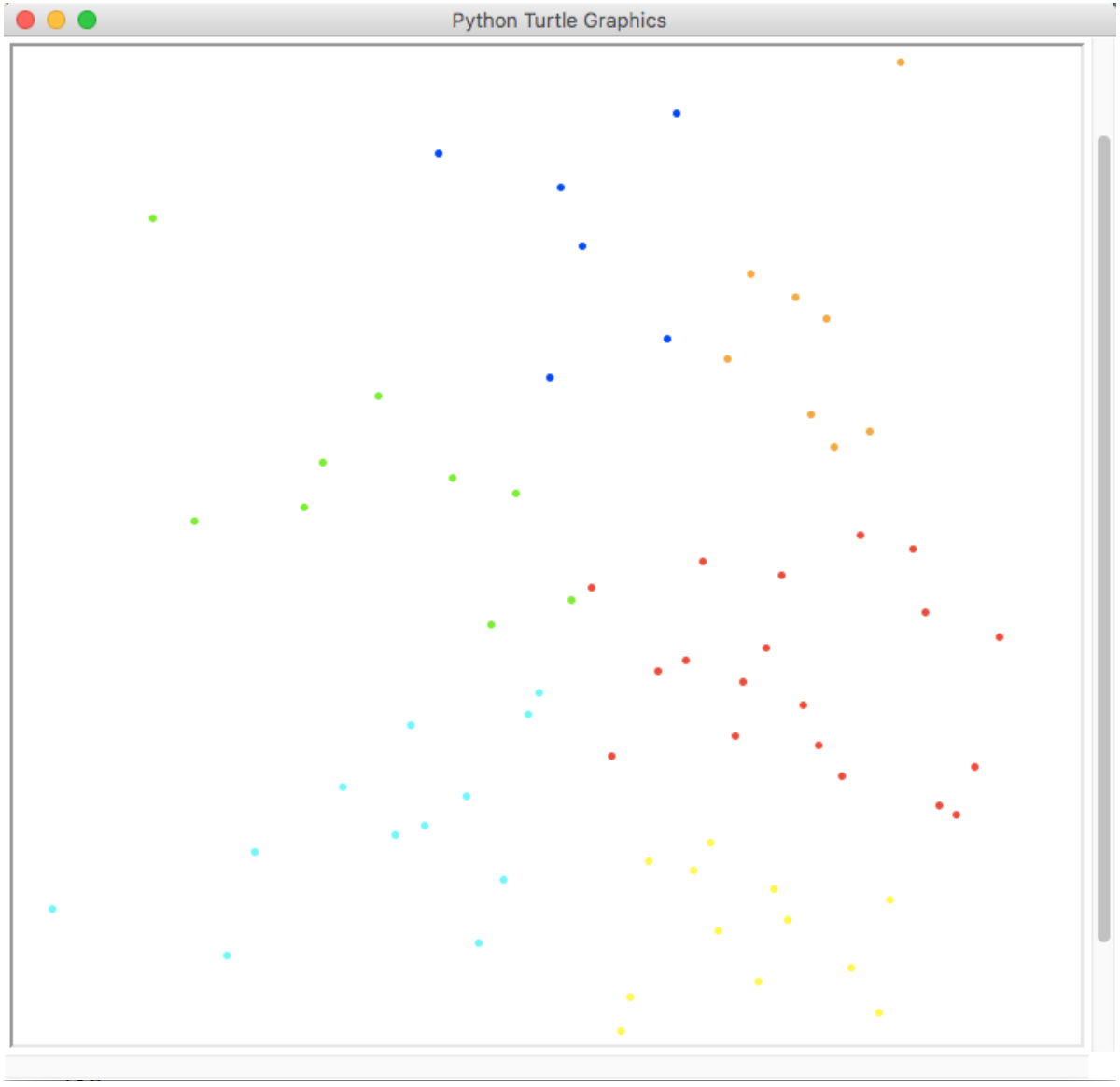
Introduction

Proposed Argument

Architecture

Results

Concluding Thoughts



Overview

1 Introduction

2 Proposed Argument

3 Architecture

4 Results

5 Concluding Thoughts

GenSequence in all its Power

- It is what it says it is
- Nearly end-to-end automation
- Knowing about input informs the expected output?

Future Work

- Test GenSequence against an open-source project
- Machine Learning Models
- Database-Driven Applications
- Combine user-written spec files