

Learning How to Teach Computer Science – And Why I Teach the Way I Do

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Professor of the Practice

Duke University

Durham, NC USA

So Many People To Thank!

- My Husband and Family
- My mentors
- So many colleagues
 - AP CS, SIGCSE, ITiCSE Working Groups, Algorithm Visualization, JFLAP, Alice, CRA-WP, Rensselaer, Duke, ...
- So many students



Thanks to Steve Wolfman and Gary Lewendoski for the SIGCSE 2010 scarf!

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2

My Journey starts Way Back

- Very shy
- Me and my sisters
 - May 1970
- Solved a lot of puzzles
- Loved Math
- Interest in teaching

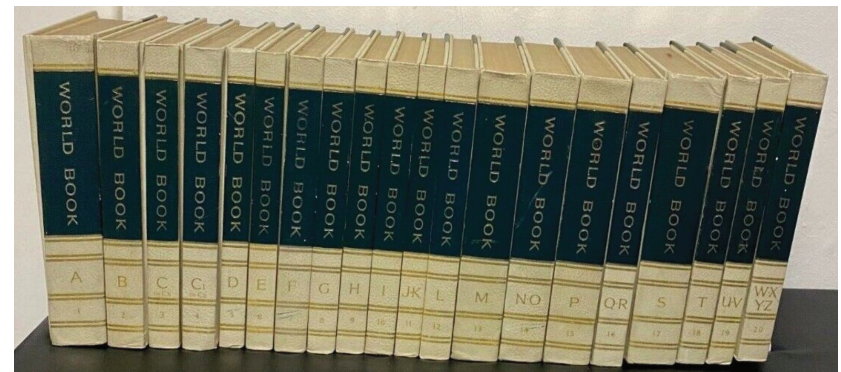


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3

My World Wide Web



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4

Computers?

- My Dad started ADP with Don Harley
- Large Disk drives and tape drives
- No computers in my H.S.



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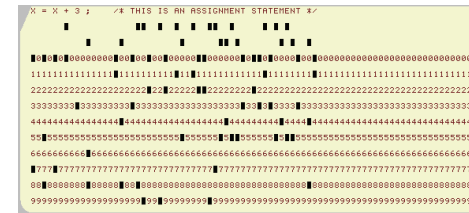
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College – North Carolina State University



- Liked Math a lot
- Took programming course first semester
 - PL/1

```
Hello2: proc options(main);
      put list ('Hello, world!');
end Hello2;
```

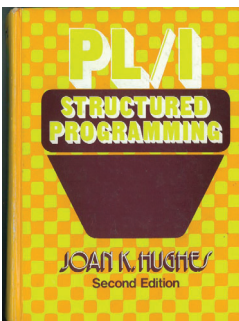


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6

PL/1 Structured Programming by Hughes



Contents

Chapter	
1	Introduction to PL/I 1
2	Top-Down Structured Programming 41
3	Data Types and Data Manipulation 101
4	Logical Testing 175
5	Table Handling 245
6	File Declarations and Stream I/O 313
7	Record I/O, Structures, Pictures 387
8	File Processing 473
9	Subroutines and Functions 563
10	List Processing and Storage Classes 601
Appendix	
A	Answers to Checkpoint Questions 663
B	Built-In Functions 691
C	PL/I Language Comparison Charts 706
D	IBM Data Formats 756
E	Glossary of PL/I Terms 776
Index	803

March 17, 2023

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7

PL/1 Program – Table for Powers of 2

766 PL/I Structured Programming

Positive Binary Values		Absolute Values		Negative Binary Values	
Bit Position	Decimal Equivalent	Bit Position	Decimal Equivalent	Bit Position	Decimal Equivalent
0123 4567 8901 2345 6789 0123 4567 8901		0123 4567 8901 2345 6789 0123 4567 8901		0123 4567 8901 2345 6789 0123 4567 8901	
0000 0000 0000 0000 0000 0000 0000 0000	0	0	0	1111 1111 1111 1111 1111 1111 1111 1111	-1
0000 0000 0000 0000 0000 0000 0000 0001	1	1	1	1111 1111 1111 1111 1111 1111 1111 1110	-2
0000 0000 0000 0000 0000 0000 0000 0010	2	2	2	1111 1111 1111 1111 1111 1111 1111 1101	-4
0000 0000 0000 0000 0000 0000 0000 0011	3	3	3	1111 1111 1111 1111 1111 1111 1111 1100	-8
0000 0000 0000 0000 0000 0000 0000 0100	4	4	4	1111 1111 1111 1111 1111 1111 1111 1011	-16
0000 0000 0000 0000 0000 0000 0000 0101	5	5	5	1111 1111 1111 1111 1111 1111 1111 1010	-32
0000 0000 0000 0000 0000 0000 0000 0110	6	6	6	1111 1111 1111 1111 1111 1111 1111 1001	-64
0000 0000 0000 0000 0000 0000 0000 0111	7	7	7	1111 1111 1111 1111 1111 1111 1111 1000	-128
0000 0000 0000 0000 0000 0000 0001 0000	8	8	8	1111 1111 1111 1111 1111 1111 1110 0000	-256
0000 0000 0000 0000 0000 0000 0001 0001	9	9	9	1111 1111 1111 1111 1111 1111 1110 0001	-512
0000 0000 0000 0000 0000 0000 0001 0010	10	10	10	1111 1111 1111 1111 1111 1111 1110 0010	-1024
0000 0000 0000 0000 0000 0000 0001 0011	11	11	11	1111 1111 1111 1111 1111 1111 1110 0011	-2048
0000 0000 0000 0000 0000 0000 0001 0100	12	12	12	1111 1111 1111 1111 1111 1111 1110 0100	-4096
0000 0000 0000 0000 0000 0000 0001 0101	13	13	13	1111 1111 1111 1111 1111 1111 1110 0101	-8192
0000 0000 0000 0000 0000 0000 0001 0110	14	14	14	1111 1111 1111 1111 1111 1111 1110 0110	-16384
0000 0000 0000 0000 0000 0000 0001 0111	15	15	15	1111 1111 1111 1111 1111 1111 1110 0111	-32768
0000 0000 0000 0000 0000 0000 0010 0000	16	16	16	1111 1111 1111 1111 1111 1111 1101 0000	-65536
0000 0000 0000 0000 0000 0000 0010 0001	17	17	17	1111 1111 1111 1111 1111 1111 1101 0001	-131072
0000 0000 0000 0000 0000 0000 0010 0010	18	18	18	1111 1111 1111 1111 1111 1111 1101 0010	-262144
0000 0000 0000 0000 0000 0000 0010 0011	19	19	19	1111 1111 1111 1111 1111 1111 1101 0011	-524288
0000 0000 0000 0000 0000 0000 0010 0100	20	20	20	1111 1111 1111 1111 1111 1111 1101 0100	-1048576
0000 0000 0000 0000 0000 0000 0010 0101	21	21	21	1111 1111 1111 1111 1111 1111 1101 0101	-2097152
0000 0000 0000 0000 0000 0000 0010 0110	22	22	22	1111 1111 1111 1111 1111 1111 1101 0110	-4194304
0000 0000 0000 0000 0000 0000 0010 0111	23	23	23	1111 1111 1111 1111 1111 1111 1101 0111	-8388608
0000 0000 0000 0000 0000 0000 0011 0000	24	24	24	1111 1111 1111 1111 1111 1111 1100 0000	-16777216
0000 0000 0000 0000 0000 0000 0011 0001	25	25	25	1111 1111 1111 1111 1111 1111 1100 0001	-33554432
0000 0000 0000 0000 0000 0000 0011 0010	26	26	26	1111 1111 1111 1111 1111 1111 1100 0010	-67108864
0000 0000 0000 0000 0000 0000 0011 0011	27	27	27	1111 1111 1111 1111 1111 1111 1100 0011	-134217728
0000 0000 0000 0000 0000 0000 0011 0100	28	28	28	1111 1111 1111 1111 1111 1111 1100 0100	-268435456
0000 0000 0000 0000 0000 0000 0011 0101	29	29	29	1111 1111 1111 1111 1111 1111 1100 0101	-536870912
0000 0000 0000 0000 0000 0000 0011 0110	30	30	30	1111 1111 1111 1111 1111 1111 1100 0110	-1073741824
0000 0000 0000 0000 0000 0000 0011 0111	31	31	31	1111 1111 1111 1111 1111 1111 1100 0111	-2147483648
0000 0000 0000 0000 0000 0000 0100 0000	32	32	32	1111 1111 1111 1111 1111 1111 1011 0000	-4294967296
0000 0000 0000 0000 0000 0000 0100 0001	33	33	33	1111 1111 1111 1111 1111 1111 1011 0001	-8589934592
0000 0000 0000 0000 0000 0000 0100 0010	34	34	34	1111 1111 1111 1111 1111 1111 1011 0010	-17179869184
0000 0000 0000 0000 0000 0000 0100 0011	35	35	35	1111 1111 1111 1111 1111 1111 1011 0011	-34359738368
0000 0000 0000 0000 0000 0000 0100 0100	36	36	36	1111 1111 1111 1111 1111 1111 1011 0100	-68719476736
0000 0000 0000 0000 0000 0000 0100 0101	37	37	37	1111 1111 1111 1111 1111 1111 1011 0101	-137438953472
0000 0000 0000 0000 0000 0000 0100 0110	38	38	38	1111 1111 1111 1111 1111 1111 1011 0110	-274877906944
0000 0000 0000 0000 0000 0000 0100 0111	39	39	39	1111 1111 1111 1111 1111 1111 1011 0111	-549755813888
0000 0000 0000 0000 0000 0000 0101 0000	40	40	40	1111 1111 1111 1111 1111 1111 1010 0000	-1099511627776
0000 0000 0000 0000 0000 0000 0101 0001	41	41	41	1111 1111 1111 1111 1111 1111 1010 0001	-2199023255552
0000 0000 0000 0000 0000 0000 0101 0010	42	42	42	1111 1111 1111 1111 1111 1111 1010 0010	-4398046511104
0000 0000 0000 0000 0000 0000 0101 0011	43	43	43	1111 1111 1111 1111 1111 1111 1010 0011	-8796093022208
0000 0000 0000 0000 0000 0000 0101 0100	44	44	44	1111 1111 1111 1111 1111 1111 1010 0100	-17592186044416
0000 0000 0000 0000 0000 0000 0101 0101	45	45	45	1111 1111 1111 1111 1111 1111 1010 0101	-35184372088832
0000 0000 0000 0000 0000 0000 0101 0110	46	46	46	1111 1111 1111 1111 1111 1111 1010 0110	-70368744177664
0000 0000 0000 0000 0000 0000 0101 0111	47	47	47	1111 1111 1111 1111 1111 1111 1010 0111	-140737488355328
0000 0000 0000 0000 0000 0000 0110 0000	48	48	48	1111 1111 1111 1111 1111 1111 1011 0000	-281474976710656
0000 0000 0000 0000 0000 0000 0110 0001	49	49	49	1111 1111 1111 1111 1111 1111 1011 0001	-562949953421312
0000 0000 0000 0000 0000 0000 0110 0010	50	50	50	1111 1111 1111 1111 1111 1111 1011 0010	-1125899906842624
0000 0000 0000 0000 0000 0000 0110 0011	51	51	51	1111 1111 1111 1111 1111 1111 1011 0011	-2251799813685248
0000 0000 0000 0000 0000 0000 0110 0100	52	52	52	1111 1111 1111 1111 1111 1111 1011 0100	-4503599627370496
0000 0000 0000 0000 0000 0000 0110 0101	53	53	53	1111 1111 1111 1111 1111 1111 1011 0101	-9007199254740992
0000 0000 0000 0000 0000 0000 0110 0110	54	54	54	1111 1111 1111 1111 1111 1111 1011 0110	-18014398509481984
0000 0000 0000 0000 0000 0000 0110 0111	55	55	55	1111 1111 1111 1111 1111 1111 1011 0111	-36028797018963968
0000 0000 0000 0000 0000 0000 0111 0000	56	56	56	1111 1111 1111 1111 1111 1111 1010 0000	-72057594037927936
0000 0000 0000 0000 0000 0000 0111 0001	57	57	57	1111 1111 1111 1111 1111 1111 1010 0001	-144115188075855872
0000 0000 0000 0000 0000 0000 0111 0010	58	58	58	1111 1111 1111 1111 1111 1111 1010 0010	-288230376151711744
0000 0000 0000 0000 0000 0000 0111 0011	59	59	59	1111 1111 1111 1111 1111 1111 1010 0011	-576460752303423488
0000 0000 0000 0000 0000 0000 0111 0100	60	60	60	1111 1111 1111 1111 1111 1111 1010 0100	-1152921504606846976
0000 0000 0000 0000 0000 0000 0111 0101	61	61	61	1111 1111 1111 1111 1111 1111 1010 0101	-2305843009213693952
0000 0000 0000 0000 0000 0000 0111 0110	62	62	62	1111 1111 1111 1111 1111 1111 1010 0110	-4611686018427387904
0000 0000 0000 0000 0000 0000 0111 0111	63	63	63	1111 1111 1111 1111 1111 1111 1010 0111	-9223372036854775808
0000 0000 0000 0000 0000 0000 0111 1000	64	64	64	1111 1111 1111 1111 1111 1111 1011 0000	-18446744073709551616
0000 0000 0000 0000 0000 0000 0111 1001	65	65	65	1111 1111 1111 1111 1111 1111 1011 0001	-36893488147419103232
0000 0000 0000 0000 0000 0000 0111 1010	66	66	66	1111 1111 1111 1111 1111 1111 1011 0010	-73786976294838206464
0000 0000 0000 0000 0000 0000 0111 1011	67	67	67	1111 1111 1111 1111 1111 1111 1011 0011	-147573952589676412928
0000 0000 0000 0000 0000 0000 0111 1100	68	68	68	1111 1111 1111 1111 1111 1111 1011 0100	-295147905179352825856
0000 0000 0000 0000 0000 0000 0111 1101	69	69	69	1111 1111 1111 1111 1111 1111 1011 0101	-590295810358705651712
0000 0000 0000 0000 0000 0000 0111 1110	70	70	70	1111 1111 1111 1111 1111 1111 1011 0110	-1180591620717411303424
0000 0000 0000 0000 0000 0000 0111 1111	71	71	71	1111 1111 1111 1111 1111 1111 1011 0111	-2361183241434822606848
0000 0000 0000 0000 0000 0000 1000 0000	72	72	72	1111 1111 1111 1111 1111 1111 1010 0000	-4722366482869645213696
0000 0000 0000 0000 0000 0000 1000 0001	73	73	73	1111 1111 1111 1111 1111 1111 1010 0001	-9444732965739290427392
0000 0000 0000 0000 0000 0000 1000 0010	74	74	74	1111 1111 1111 1111 1111 1111 1010 0010	-18889465931478580854784
0000 0000 0000 0000 0000 0000 1000 0011	75	75	75	1111 1111 1111 1111 1111 1111 1010 0011	-37778931862957161709568
0000 0000 0000 0000 0000 0000 1000 0100	76	76	76	1111 1111 1111 1111 1111 1111 1010 0100	-75557863725914323419136
0000 0000 0000 0000 0000 0000 1000 0101	77	77	77	1111 1111 1111 1111 1111 1111 1010 0101	-15111572745182864827872
0000 0000 0000 0000 0000 0000 1000 0110	78	78	78	1111 1111 1111 1111 1111 1111 1010 0110	-30223145490365729655744
0000 0000 0000 0000 0000 0000 1000 0111	79	79	79	1111 1111 1111 1111 1111 1111 1010 0111	-60446290980731459311488
0000 0000 0000 0000 0000 0000 1001 0000	80	80	80	1111 1111 1111 1111 1111 1111 1011 0000	-120892581961462918622976
0000 0000 0000 0000 0000 0000 1001 0001	81	81	81	1111 1111 1111 1111 1111 1111 1011 0001	-241785163922925837245952
0000 0000 0000 0000 0000 0000 1001 0010	82	82	82	1111 1111 1111 1111 1111 1111 1011 0010	-483570327845851674491904
0000 0000 0000 0000 0000 0000 1001 0011	83	83	83	1111 1111 1111 1111 1111 1111 1011 0011	-967140655691703348983808
0000 0000 0000 0000 0000 0000 1001 0100	84	84	84	1111 1111 1111 1111 1111 1111 1011 0100	-1934281311383406697967616
0000 0000 0000 0000 0000 0000 1001 0101	85	85	85	1111 1111 1111 1111 1111 1111 1011 0101	-3868562622766813395935232
0000 0000 0000 0000 0000 0000 1001 0110	86	86	86	1111 1111 1111 1111 1111 1111 1011 0110	-7737125245533626791870464
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0000 0000 0000 0000 0000 0000 1010 0010	90	90	90	1111 1111 1111 1111 1111 1111 1010 0010	-123794003928538028669927424
0000 0000 0000 0000 0000 0000 1010 0011	91	91	91	1111 1111 1111 1111 1111 1111 1010 0011	-247588007857076057339854848
0000 0000 0000 0000 0000 0000					

Jobs at NCSU and where to go next?

- Systems Programmer – University Systems Control Center
 - Pull data off of Magnetic tapes
- Undergraduate Research Assistant
 - David McAllister, Numerical Analysis



David McAllister



- Double major in Computer Science and Math
 - Start of Senior year – Question led me to Math Advisor
 - Dana Latch
 - You are going to graduate school, aren't you?



Dana Latch

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9

Applied to PhD programs and Industry

- Applied to PhD programs
- IBM
 - Got job offer and Accepted
- Still waiting from PhD programs



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10

Issue with my GRE Score

- Quantitative – High score – 90%
- High GPA
- Verbal – low score - 28%
- Prof. Latch referred me to a Psychologist for evaluation
 - Evaluation (Feb 1983):
 - "...Miss Rodger has a learning disability. ... this disability is a subtle one and a discreet one that affects her ability to retain small bits of verbal information."
 - "I believe that deficits in both of these areas are primarily responsible for her low GRE Verbal score..."
 - "present no reason to indicate that Miss Rodger's intellectual capacity would not be sufficient to handle graduate work in the area she will enter."

Sent letter to
graduate
schools

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11

Sent Letter to Graduate Schools



Office of the
Vice President for Research and
Dean of the Graduate School

March 23, 1983

Dear Ms. Rodger:

I am pleased to offer you official admission to study toward the Doctor of Philosophy degree in the Department of Computer Sciences for the 1983 fall session at the West Lafayette campus. Your admission is conditional upon the following:

1. Demonstration of proficiency in English composition during your first term. This may be accomplished in the Office of Writing Review, Heavilon Hall.
2. Satisfactory completion of your undergraduate degree and submission of your undergraduate final transcript during your first term.

Demonstrate
proficiency in
English
Composition

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12

What about that IBM job?

- Turned down the job to go to graduate school
- They offered me a summer job!

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13

English Proficiency Done!

PURDUE UNIVERSITY OFFICE OF WRITING REVIEW
September 20, 1983

Dear Ms. Rodger,

It is a pleasure to inform you that you have cleared the English requirement for graduate students and that the Graduate School has been so notified. Since neither this office nor the Graduate School normally notifies your major professor, you may want to show him this note. Then, we suggest that you keep it as official evidence that you have met the requirement. If you would like to come by the office and look over the corrections on your paper, we will be glad to show it to you.

Demonstrated
proficiency in
English
Composition!

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14

Graduate School at Purdue

- Teaching Assistant for intro programming in Fortran
 - Taught several Discussion sections
 - Punch cards
- First Semester deciding research area
 - Numerical Analysis
 - Algorithms
- TA for several other courses
- Liked teaching and helping students!

PURDUE UNIVERSITY



Greg
Frederickson

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15

Finished PhD at Purdue

- PhD Purdue University 1989
 - Computational Geometry
 - Parallel Scheduling Algorithms
- Job Search
 - Two-body problem

PURDUE UNIVERSITY

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16

Assistant Professor Rensselaer Polytechnic Institute



- 1989-1994
- Continued research in algorithms
- First two women faculty in dept – me and Ellen Walker
- Really like teaching and helping students



Ellen Walker

Career Change from a Lunch at a SIGCSE TS

- Presented paper at SIGCSE 1994 in March in Phoenix, Arizona
- Heard about new position at Duke University
- I was listening, but had low self-esteem
- One month later
 - Got two NSF grants – Education, and Broadening Participation
- Sunday, Emailed Alan Biermann to inquire about position



Rocky Ross



Alan Biermann

Career Change from a Lunch at a SIGCSE TS

- Alan Biermann's response:
 - "We are having 3 candidates interview next week and may put out an offer."
 - "It is probably too late to apply now unless our search is unsuccessful in which case a second round could take place."
- I emailed him back and said I would apply
 - I mention I just got 2 NSF grants!
- He emails back:
 - "Congratulations on your grants success. Yes, you should send in your application. (But do not put a huge effort into it unless you find out we have reopened the search.)"
- On Monday, I FEDEX'd my paper application!



Alan Biermann

Career Change from a Lunch at a SIGCSE TS

- Tuesday: I get a call from Owen Astrachan
 - They need my reference letters today and want me to come interview this week.
- Wednesday: an email from Owen
 - "I'd like to extend an invitation to come to Duke", "If you could arrange to come by tomorrow evening (Thurs)"
- I email him on Thursday:
 - "I picked up my tickets this morning. So you can find me, I'll be wearing white jeans and white sneakers. I have long brown hair and wear glasses."
- He emails back:
 - "I got your abstract and your self-description. I'm kind of skinny, wear glasses and will be looking like I'm looking for someone."



Owen Astrachan

Thank you for reference letters!



Mukkai
Krishnamoorthy



Erich Kaltofen

Bob McLaughlin

Assistant Professor of the Practice Duke University

- Since 1994
- Assistant -> Associate -> Professor of the Practice
- Been involved with SIGCSE in many ways and lots of communities through SIGCSE interactions
- Here are some of the communities I have been involved with



Community: AP Computer Science

- Test Development Committee 1995-2001
- CS A Exam and CS B Exam
 - Pascal 1984-1998
 - C++ 1999-2003
 - Java 2004 – present
- Lots of panels at SIGCSE on changing AP CS



Community on Algorithm Visualization

- 1992 – Computers in Science Education and Training Workshop, Nova Scotia, met John Stasko
- SIGCSE conferences met many people
- My Workshop on Interactive and Visual Tools 1996
 - Gave talks – Stasko, Poplawski, Ericson, Guzdial, ...
- AlgoViz – Cliff Shaffer and others
- Many ITiCSE Working Groups on Algorithm Visualization – Tom Naps and others
- Online textbooks – OpenDSA, Runestone Academy



John Stasko



Cliff Shaffer

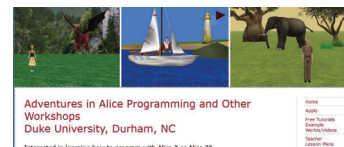
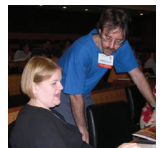


Tom Naps



Community - CS into K-12 with Alice

- Met Wanda Dann and Steve Cooper at SIGCSE 02
- Integrating Alice into CS 0
- Workshop 2005 at Duke
- First Alice Symposium at Duke – College and HS
- Adventures in Alice Programming!
- Many years with K-12!



What about My Disability?

- Diagnosed as heading to Graduate School
- Never got any accommodations in Graduate School
- Never got any accommodations as a Professor
- It has been hard!
- Takes me longer to do things
 - Writing
 - Organizing thoughts
- Been easier to talk about with
 - BPC activities, Access Computing, NCWIT, CRA-WP



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25

Another Psych Evaluation

- November 2021
 - "scores revealed a large and unusual discrepancy between verbal reasoning and nonverbal reasoning, indicating an underlying verbal-based learning disability"
 - "very mild/high functioning end of the autism spectrum"
 - Camouflaging behaviors – masking or strategies to hide autistic characteristics

I'm autistic

- Nice to have a name to my difficulties

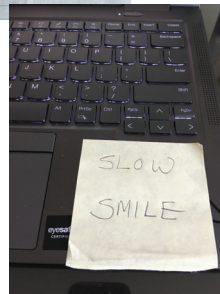
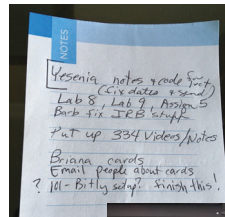
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26

How do I Compensate?

- I start things really early or else!
- I write down notes everywhere!
- In meetings I write down and organize my thoughts before speaking
- I have a sticky note on my laptop for lecture
- I say tongue-twisters for articulation
 2. Betty Botter bought some butter
But she said the butter's bitter
If I put it in my batter, it will make my batter bitter
But a bit of better butter will make my batter better
So 'twas better Betty Botter bought a bit of better butter



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27

That is my Journey, now on to Teaching

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28

Learning How To Teach Computer Science

- Amazing that getting a PhD means you can now teach!
 - Little Training -> Being a Teaching Assistant
- First semester at Rensselaer – Challenge – Prior Dept Decision:
 - Combine CS1/CS2 with Foundations of Computing (automata, grammar)
 - Give challenge to new women faculty! Ellen Walker and me
- How did we survive:
 - Energetic
 - Loved both subjects
 - Stay one step ahead of students!

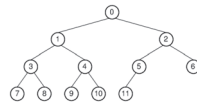
Don't do this to your new faculty!

Advice from many years on Learning to Teach

- 7 tips
- By the way – I'm still learning!

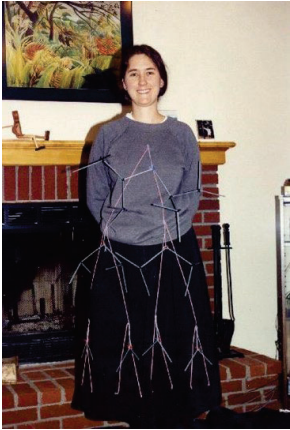
1) Borrow

- Borrow lecture notes and slowly make them your own
- Borrow assignments and slowly make them your own
- Borrow Ideas
- You are at a great place to borrow ideas – SIGCSE TS
 - "Making Lemonade: Exploring the bright side of large lecture courses", Wolfman, SIGCSE 02
 - Make a binary tree with your class to find the depth of the tree
 - Nifty Assignments
 - Very cool assignments since 1999
 - Boggle, Book Recommendations



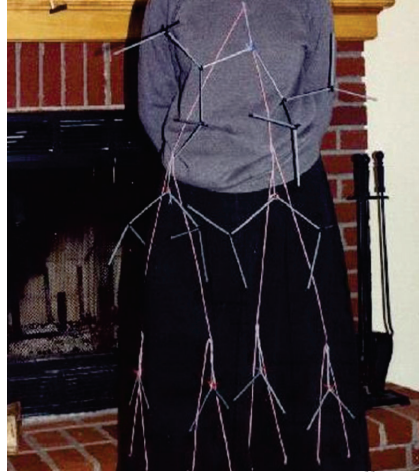
2) Make concepts visual

What data structure is this?



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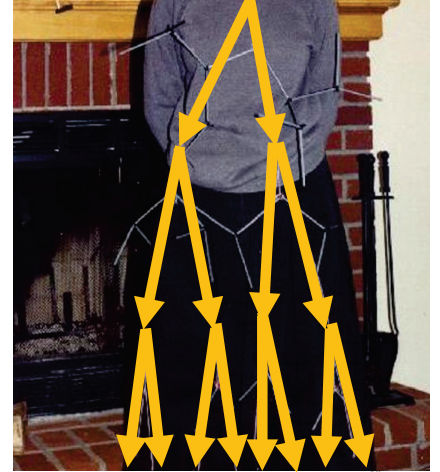


What data structure is this?

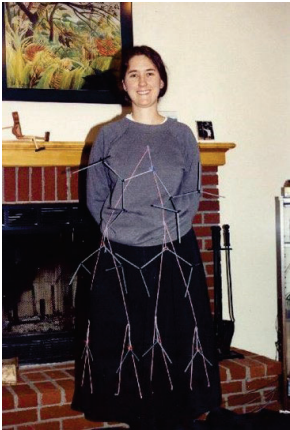


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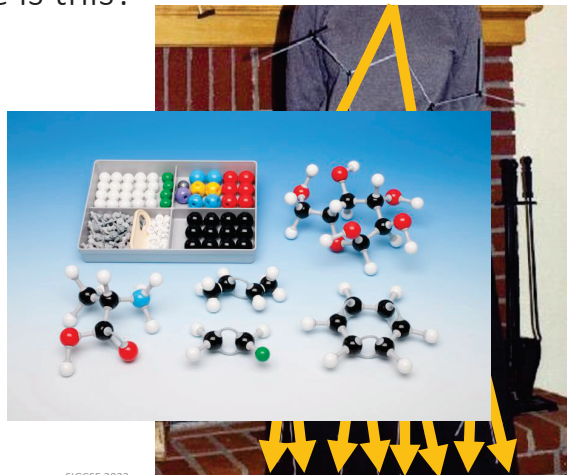


What data structure is this?



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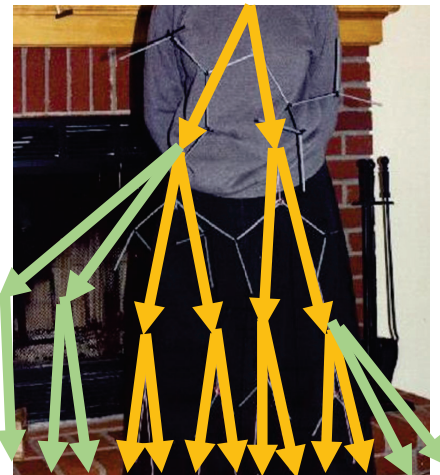


What data structure is this?



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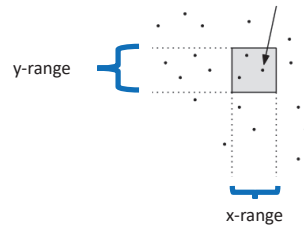
Attached to
each node,
green
subtree of
the same size
made with
molecule kit

Only two
shown

What is it?

2-D range tree

- Here is the problem
- Points in the x-y plane
- Search in for those points in a square

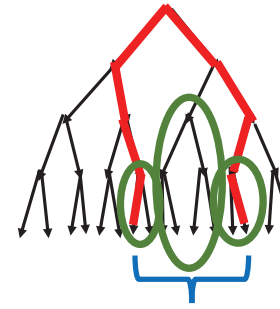


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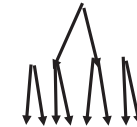
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37

Main tree by x-values, subtree by y-values



In the x-range



Each subtree organized by y-value

Search each subtree by y-value

Did you follow that?

- Engagement Taxonomy
- "Exploring the role of Visualization and Engagement in Computer Science Education", ITiCSE 2002 Working Group, Naps et al.
- Six levels of engagement with visualization technology
 - No viewing ← lowest level
 - Viewing
 - Responding
 - Changing
 - Constructing
 - Presenting

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39

3) Make Lecture Interactive – Don't give answers Names, Types, and Values

- Relate to a file. Consider: `cats.jpg`
- What is its name?
- What is its type?
- What is its value?

Names, Types, and Values

- Relate to a file. Consider: `cats.jpg`
- What is its name?
 - `cats.jpg`
- What is its type?
 - `.jpg` (type of image file)
- What is its value?
 - Content of the file, picture of cats?



1/17/23

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101, Spring 2023

27

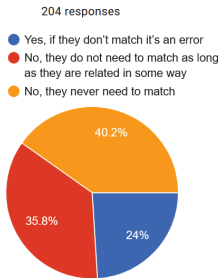
40

Compare input from all

- Use forms (google forms) or clickers

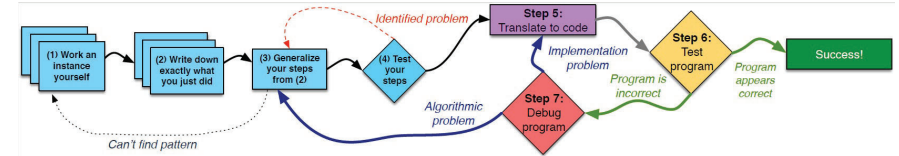
Do the variable names of the argument and parameter need to match (as in the names are exactly the same)?

- ☐ Yes, if they don't match it's an error
- ☐ No, they do not need to match as long as they are related in some way
- ☐ No, they never need to match



Use interactive techniques

- In CS1 we teach 7 steps: from problem to running code



- Will students use this?
- Not unless they see you using it!
- We use it in lecture a lot to solve problems

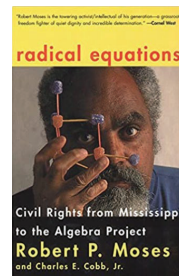
"Translation from problem to code in 7 steps",
CompEd 19, Hilton, Lipp, and Rodger, 2019.

From a CS 1 student:

"I just want to tell you that I tried the seven step method, and I **worked on all of my code** for one or two hours **before I even looked at the computer**. AND IT WORKED! I got all my code right on the first try! For the first time ever, I don't have to go to the help lab ..."

Bob Moses – Interactive Techniques for Algebra

- 1960's - Civil Rights Activist
 - Organizer Black voter registration drive in Mississippi
 - Fighting the use of law to oppress the black vote
- 1982 – MacArthur Genius Award
- 80's – Closing the gap with algebra
 - No algebra in 8th grade in his kids' school
 - First step – get all kids to be able to take algebra
 - Second step – How to empower students, start with a train trip
 - Algebra as a gateway to higher level math/science
 - Huge movement! Interactive approach increased pass rates



Strongly recommend his book

Constance Bland

- Mississippi Valley State University, Professor, Chair, Vice president of Academic Affairs
- In 1999, the only Black woman to get a PhD in CS.
- Bob Moses wrote that she says: "I wasn't committed...I liked the idea of math based on a student's experience...", "... it really began to sink in just how valuable this project was or could be"
- She was a co-PI (Mississippi site) on my NSF Alice grant to teach middle school teachers programming!



4) Use Visual and Interactive Tools in Teaching

- Many Tools for learning programming:



- KEY: You must use the tools while teaching!
- Students need to see you make mistakes!

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45

Python Tutor – My Favorite tool for Visualizing data concepts in CS 1

- Example: Concatenation of two Python lists
- Two ways to demo
 - Step through example using Python Tutor
 - Copy screen shots onto a slide
- Pause to ask questions
- This example I borrowed from Kristin Stephens-Martinez!

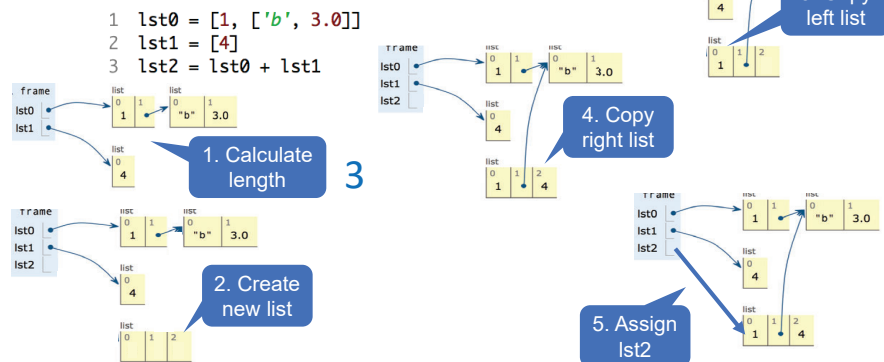
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46

Concatenation of two lists, 5 steps: Length, create, copy, copy, assign

- How is the inner list copied?



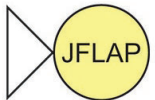
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Compsci 101, Spring 2023

47

Example: use JFLAP in teaching Automata

- Use JFLAP during lecture to step through an example
 - Building a Finite State Machine and tracing through it



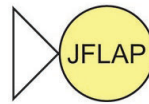
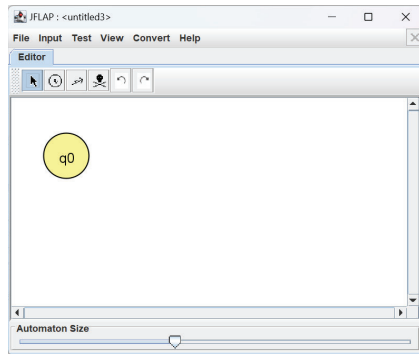
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48

During lecture, step through an example

- Building a Finite State Machine



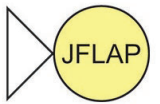
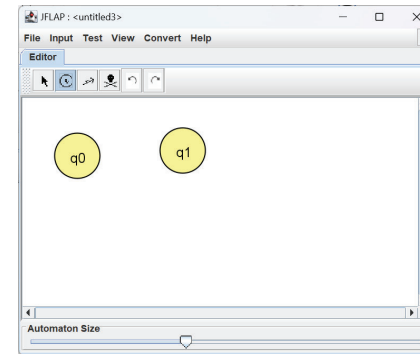
Students tell me
what to do

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49

During lecture, step through an example

- Building a Finite State Machine

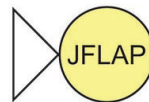
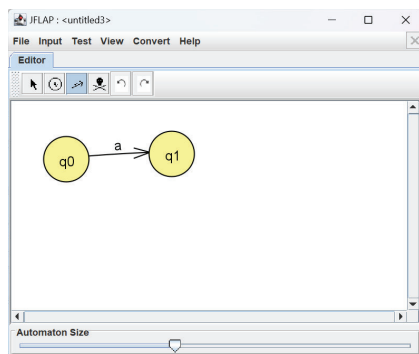


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50

During lecture, step through an example

- Building a Finite State Machine

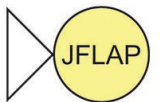
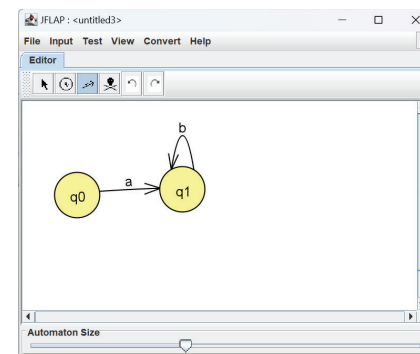


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51

During lecture, step through an example

- Building a Finite State Machine

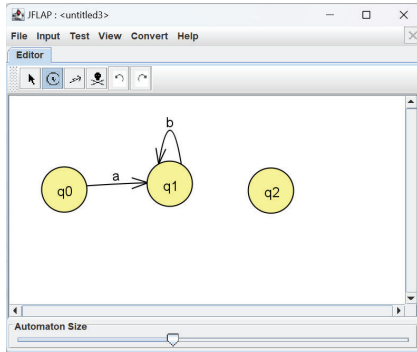


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52

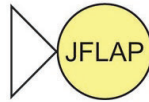
During lecture, step through an example

- Building a Finite State Machine



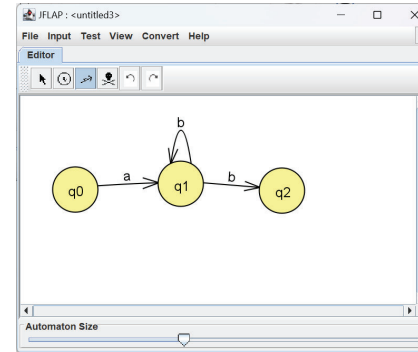
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53



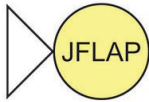
During lecture, step through an example

- Building a Finite State Machine



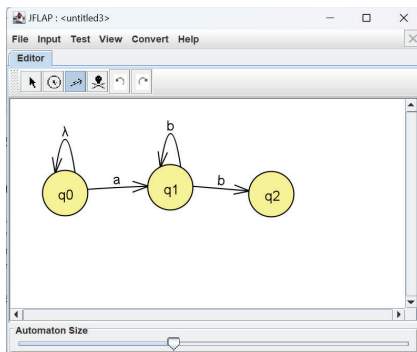
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54



During lecture, step through an example

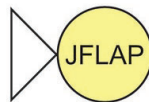
- Building a Finite State Machine



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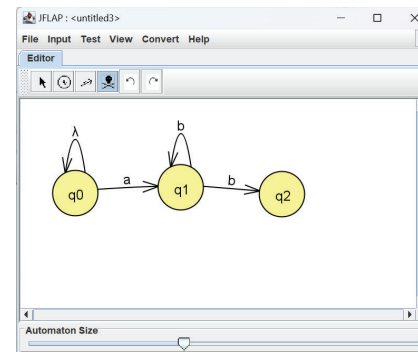
55

Oops!



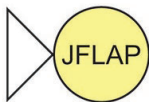
During lecture, step through an example

- Building a Finite State Machine



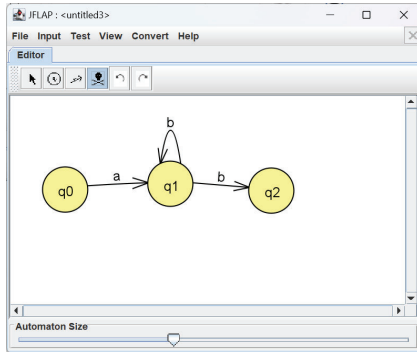
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56

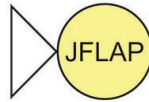


During lecture, step through an example

- Building a Finite State Machine



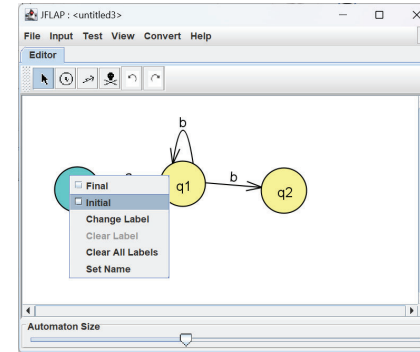
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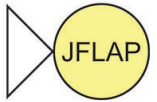
57

During lecture, step through an example

- Building a Finite State Machine



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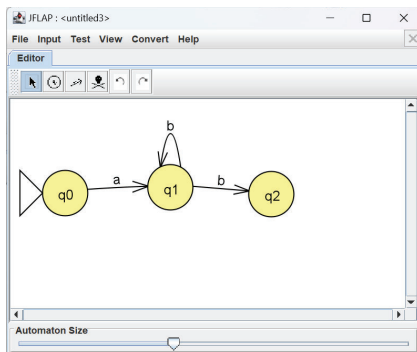


Some things
may not be
obvious

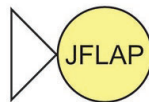
58

During lecture, step through an example

- Building a Finite State Machine



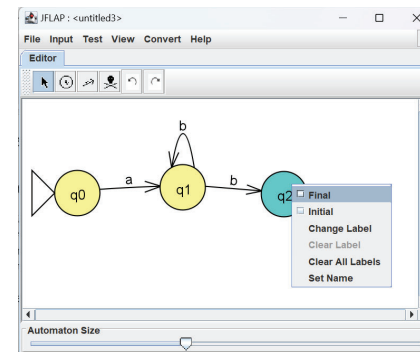
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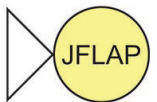
59

During lecture, step through an example

- Building a Finite State Machine



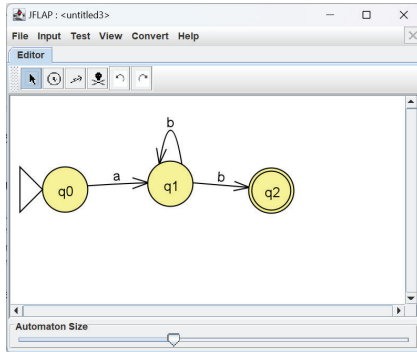
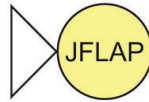
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60

During lecture, step through an example

- Building a Finite State Machine

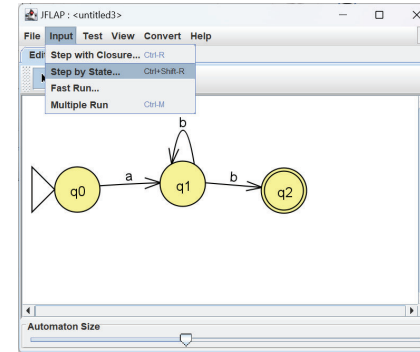
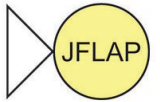


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61

During lecture, step through an example

- Trace an input string

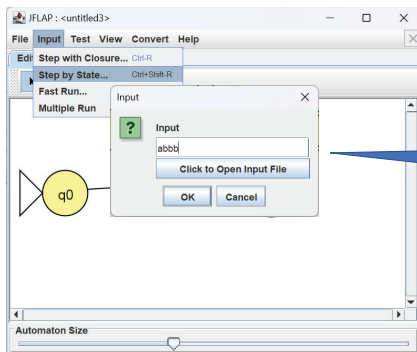
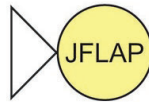


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62

During lecture, step through an example

- Trace an input string

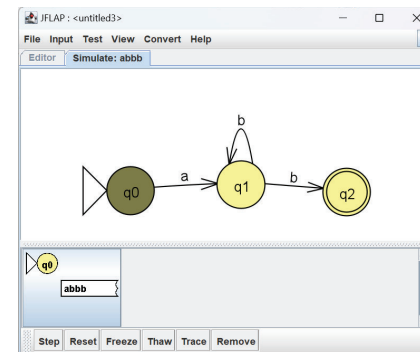
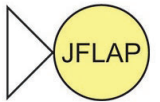


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63

During lecture, step through an example

- Trace an input string

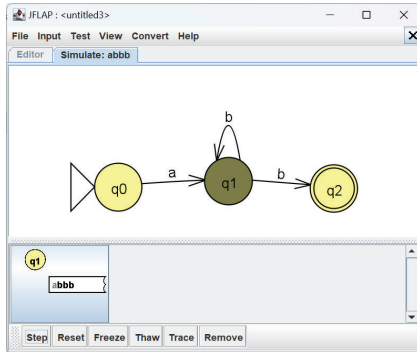
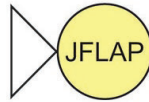


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64

During lecture, step through an example

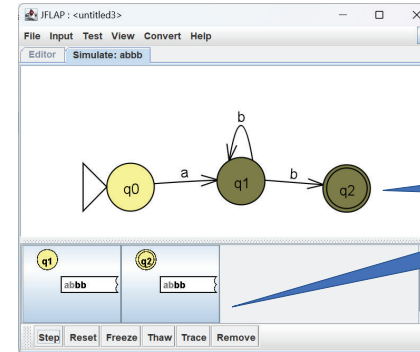
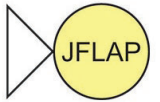
- Trace an input string



65

During lecture, step through an example

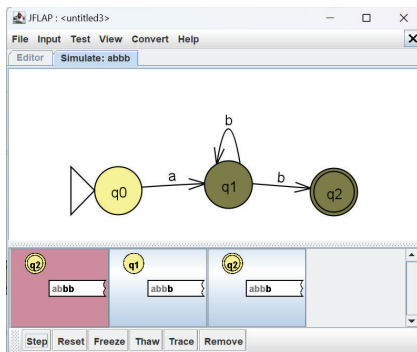
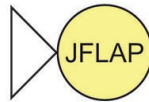
- Trace an input string



66

During lecture, step through an example

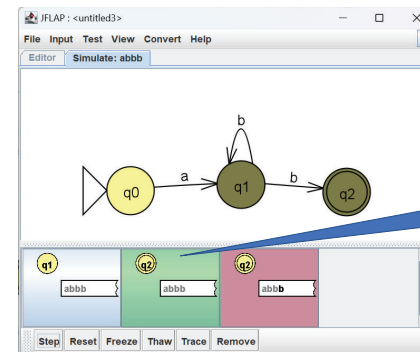
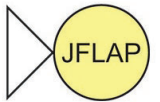
- Trace an input string



67

During lecture, step through an example

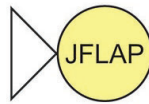
- Trace an input string



68

Other ways I use JFLAP in teaching

- Step through a proof or example
 - Converting an NFA to DFA
 - Show parsing some strings can take a long time!
 - Pause and ask what will happen next!
- Use JFLAP for homework problems
 - Check your answer on a conversion
 - Build an NPDA for a particular language
 - Compare parsing methods
- Students use for studying for an exam



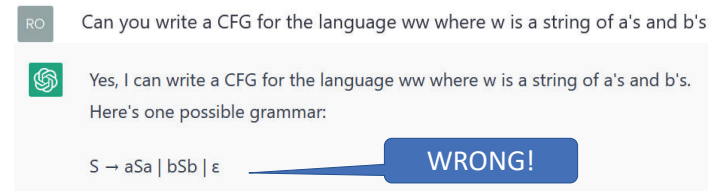
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Trying to solve impossible problems

- Build an NPDA or write a CFG for $L = \{ww \mid w \in \Sigma^*\}$, $\Sigma = \{a, b\}$
 - In class exercise
 - IMPOSSIBLE, NPDA has one stack, This language is NOT context-free
- Asked ChatGPT to solve this problem



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70

Use ChatGPT in class to solve problems

$$L = \{ww \mid w \in \Sigma^*\}, \Sigma = \{a, b\}$$

RO But abbabb should be in this language, and your grammar does not generate that string.

GG You are correct, my apologies for the oversight in my previous answer. The grammar I provided generates strings of the form ww, but not strings of the form abbabb. Here's an updated grammar that generates both:

$$\begin{aligned} S &\rightarrow aSbA \mid bSaA \mid \epsilon \\ A &\rightarrow aAbA \mid bAbA \mid \epsilon \end{aligned}$$

WRONG!

This grammar has two non-terminals, S and A. The start symbol S generates

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71

Use ChatGPT in class to solve problems

$$L = \{ww \mid w \in \Sigma^*\}, \Sigma = \{a, b\}$$

RO But this grammar generates the string aabbab which is not in the language L



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72

Use ChatGPT in class to solve problems

$$L = \{ww \mid w \in \Sigma^*\}, \Sigma = \{a, b\}$$

RO But this grammar generates the string aabbab which is not in the language L



You're right, I apologize for the mistake. Here's an updated CFG that should generate only strings of the form ww:

$S \rightarrow aSb \mid bSa \mid \epsilon$

WRONG
This is the first wrong grammar again!!

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73

Use ChatGPT in class to solve problems

$$L = \{ww \mid w \in \Sigma^*\}, \Sigma = \{a, b\}$$

Using these productions, we can derive the string abbabb as follows:

$S \rightarrow bSa \rightarrow baba$

But it doesn't derive the string???

But we cannot derive the string aabbab using this CFG.

I hope this updated answer is helpful.

Totally busted!

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74

If you can't find a tool, build one

- A few tips from experience with JFLAP

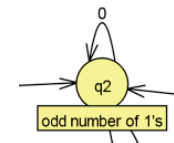
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75

What can make the tool more useable?

- Annotations on states
- Multiple run window
 - Develop test data
 - Easier for grading
- General definitions
 - FA – recognize one or more symbols
 - NPDA – pop or push 0 or more symbols
- Batch processing



Multiple Run		
Input		Result
a		Accept
aa		Accept
aab		Accept
aabb		Accept
ac		Reject
acb		Reject
abcb		Accept
abccb		Accept
abccab		Reject
bc		Reject

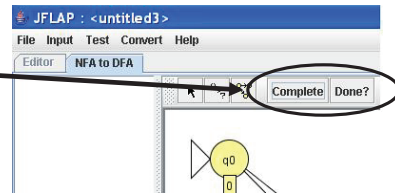
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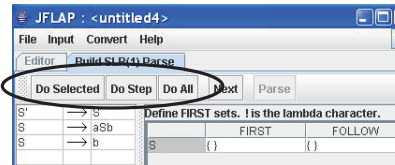
76

In following an algorithm, allow user to proceed on if they got it

- Complete the rest for them



- Complete parts for them



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77

Add Pause/Checkpoint questions

- Allow for pause to think about what comes next
- Undo/go back
- Pop up a quiz question to see if the user understands what he/she just did

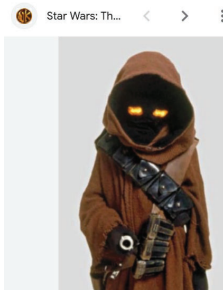
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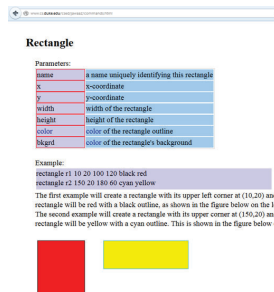
78

Naming your software tool

- What is a good name?
- One tool Jawa



Jawa - Star Wars: The Old Re...



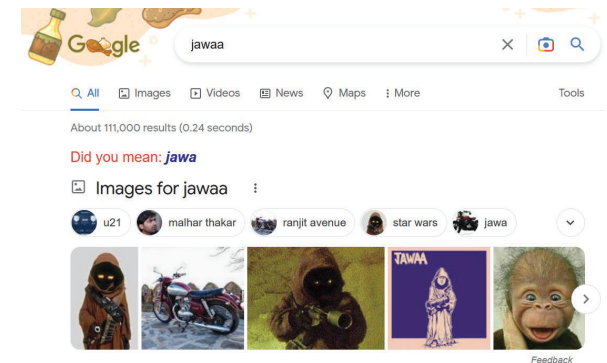
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79

Naming your software tool

- What is a good name?
- One tool Jawa
- Search
 - Mostly star wars!



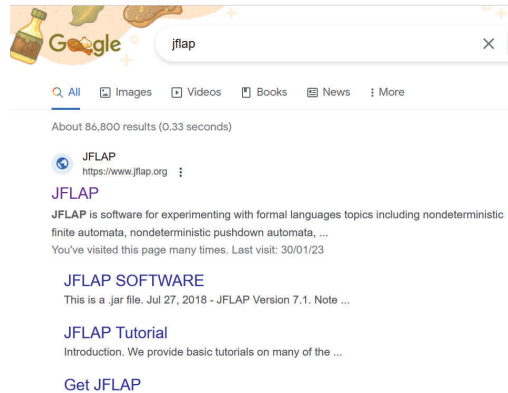
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80

Naming your software tool

- What is a good name?
- JFLAP originally named FLAP
 - Formal Languages and Automata Package
- Java came along...
 - JFLAP



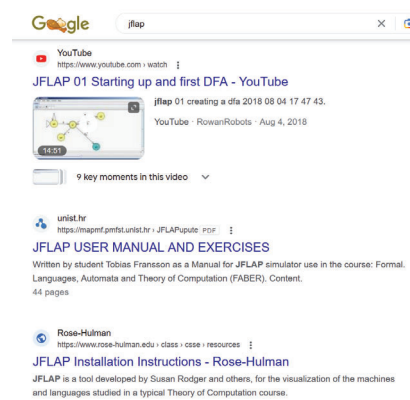
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81

Naming your software tool

- What is a good name?
- FLAP
 - Formal Languages and Automata Package
- Java came along...
 - JFLAP



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82

5) Use Applications to show WHY!

- CS 1 - Build a recommender system to recommend books, movies and restaurants
 - Dictionaries, parallel lists, etc.



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83

Use Applications to show WHY!

- Automata Theory and Formal Languages
 - Why are we learning this?
- Relate it to what they know
 - They have all had errors when compiling their program
 - **ERROR ON LINE 63**

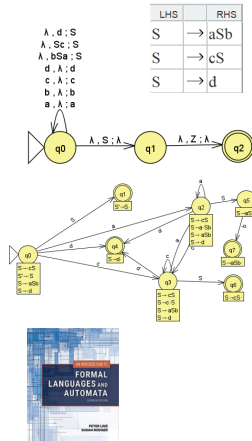
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84

Use Applications to show WHY!

- Write an interpreter for a small language
 - Write a CFG to define the programming language
 - LR Parsing – NPDA that models the LR parsing process
 - Build an LR Parse Table – build a DFA with states that have meaning about what is on the stack so far
- Spent summer 2021 (pandemic) writing 3 chapters on parsing to add applications section to Formal Languages and Automata Textbook



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85

6) Make it Hands on and Fun!

- Explore different Sorting algorithms
- Sort with cards!



March 17, 2023

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86

Make it Hands on and Fun!

- Explore different Sorting algorithms
- Sort with cards!
- Use Big Cards!
 - Height: 14.5 inches = 36.3 cm



March 17, 2023

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87

Make it Hands on and Fun!

- Explore different Sorting algorithms
- Sort with cards!
- Use Big Cards!
 - Height: 14.5 inches = 36.3 cm
- Sort with cookies!



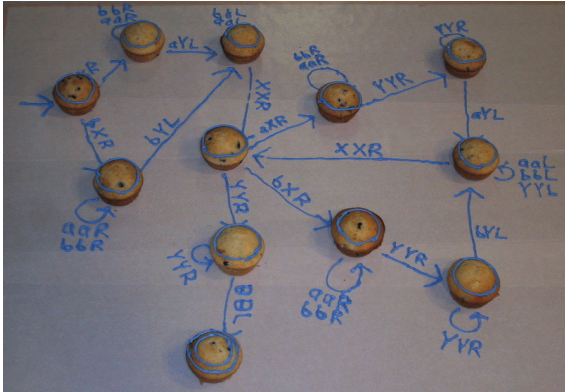
March 17, 2023

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88

Make it Hands on and Fun!

- TM made of blueberry muffins
- What is the error in it?



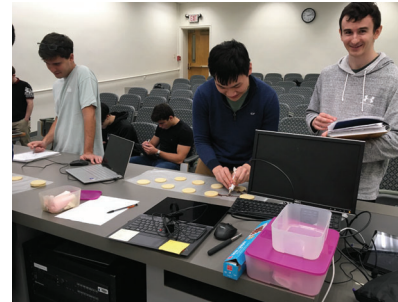
March 17, 2023

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89

Make it Hands on and Fun!

- Students build DFA with cookies and icing



March 17, 2023



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90

Or just Surprise them with a treat!

- Fall 2022 CompSci 101 Python Cookies



March 17, 2023



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91

April 2020 – Make your own cookies!

<https://bit.ly/makeJavaCookies>

MAKING JAVA COOKIES

by Susan Rodger



March 17, 2023

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93

7) Make change happen!

- Change your lecture
 - Borrow ideas from others!
- Change lives
 - Mentor students, junior faculty, staff
 - Mentor anyone you can!
- Attend a Mentoring workshop
 - Or encourage others to
- Change the culture in Computing

CRA Leadership Academy for Faculty



Early & Mid-Career Mentoring Workshop

2023 GRAD COHORT



Cultural Competence in Computing (3C) Fellows



March 17, 2023

Nicki Washington

Shani Daily

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94

Questions?



Python Logo cookies

March 17, 2023



Alice cookies



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95