Concise Graphical Representations of Student Effort on Weekly Many Small Programs

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Introduction

> CS1 students code a lot
>> Many small programs approach: 5-7 programs /week
>> Lots of missing information

> Need insight into students' coding process

Time spent?   Days worked?

Order of completion?   # Runs?

Score earned?   Took breaks?

lab.cpp

?

> Goal: Quick & concise to gain this insight
>> "Programming workflow charts"
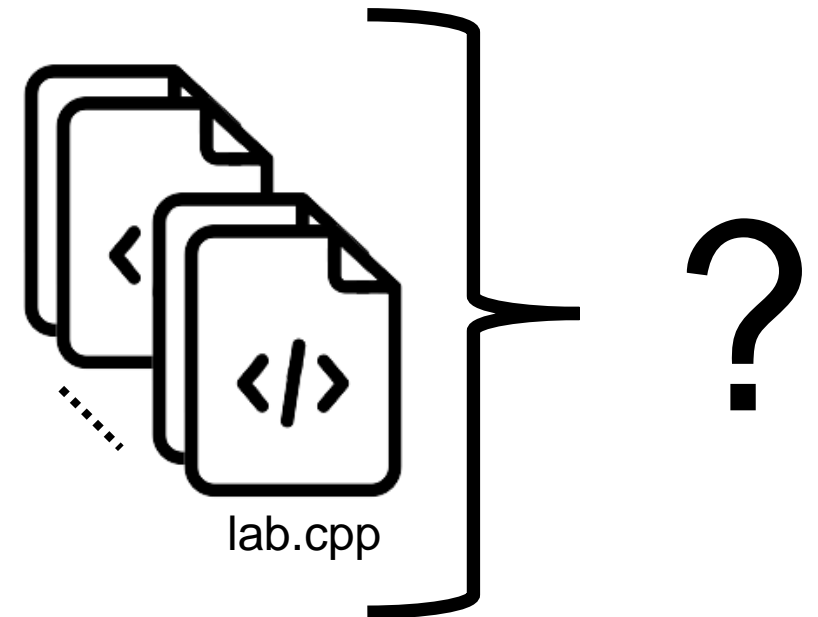
Background – MSP teaching approach

- › MSP - Many small programs
  - › 5-7 programs per week

- › Characteristics
  - › Concise prompt
  - › 20-50 lines of code (solution)
  - › One topic per lab

- › Benefits[1,2]
  - › Earlier starts
  - › Reduced stress
  - › Additional practice

[1]J.M. Allen, F. Vahid, K. Downey, and A. Edgcomb. Weekly Programs in a CS1 Class: Experiences with Auto-graded Many-small Programs (MSP), Proceedings of ASEE Annual Conference, 2018.

[2]J.M. Allen, F. Vahid, A. Edgcomb, K. Downey, and K. Miller. An Analysis of Using Many Small Programs in CS1, ACM SIGCSE Technical Symposium on Computer Science Education, 2019.
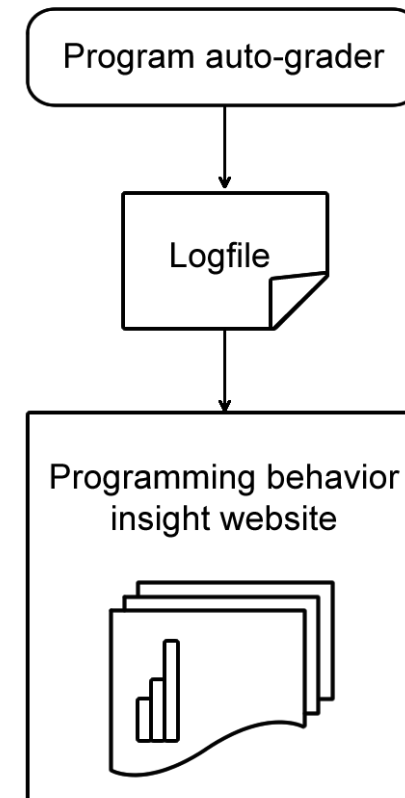

| MSP (100%) | 20% | 20% | 20% | 20% | 20% |
| OLP (100%) | 100% | | | | |
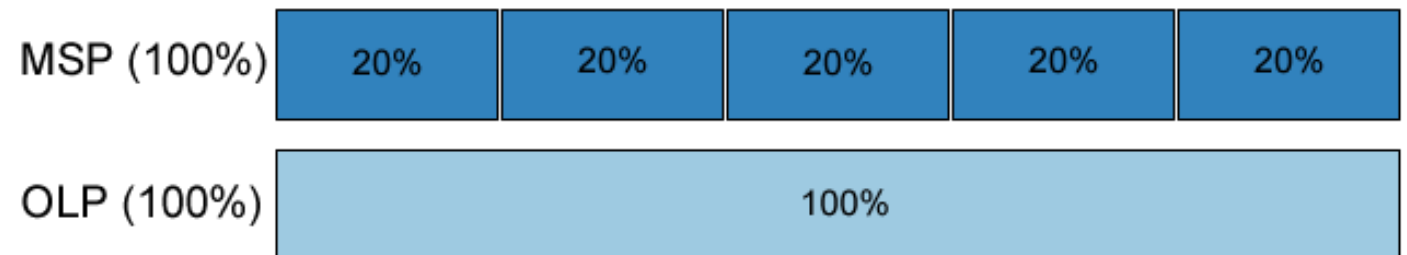
Background – Program auto-grader

› Modern day auto-graders (ex. zyLabs by zyBooks)

  › Easy to use

  › Immediate score feedback

  › zyBooks: built-in IDE

› Log file

  › Develop: testing

  › Submit: grading

	A	B	C	D	E	F	G
1	lab_id	user_id	timestamp	submission	zip_location	score	max_score
2	LAB: Sample 1	1103	1/1/2021 17:23	1	https://xyz.zip	8	10
3	LAB: Sample 1	1103	1/1/2021 17:32	0	https://xyz.zip		
4	LAB: Sample 2	1103	1/1/2021 18:11	0	https://xyz.zip		
5	LAB: Sample 3	1103	1/2/2021 12:00	1	https://xyz.zip	10	10
6	LAB: Sample 7	1103	1/2/2021 12:09	1	https://xyz.zip	2	10

Program auto-grader

CodeLab
Codio
CodingRooms
Mimir
MyProg...Lab
Vocareum
zyLabs

Logfile

Programming behavior
insight website

Effort signs
Feature classifications
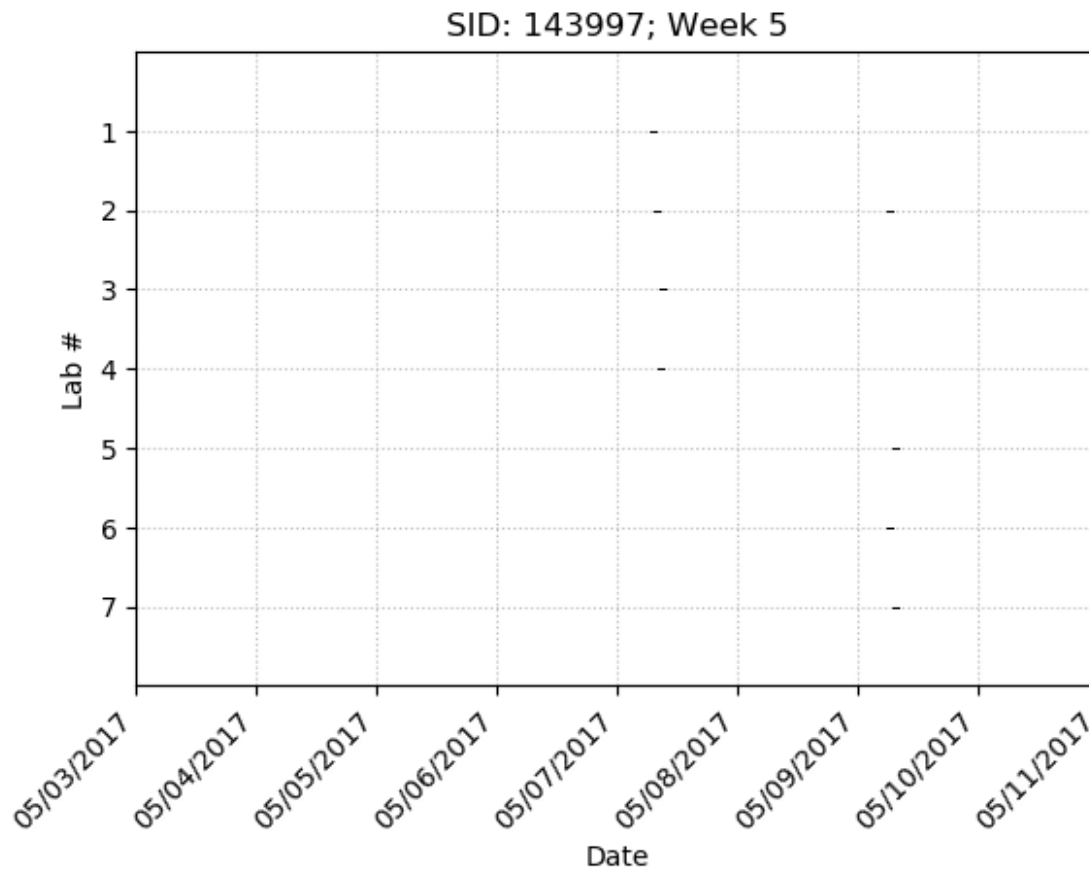Programming Workflow
  Charts

Version 1: Calendar view (2017)

SID: 143997; Week 5

Features

- › Weekly calendar view
  - › Labs on y-axis, Dates on x-axis
- › Horizontal lines to indicate time spent

Tradeoffs
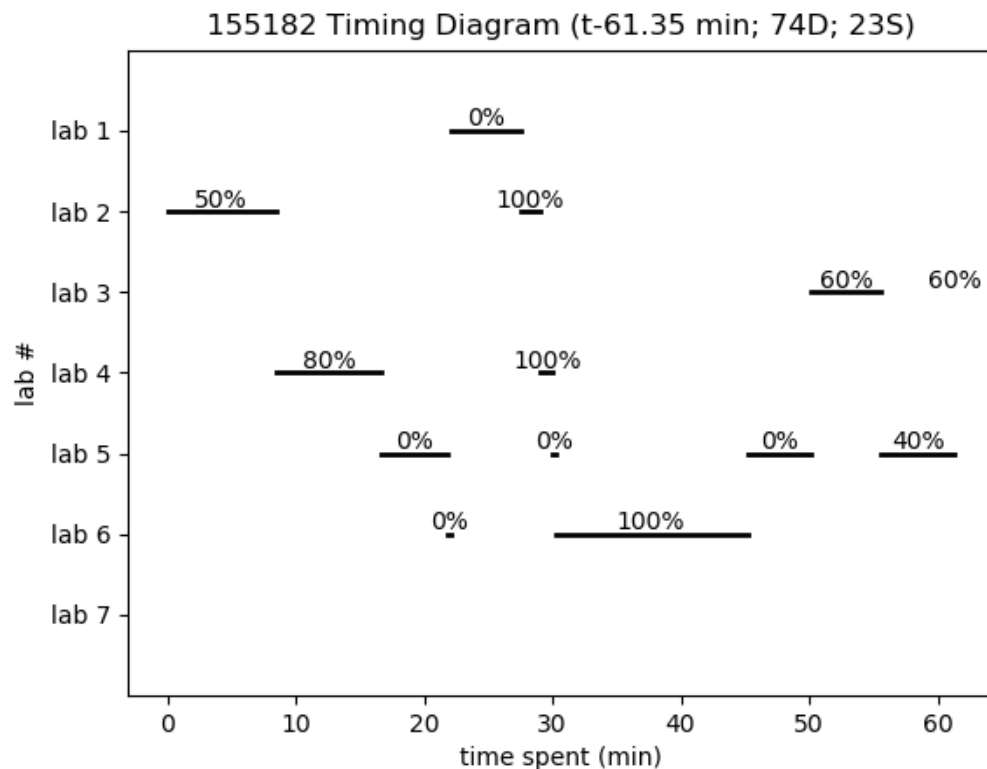
- › Pros: weekly view
- › Cons: data too small

Version 2: Compressed chart (2018)

155182 Timing Diagram (t-61.35 min; 74D; 23S)

Features

› Total time view
  › Labs on y-axis, Time spent on x-axis
› Horizontal lines to indicate time spent
  › Score earned (%)

Tradeoffs

› Pros: data representation
› Cons: readability

Version 3: Clarity & readability (2018)

135322 Week 4 Lab Gantt Chart (132min, 166dev, 17sub)

Features

› Colors
› Data summary labels
› Grid
› Updated logic

Tradeoffs

› Pros: readability
› Cons: readability (slight)
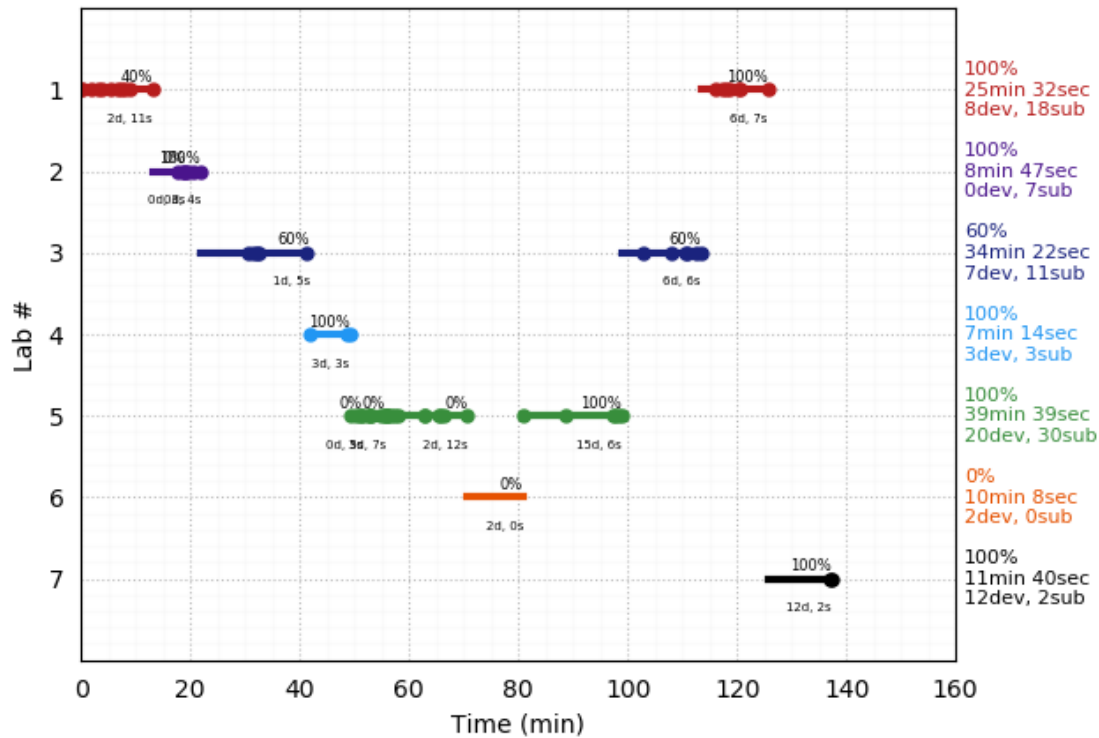› Considerations: line colors & styles
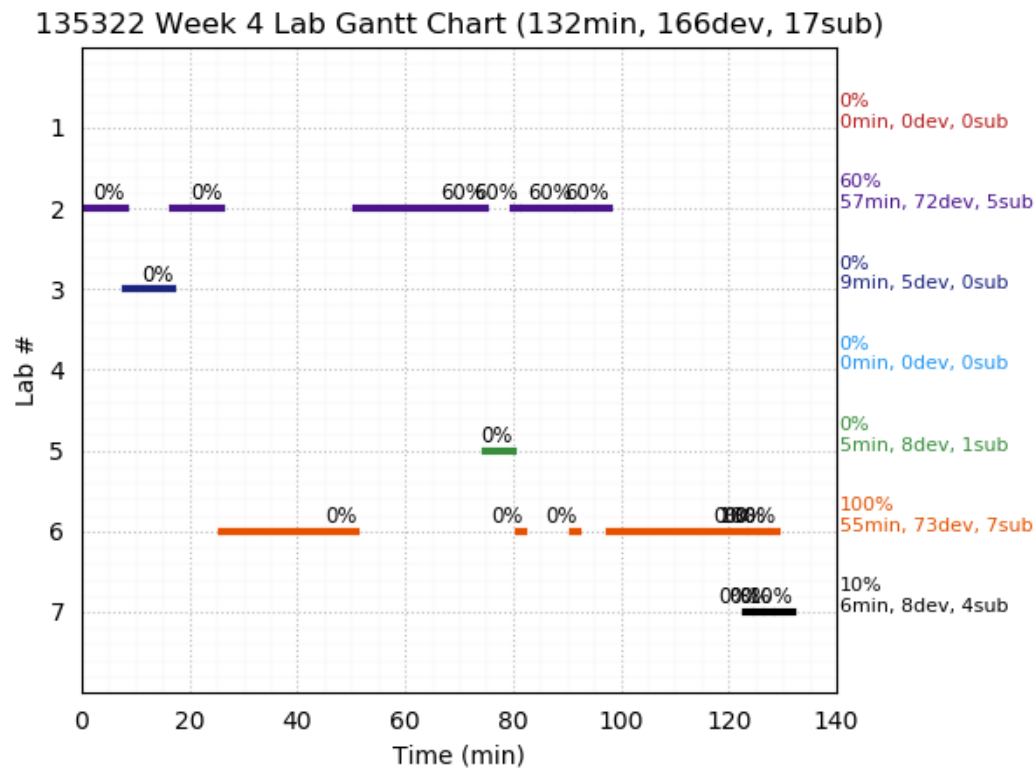
Version 4a: Run type (2019)

SID: 64046; Week 2 LA Gantt Plot (137min 22sec; 52dev; 71sub)

Features

› Develop & submit indicators
  › Text & solid points
› Minor update to labels

Tradeoffs

› Pros: more information
› Cons: clutter, readability, & data representation
› Considerations: indicator shape

Version 4b: Run type details (2019)

SID: 64046; Week 2 LA Gantt Plot (137min 22sec; 52dev; 71sub)

Features

- Develop & submit indicators
  - Text & solid points
  - Character 'tails'
- Minor update to labels

Tradeoffs

- Pros: more information, data representation
- Cons: extra clutter & readability
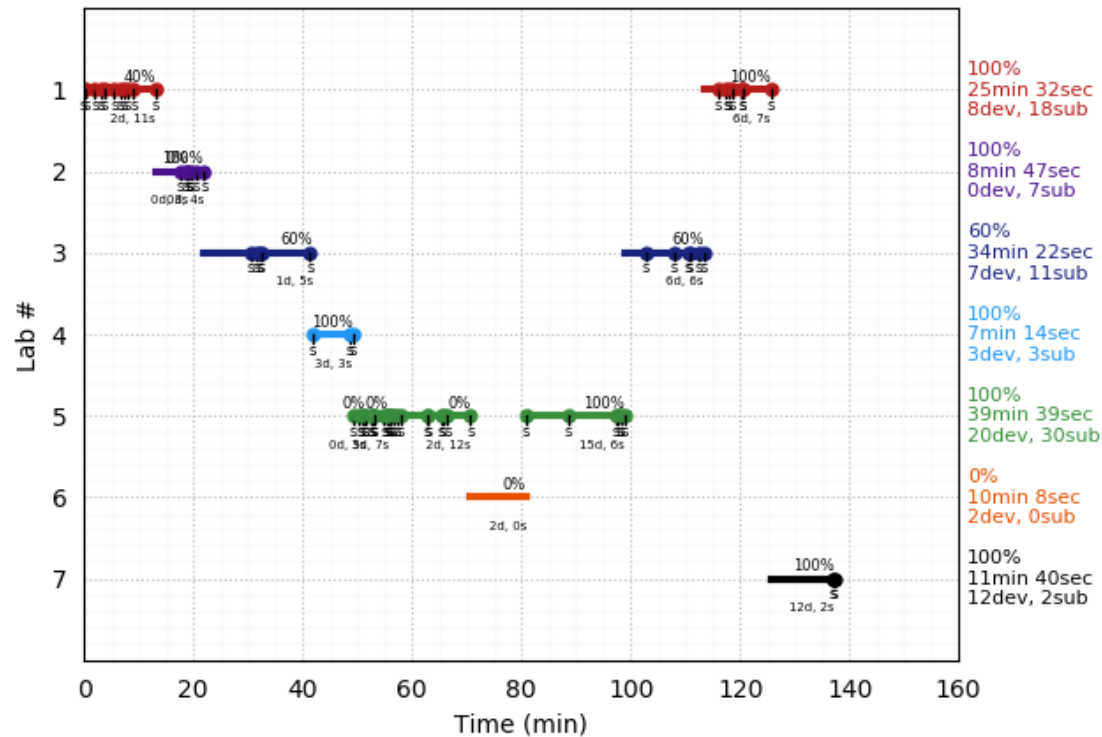
Version 5: Tick marks (2020)

Week 7 Workflow (205min 35sec; 217d; 19s)

Features

› Develop & submit indicators
  › Tick marks

Tradeoffs

› Pros: more information & readability
› Cons: minor clutter
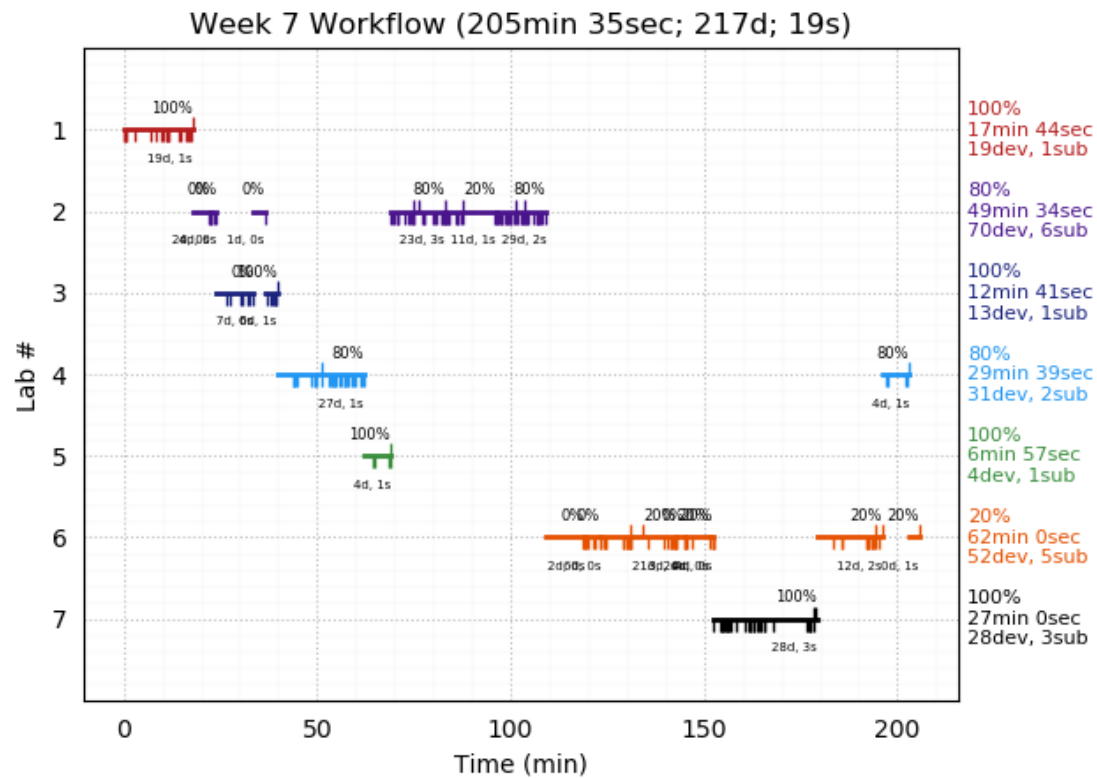
Version 6: Pivot indicators (2020)

Pivot: A switch between lab activities without completing the current lab activity.
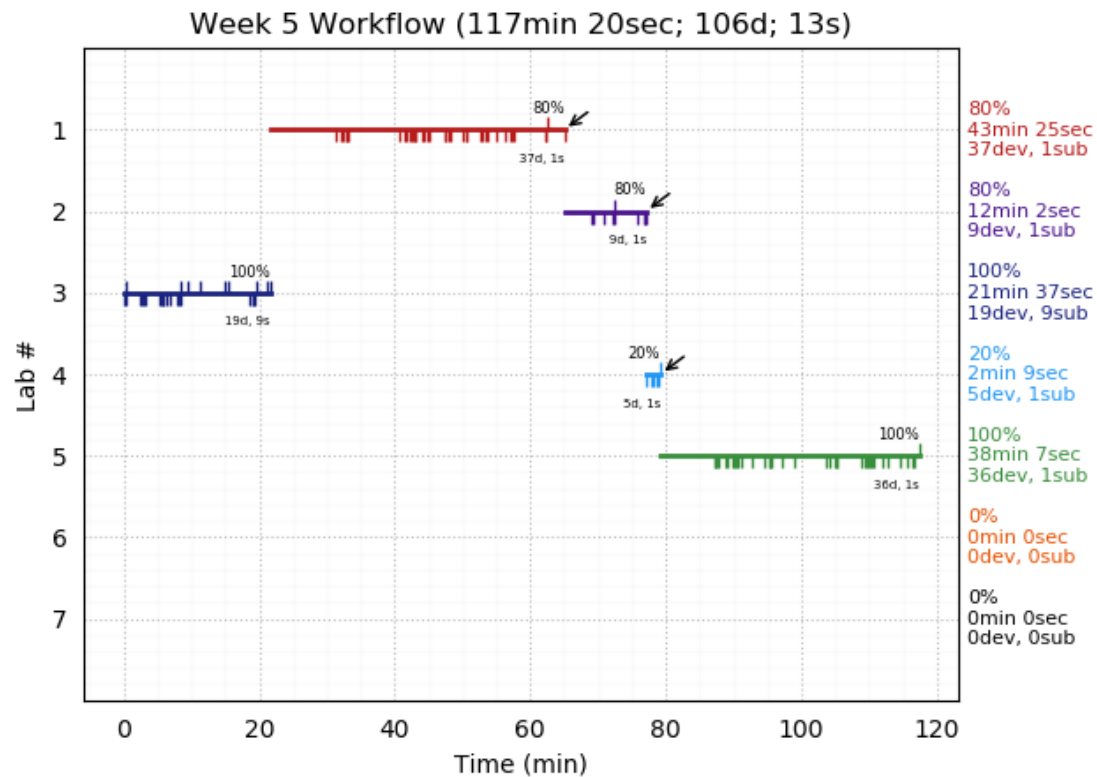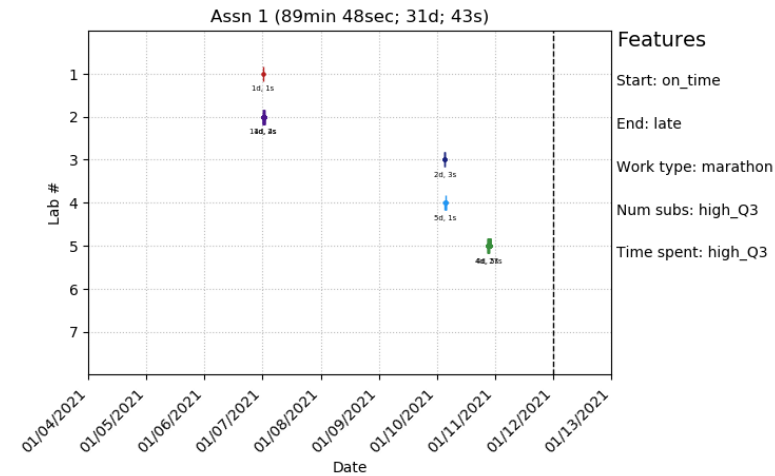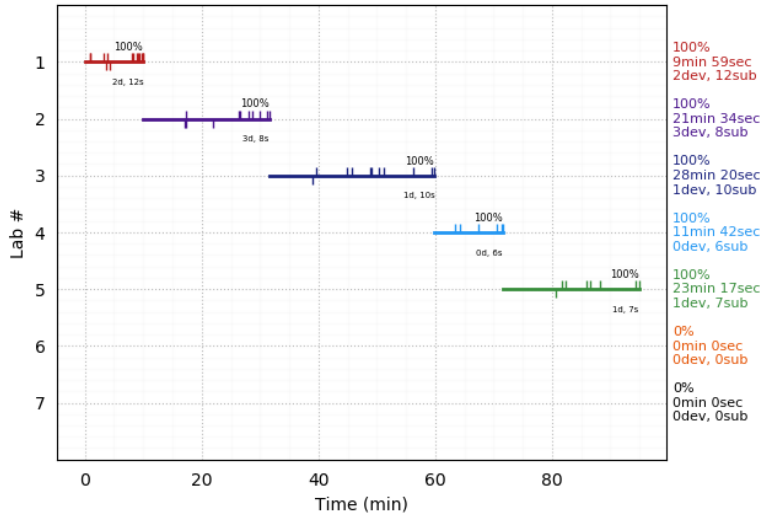
Features

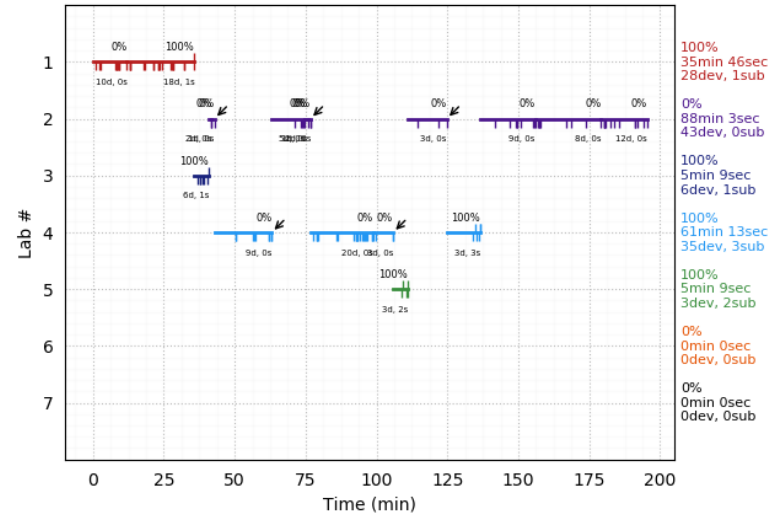> Pivot indicators
>> Arrow to indicate pivots

Current uses

- › Understanding student effort
  - › Normal, struggling, suspicious
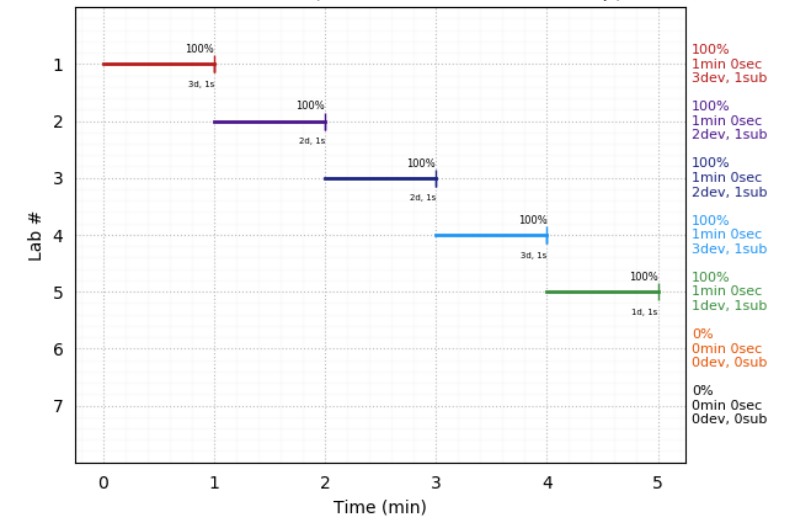- › Basic student classifications
- › Interactive website
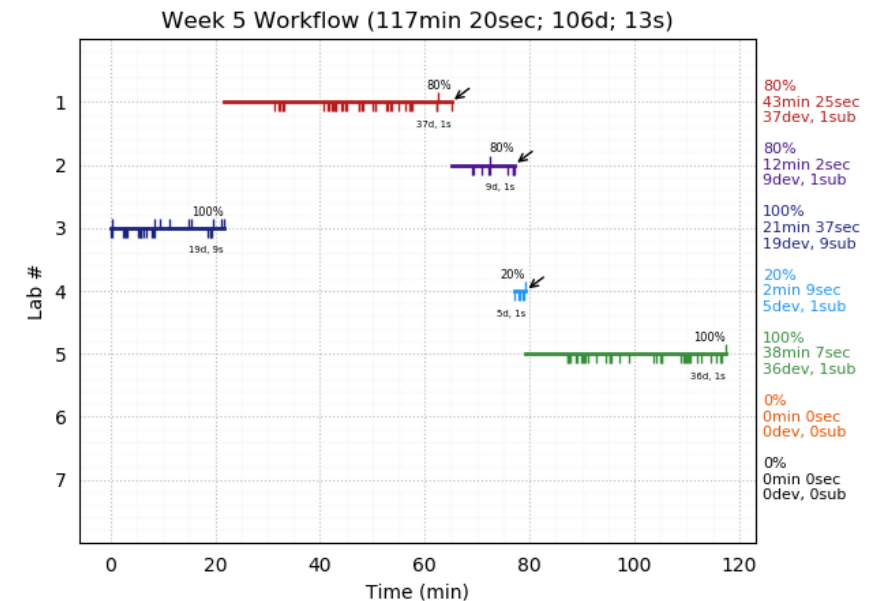
Conclusion

- **Evolution over 3 years**

- **Useful in CS1**
  - Gain insight on student behavior
  - Recognize typical patterns
  - Instructor & TA

- **Future**
  - Auto detect struggle
  - Improved classifiers
  - Interactive website for instructors (hopefully soon ☺)

lab.cpp
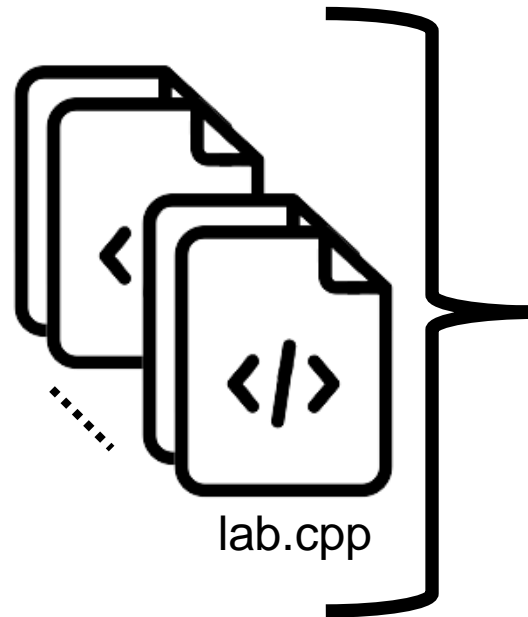
Programming Workflow Charts

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Appendix A: Website Summary Table

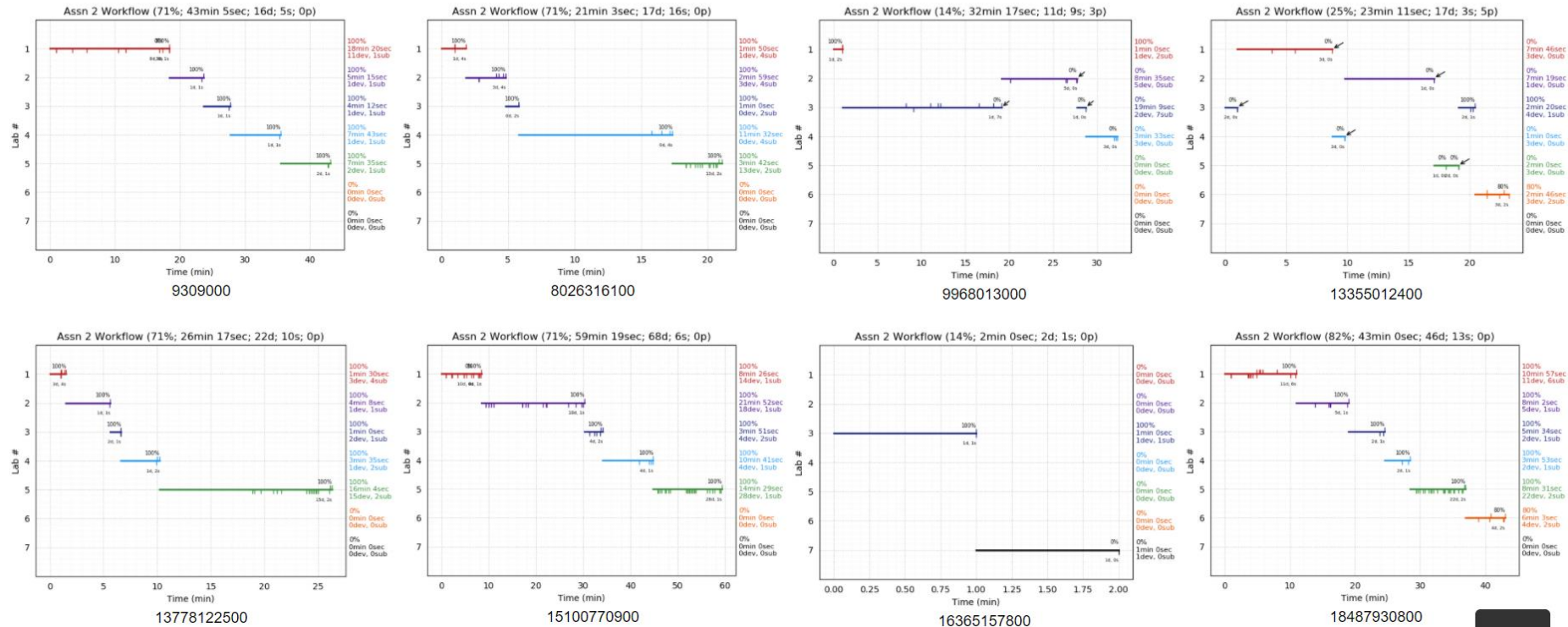## SIGCSE Sample Programming Workflow Charts

Assignment 2

	Averages					
	Timespent (sec)	# Runs	Score (%)	# Develops	# Submits	# Pivots
Assignment Total [298 students]	**1h 2m 58s**	**57**	**98**	**42**	**15**	**1**
- Lab 1 (LAB: Divide by x) [298 students]	12m 35s	14	99	10	4	0
- Lab 2 (LAB: Driving costs) [298 students]	12m 44s	10	99	7	3	0
- Lab 3 (LAB: Expression for calories burned during workout) [298 students]	11m 58s	9	99	7	3	0
- Lab 4 (LAB: Using math functions) [297 students]	12m 50s	10	98	7	3	0
- Lab 5 (LAB: Phone number breakdown) [294 students]	9m 45s	12	99	10	2	0
- Lab 6 (LAB: Simple statistics) [56 students]	14m 29s	15	74	10	5	0
- Lab 7 (LAB: Musical note frequencies) [23 students]	12m 44s	13	78	11	2	0

Appendix B: Website Chart View

Appendix C: OLP Chart View