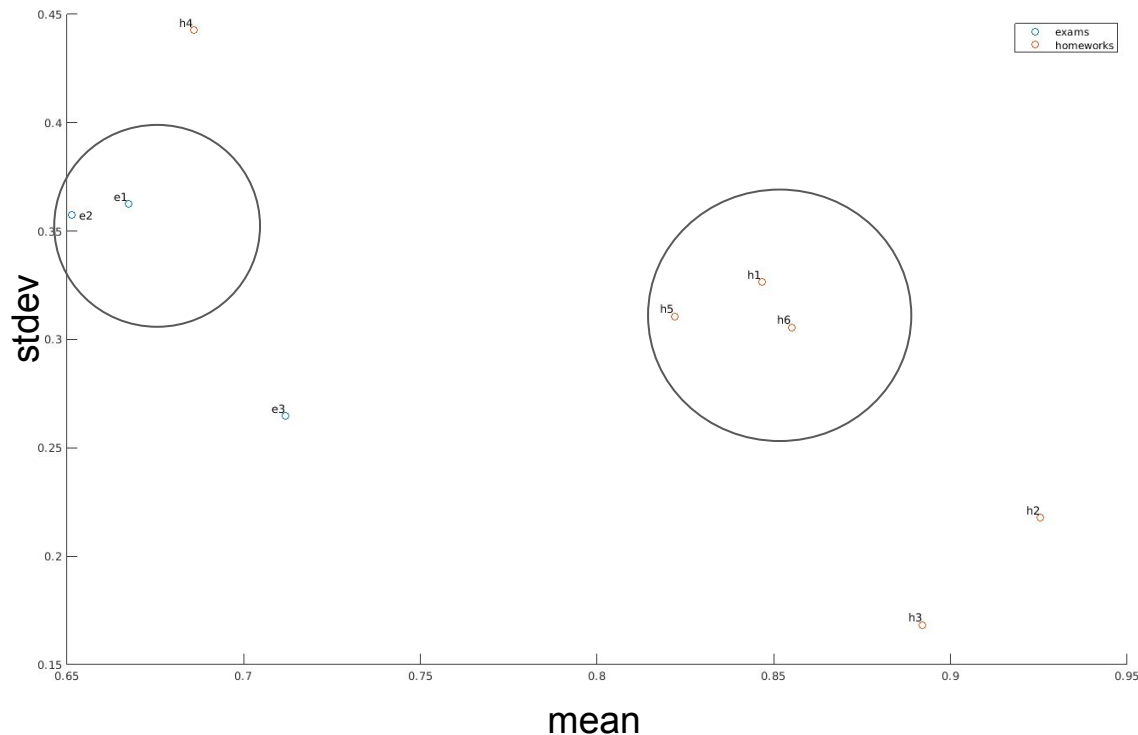# Course Inference

Summary

Questions

- Did students receive outside help on homework?
- Do homeworks help students review prerequisites?
- Do discussions and piazza sections help?
- What concepts did students find hard or find easy?

Did students receive help on homework?


Average normalized hw/exam scores

- Homework difficulty is about the same as exams
- Since homeworks are the first time a student learns the concept, it's expected that hw means will be lower
- But homework means tend to be around 20% higher than exam means

Did students receive outside help on homework?

- Higher homework means / lower exam means could be due to external help that the student received
    - Possible reuse of homework problems
    - online resources
    - The TA reported seeing students with answer keys before the homeworks were due
- How to identify these students?

Did students receive outside help on homework?

- Students are placed into four categories (lmls, lmhs, hmhs, hmls) by using the average std and average mean
- 6 students (20% of class) had hmls homework scores but received lmls scores on exam
- Characteristics of these 6 students?

category of students on exam vs homework
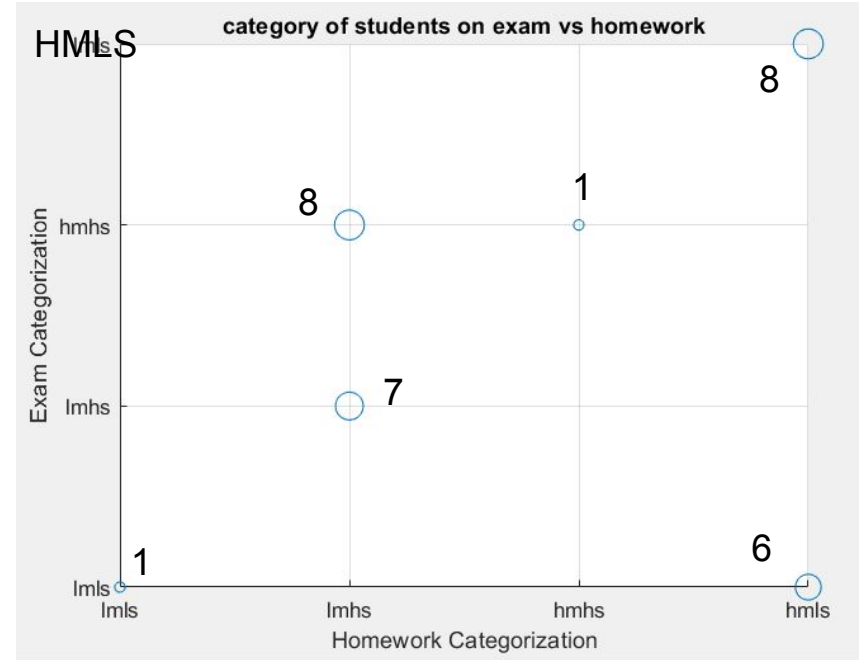
Did students receive outside help on homework?

- All six students showed negative change/ little change in scores between exams. (little change as half std deviation away from mean change of all students)
- Causes
    - Having access to previous year's answer keys may cause students who use them to not improve throughout the course.
    - They may also find it a little more challenging with more difficult questions later in the course.
    - This gives more support that these 6 students may have received outside help
- Around 20% of the class may have had detrimental effects due to using previous year's answer keys.

Do homeworks help students review prerequisites?

- 10 tags labeled as prerequisite and 14 not labeled
- Compared performance of students on prerequisite labeled tags and new tags
  - Each problem has tags associated with it. So comparing average scores on each problem.
  - In other words plotting average problem score on x axis and number of students on y axis

2.1	Intro Instructions	CS33
2.5	Representing Instructions	CS33
2.6	Logical Operations	CS33
2.7	Instructions for Making Decisions	CS33
2.8	Supporting Procedures in Computer Hardware	CS33
2.10	MIPS	
2.14	Array vs Pointers	CS33
3.5	Floating Point	
4.1	Intro Processor	M16
4.3	Building Datapath	M16
4.4	Simple Implementation Processor	
4.6	Pipelined Datapath and Control	
1.6	Performance	
4.7	Data Hazards	
4.8	Control Hazards	
4.10	Parallelism via Instructions	
1.6	Performance	
5.3	Basics Cache	CS33
5.4	Measuring/Improving Cache	
5.7	Virtual Memory	CS33
6.3	SISD, MIMD, SIMD, SPMD, and Vector	
6.4	Hardware Multithreading	
A38		
OL5		

Do homeworks help students review prerequisites?
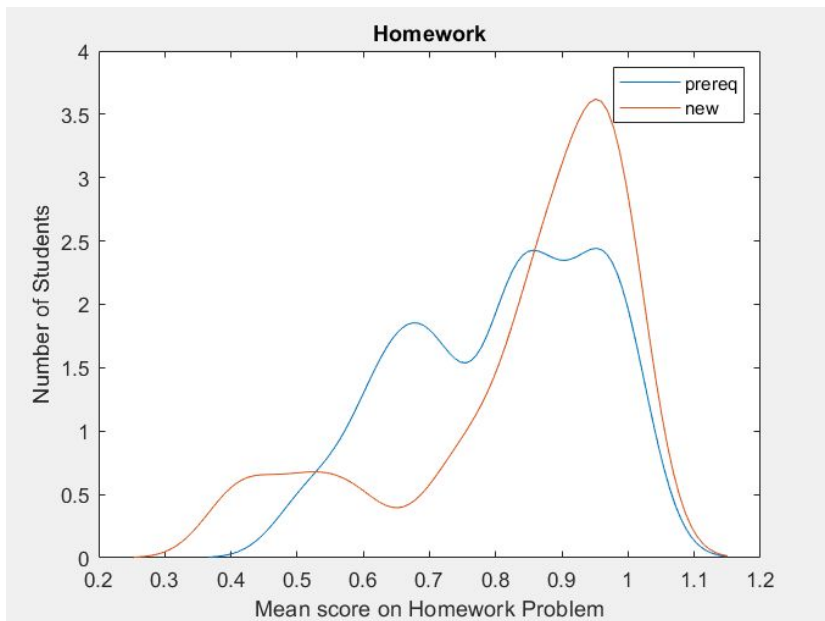
P = .0994
Distributions are significantly different
for 10% significance level
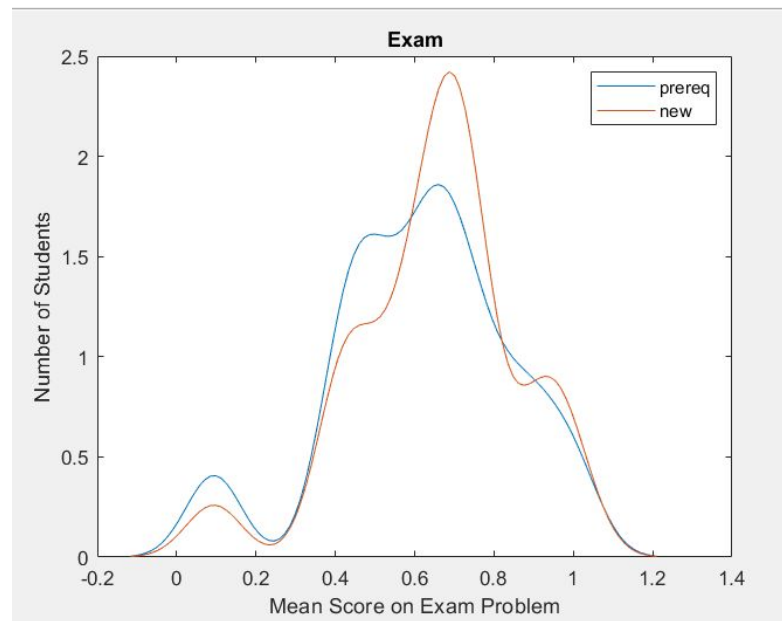
P = .8938
Distributions are not significantly
different

# Do homeworks help students review prerequisites?

- Significant difference on tags associated with prerequisites on homeworks but not on exams
- On homeworks, prerequisite tags tend to have a higher standard deviation and a lower mean
- Shows that some students are either forgetting certain prerequisite materials or that they might have understood it wrong in previous courses
    - But homeworks do seem to have an effect on remembering these materials because there is no significant difference between the two distributions on exams
- It might be helpful to either focus TA sections a little more into prerequisites or give a couple of review problems on homework.

Do discussions / piazza help?

- Between hw3 and hw4, the first TA left for a brief period of time
- Homework 4 had a huge drop in mean performance.
- The tags B, C, and D were on hw4
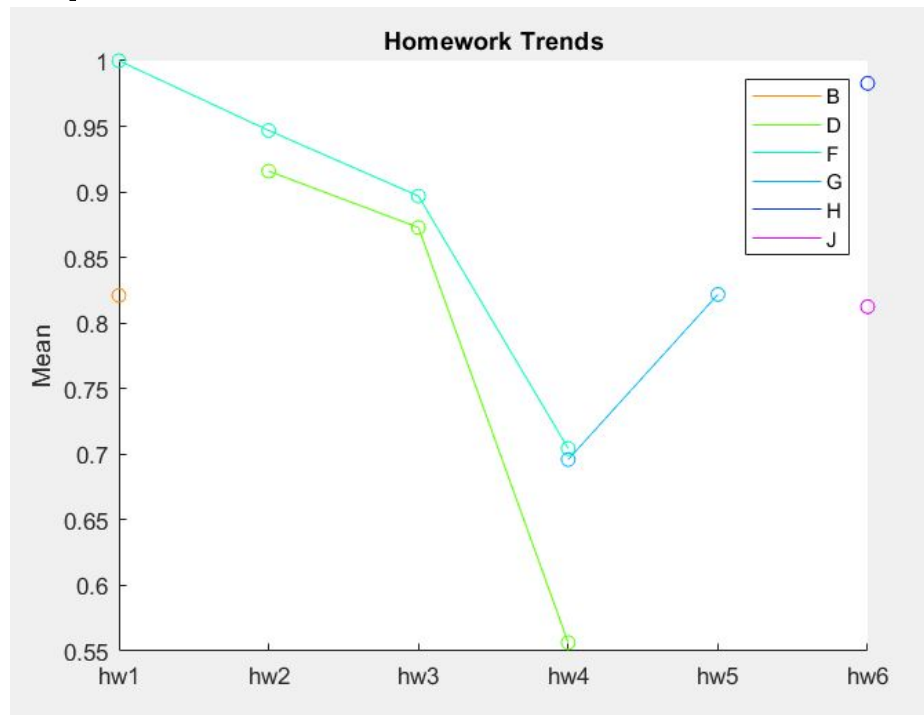
Do discussions / piazza help?
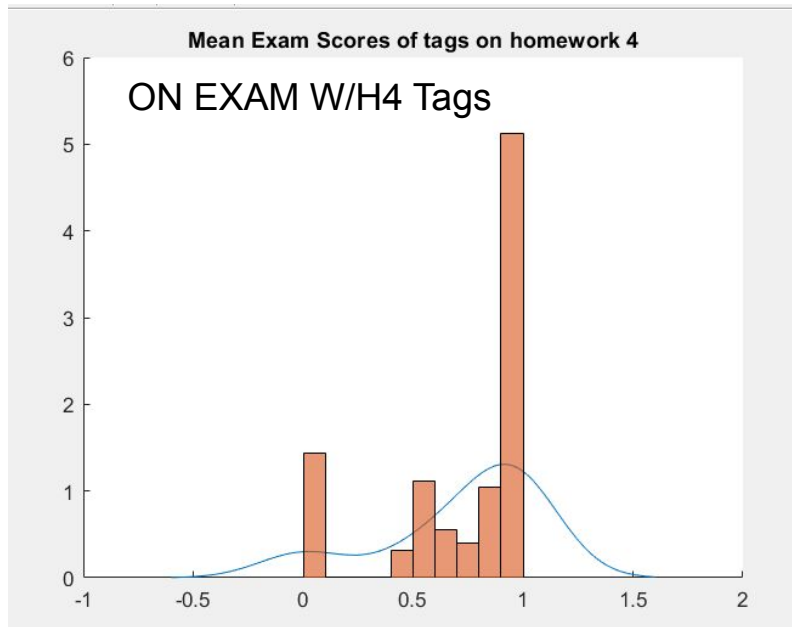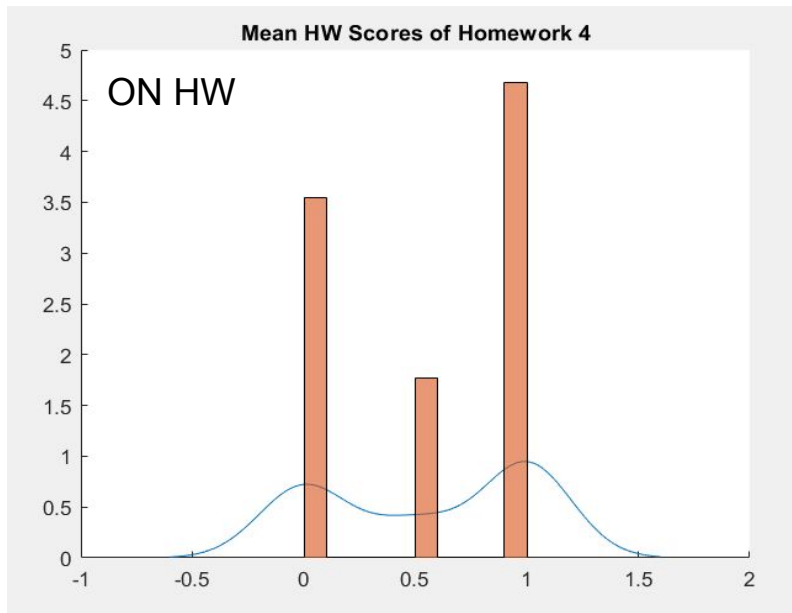
- Homework 4 was affected with a big increase in 0 scores suggesting big misunderstanding of homework concepts.
- But looking at the performance of those same concepts on exams, it seems to have been made up.

Do discussions / piazza help?

Mean Exam Scores of tags on homework 4 — ON EXAM

Mean Exam Scores of tags not on homework 4
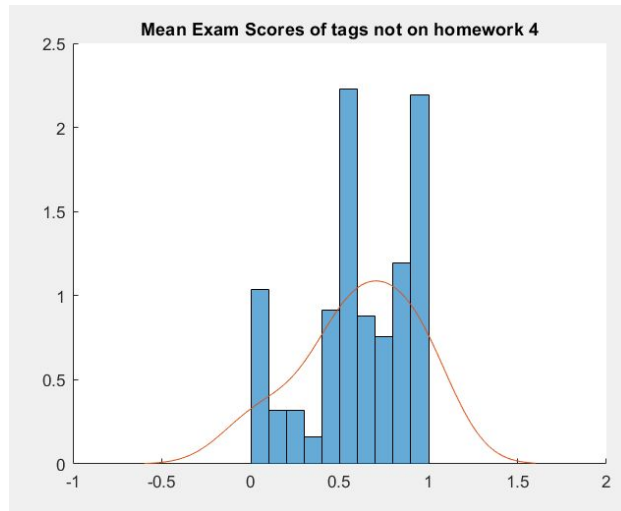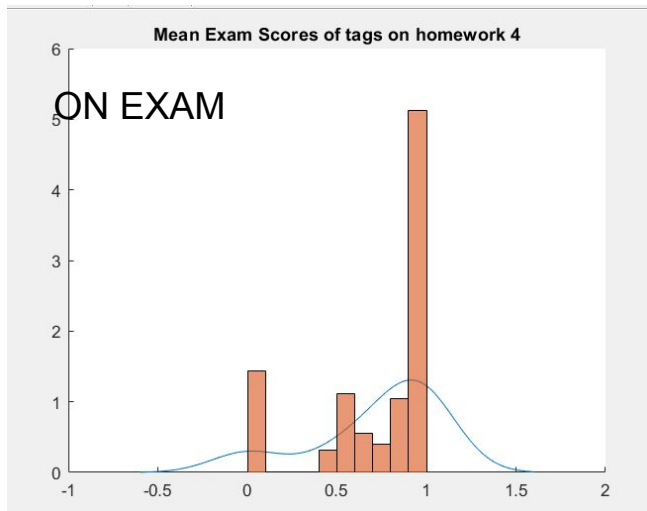
- Furthermore, by the concepts on homework 4 to concepts not on homework 4 on exams, there is no significant difference
- KS test on these two distributions resulted in a p-value of .89 which rejects the hypothesis that these two distributions are significantly different

Do discussions / piazza help?

- There was an initial drop of understanding as seen on homework
- But after the second TA recovered the TA section and started answering questions on piazza, the concepts seems perform well again
- The concepts that were on hw4 and subsequent homeworks also increased (but there was only one concept from hw4 that was on subsequent hws)
- This suggests the necessity of having discussion sections as it helps students to understand concepts better.

What concepts did student find hard or easy?

HM/HS, HM/LS, LM/HS, LM/LS

- HOMEWORK (48 Problems)
- B [1 2 2 1] 6 (HM/LS)(LM/HS)
- D [1 8 2 1] 12 (HM/LS)
- F [1 11 4 1] 17 (HM/LS)
- G [0 2 1 2] 5 (HM/LS)(LM/HS)
- H [0 2 0 0] 2 (HM/LS)
- J [0 3 3 0] 6 (HM/LS)(LM/HS)
- Total [3 28 12 5]

HM/HS, HM/LS, LM/HS, LM/LS

- EXAMS (28 Problems - Final Split Up)
- C [1 0 0 0] 1 (HM/HS)
- D [0 1 0 0] 1 (HM/LS)
- F [1 3 2 0] 6 (HM/LS)(LM/HS)
- G [2 1 4 1] 8 (LM/HS)
- H [0 1 3 0] 4 (LM/HS)
- I [1 0 2 1] 4 (LM/HS)
- J [0 1 0 3] 4 (HM/LS)
- Total [5 7 11 5]

HM/HS, HM/LS, LM/HS, LM/LS Possible Meanings

- Each tag can be assigned into a group by student's scores within the group
- HM/HS
  - Generally, Students do very well but a few students do extremely poorly
- LM/HS
  - Generally topic is hard but a few students did very well.
- HM/LS
  - Topic was easy … most people did well and no outliers
- LM/LS
  - Topic was hard … no one did well and no outliers
- HM/LS, LM/HS (Several Tags had equal number of probs in both categories)

  - These topics might not be more difficult but there exists more difficult versions of the problems

What concepts did student find hard or easy?

- On homeworks, these concepts are considered easy given that most students did well
  - Pipelining/ Datapath and Control/ Data and Control Hazards and Virtual memory/ Performance
- However, on exams, questions covering virtual memory and Data/Control hazards has LM components meaning it's more difficult on exams

|		
2.1	Intro Instructions	B
2.5	Representing Instructions	
2.6	Logical Operations	
2.7	Instructions for Making Decisions	
2.8	Supporting Procedures in Computer Hardware	
2.10		
2.14	Array vs Pointers	
3.5	Floating Point	C
4.1	Intro Processor	D
4.3	Building Datapath	
4.4	Simple Implementation Processor	
4.6	Pipelined Datapath and Control	
1.6	Performance	
4.7	Data Hazards	F
4.8	Control Hazards	
4.10		
1.6	Performance	
5.3	Basics Cache	G
5.4	Measuring/Improving Cache	
5.7	Virtual Memory	H
6.3	SISD, MIMD, SIMD, SPMD, and Vector	I
6.4	Hardware Multithreading	
A38		J
OL5		

What concepts did student find hard or easy?

- If there was no issues with students relying on solutions, then this shows that homework questions on these concepts were too easy for students compared to exams
  - There might also be difference in these concepts.
- There were also complaints with the differences between exam and homework
- Virtual Memory and Data/Control Hazards may need more difficult questions on homework in order to more adequately prepare students for exams
- Students did perform very well on Floating Point, Pipelining, and IO on exams.
  - For multithreading, there were some difficult homework problems which may have helped exam scores

What concepts did student find hard or easy?

- Students struggled with Cache/ Virtual Memory/ and Multithreading in the course
    - These were all taught in the second half of the course and were covered in less time than pipelining
    - May need to spend a little more time within these subjects and possibly a little less time on pipelining given how students are doing very well on it.
- However these all had very high std so not all students did poorly on these concepts.
- What percent of the class did poorly?

What concepts did student find hard or easy?

- Take into account every exam question on Cache, Multithreading, and Virtual memory
- Below is the distribution of scores for every attempt on a problem within these categories
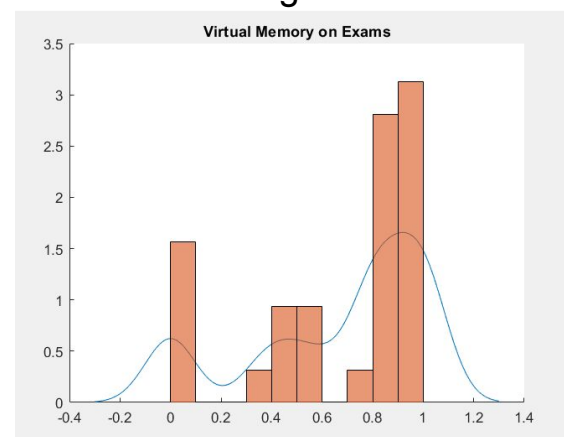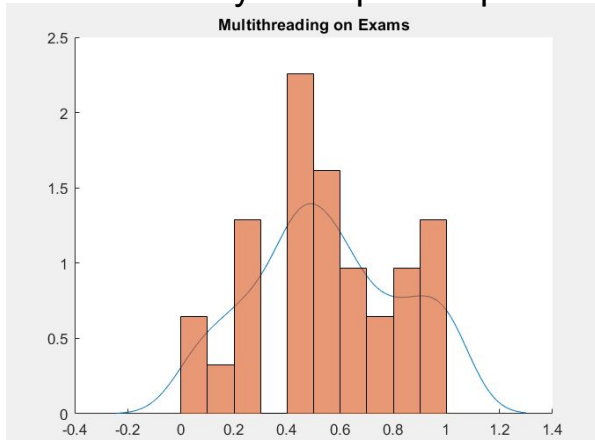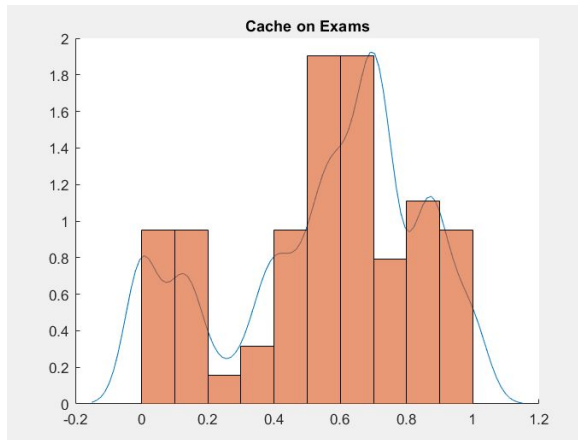
- Low mean is taken to be anything less than 0.69
- 48% below for Cache (Mean 67.74%)
- 70.97% below for Multithreading (Mean 55.03%)
- 37.5% below for Virtual Memory (Mean 68.55%)

Cache [2 1 4 1] 8 (LM/HS)
Multithreading [0 1 3 0] 4 (LM/HS)
Virtual Memory [1 0 2 1] 4 (LM/HS)

What concepts did student find hard or easy?

- Even though easier problems were included, they were all still within the threshold to be considered a hard concept.
- However, for Virtual Memory and Caching, most students did well
  - Only 37.5% and 48.5% of the class had difficulties with the problems. Since mean is still 0.69, these had a pretty difficult time with those concepts
- For multithreading, most of the class did poorly (70.97% of the class)
  - Multithreading is the very last concept in the class and this strongly suggests more time should be spent on this particular concept

Conclusions

- 20% of the class may have had detrimental effects as a result of outside help on homework
- Students coming in generally do not have prerequisites mastered and may benefit from TA sections focusing on them / review problems on homework
- TA discussion sections and Piazza answers are important in helping students in learning concepts
- There may need to be more time or supplementary material for Cache/ Virtual Memory/ and Multithreading in the course
    - Time could be taken from pipelining, data and control
    - Or from computer arithmetic since that never appeared in homeworks or exams
- Students especially needs more help in multithreading

***Normalization

- Each problem was weighted the same so I normalized scores to between 0 and 1
- But since input files did not contain maximum possible scores, I took the max score any student received to be the maximum possible score
    - Basically assumed maximum possible score == max score any student received
    - This is true for every problem except problem 3 on the final exam where the top student received 17/20
    - Factoring this one person in, no significant differences were seen.
        - Mean: 0.55 -> 0.47 (for that particular problem)
        - Std: 0.27 -> 0.24
        - The problem remains in the LM/LS category.