

A Mastery System for a CS Theory Course



Motivation

- “Normal” weighted systems have issues
 - One time testing limits growth
 - Assigning partial credit is a pain
 - Figuring out a reasonable rubric
 - Grade grubbing

Mastery Systems

- Mastery systems:
 - Allow repeated chances
 - Have a simplified grading scheme
 - Often either pass/fail, with maybe one intermediate grade
- However:
 - Often have the reputation of being work intensive
 - The grading system can be confusing for students

Class Context

- CS Theory (in the line of automata + basic complexity)
- Spring of 2025
- 25 students, no course staff
 - Liberal arts college, so this is considered huge
- Course is required for CS majors at Dickinson
- Course prerequisites:
 - Discrete Math
 - Data Structures
- Counts as a math elective
- Mostly juniors and seniors, with a couple of sophmores
 - 2 non-CS majors (taking as a math elective)

My System

- To keep thing simple, everything is based on “steps”
 - 1 step is “1/3 of a letter grade”
 - A -> A-
 - A- -> B+
- Grade based on:
 - Exams
 - Homework

My System

- Exams topic grades:
 - Pass
 - Almost pass
 - Fail

- At the end of course:
 - Fail: -2 steps
 - Almost: -1 step

- Homework grades:
 - Pass
 - Fail

- At the end of course:
 - Fail: -1 step

Topics

- FSAs
 - Interpreting FSAs
 - Creating FSAs
- “Post-FSA”
 - Regular Expressions
 - Pumping Lemma
- PDAs
 - Interpreting PDAs
 - Creating PDAs
- TMs + TM Complexity
 - Interpreting TMs
 - Proving Undecidability
- Computational Complexity
 - NP
 - NP-hardness

- The **outer** bullets correspond to **homework assignments**
- The **inner** bullets correspond to **exam topics**

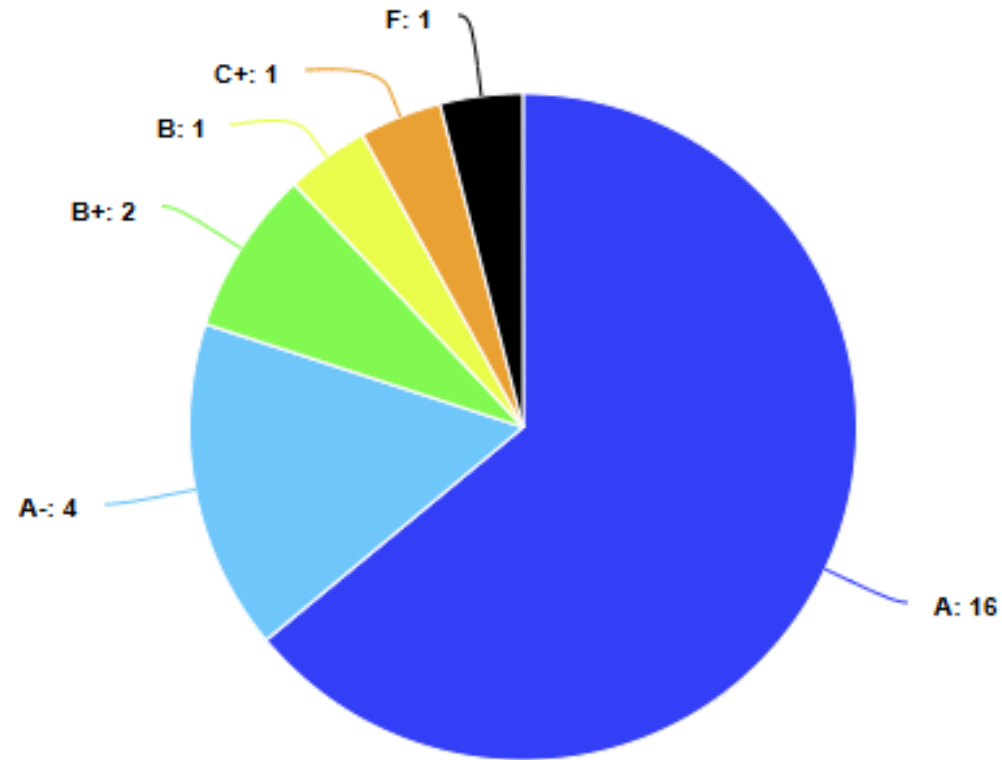
Exam Structure

- After each HW is graded, a class written exam is held
 - The exam contained a question for each topic
 - The topics on the exam included new topics + most old topics
- After the exam, students can schedule office hour exams
 - Despite name, not limited to office hours
 - Just a “try anytime I’m available”
 - I give the students a question to solve
 - If they pass, they pass
 - If not, I give feedback
 - Format:
 - If student is alone, I have them do it on the whiteboard
 - If multiple students, I have them do it written

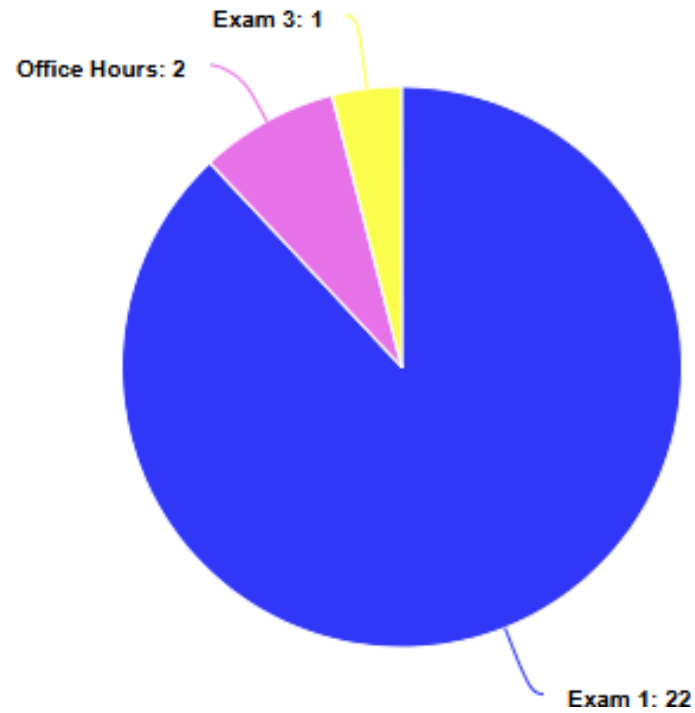
Homework

- Homework consisted of a series of questions similar to exams
- Graded as pass/fail
- Solutions are posted after submission deadline
- If failed, can turn into pass via a “reflection”:
 - They just need to show that they read the feedback and understand the solutions

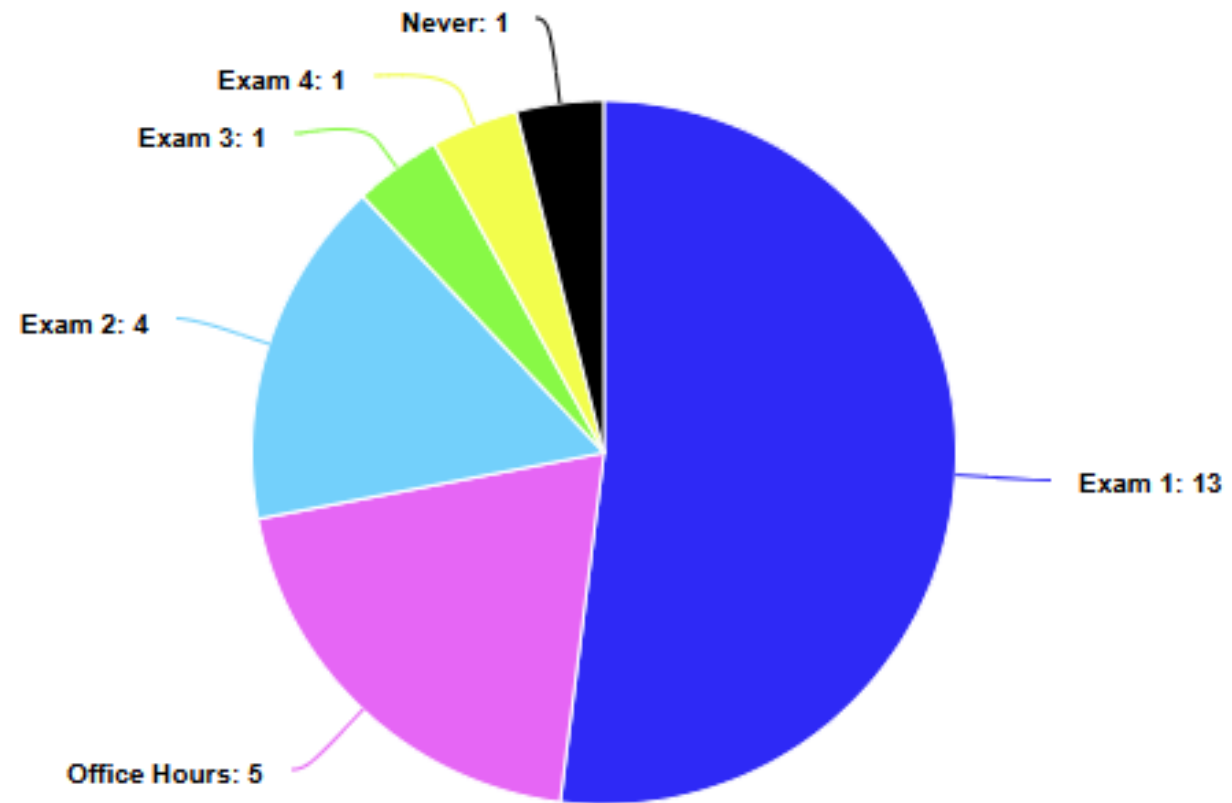
Final Grade Distribution



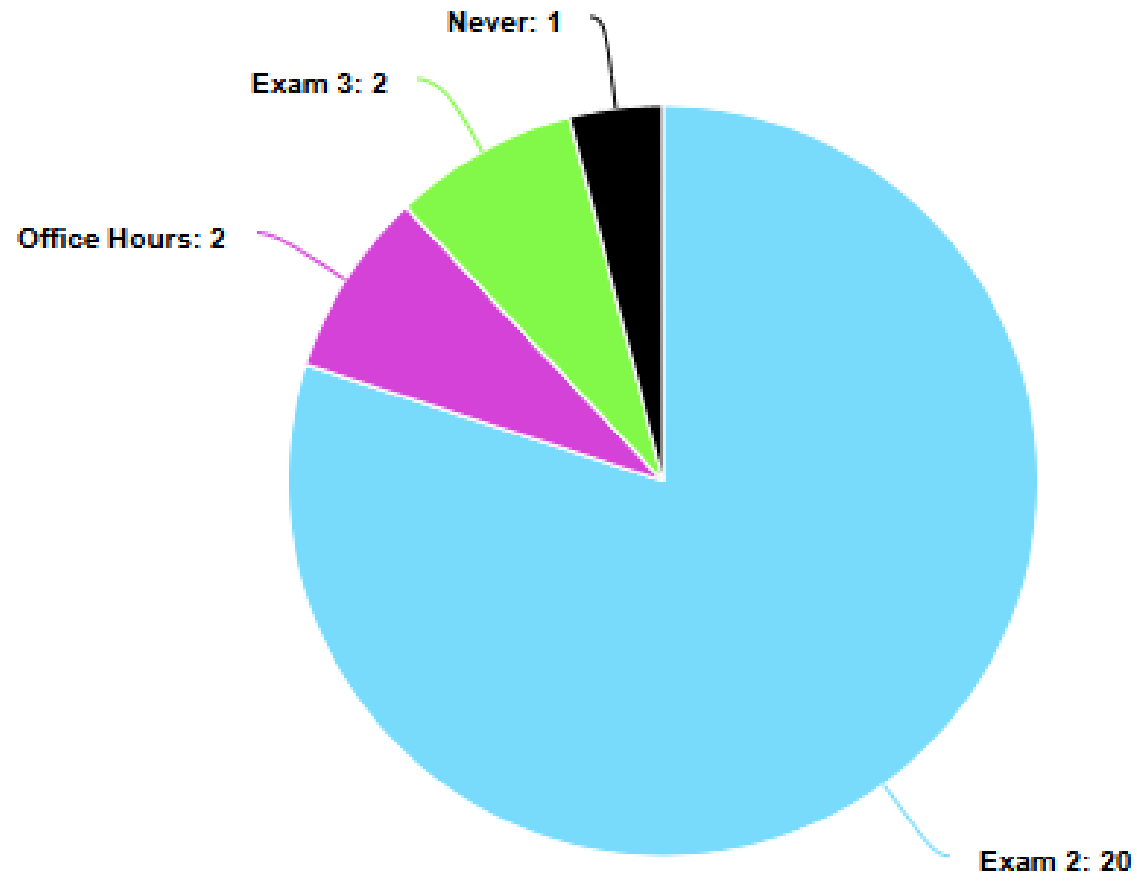
Interpreting FSA



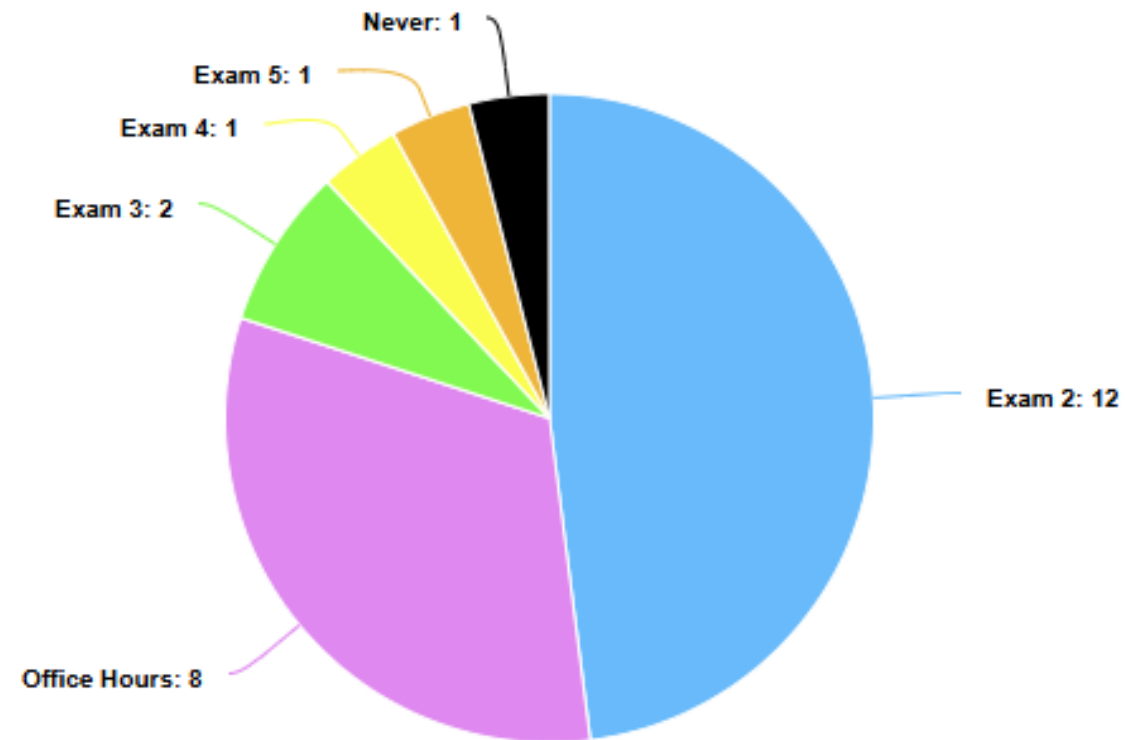
Creating FSA



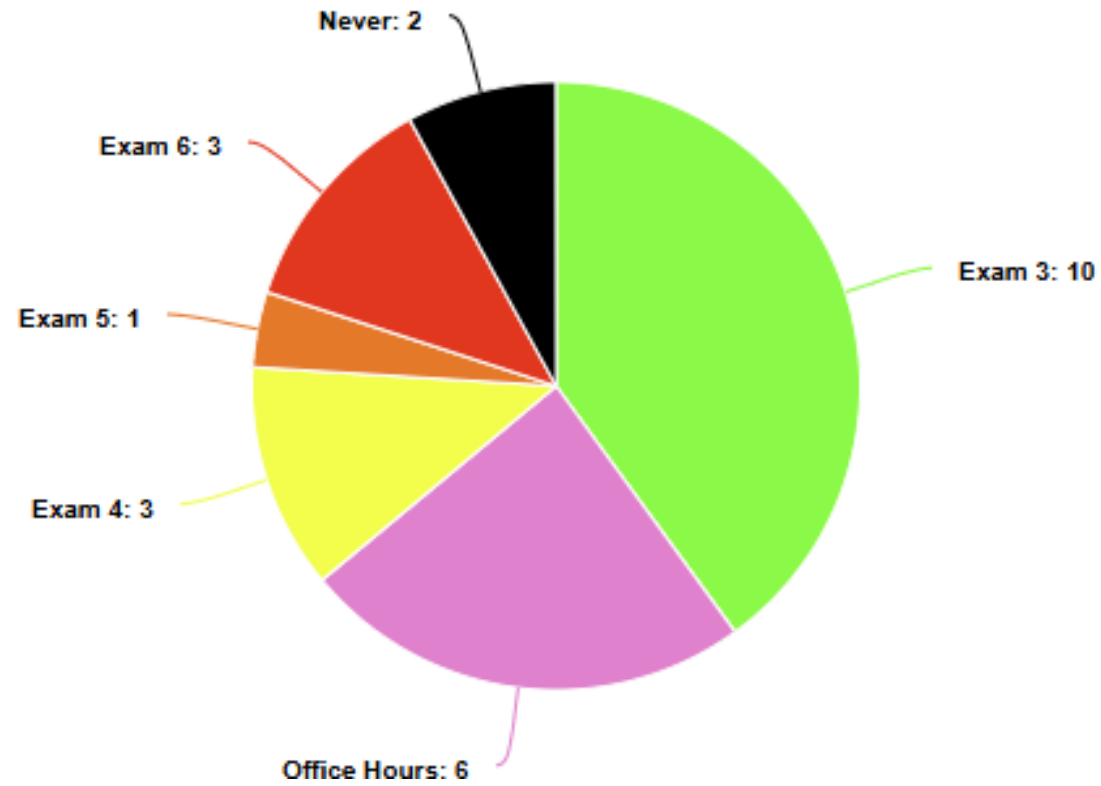
Regular Expressions



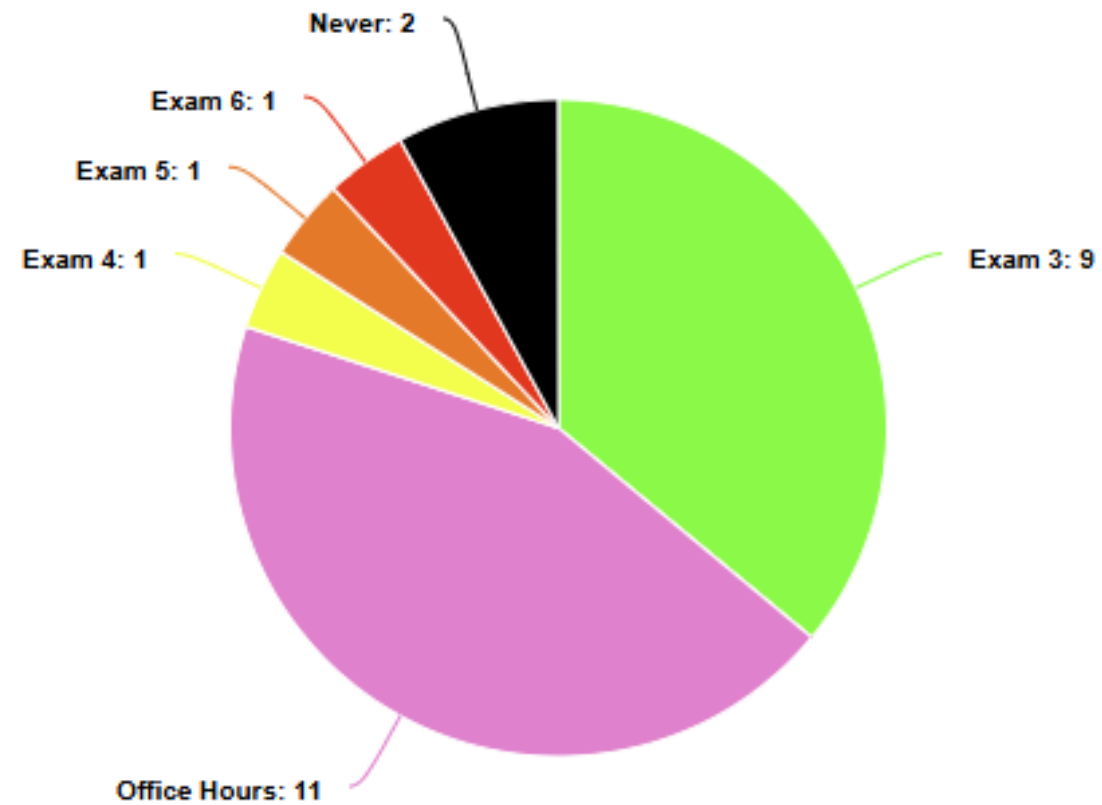
Pumping Lemma



Interpreting PDA



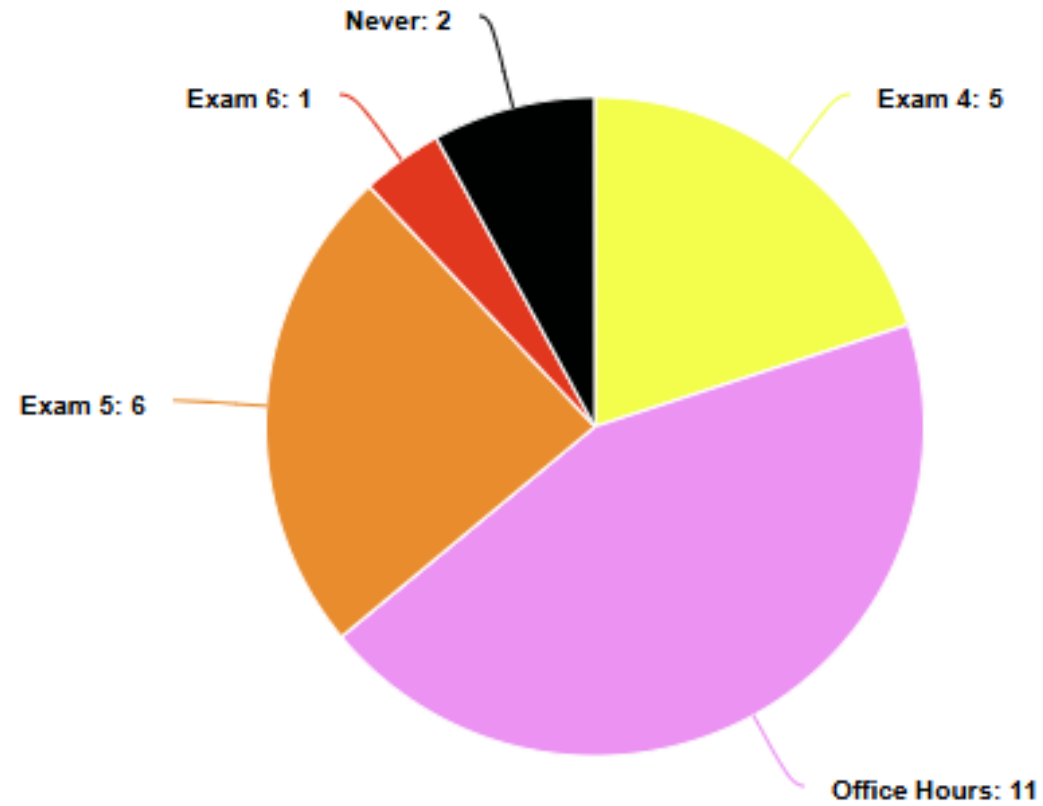
Creating PDA



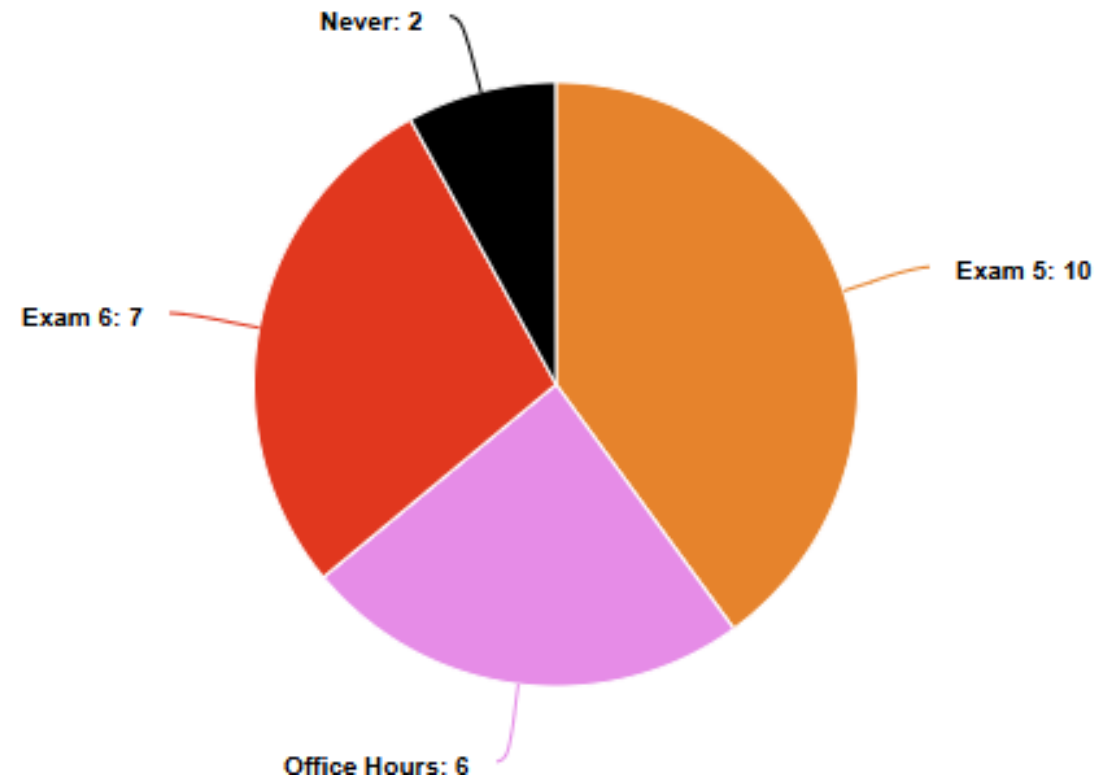
Turing Machines



Undecidability



NP



Positives

- Overall well received
- Good outcomes (representing real understanding)
- Honestly, less grading than one may expect
 - With mostly binary grading, only about 5 mins per student per exam
 - OH exams are basically instant grading
- Question creation isn't that bad
 - Automata questions pretty easy to create on the fly
 - Though written exam is more painful since using Tikz
 - Also easy for pumping lemma, undecidability, and NP
 - Turin Machines is probably the hardest one
- Scalability: If your institution allows TAs to create questions and grade, can be scalable with small enough course to staff ratios
- No grade grubbing

Lessons Learned over 4 semesters

- You HAVE to explain the system well
 - Intro lecture should basically be dedicated to it
 - Explain the philosophy of WHY. Don't just throw it on them
- When few students remain for a topic:
 - Announce that those topics will stop appearing on the exam
 - Email students and get them into OH attempts
- Be very wary of making questions too easy
- Be careful to proofread exams
- If class is larger, consider multiple out of class times scheduled that students can choose from
- Make sure to have enough topics that bombing one or two doesn't completely destroy student's grade

Negatives

- If not proactive:
 - Bunch of students during finals week
- For large courses, bad TAs will screw you
 - False positive grades are real bad in this system

Thank You!

GRADER TYPES

