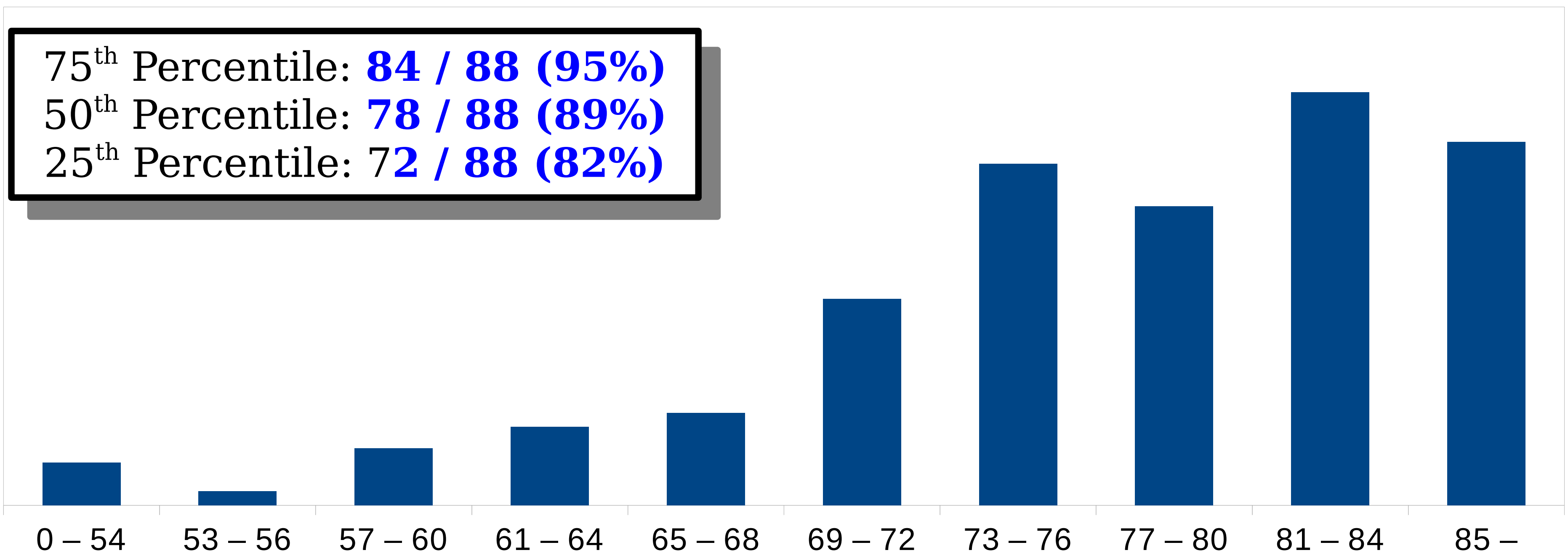
The Big Picture

Announcements

- Problem Set 9 was due thirty minutes ago. Solutions are available outside and also on the course website.
  - ***Congratulations – you're done with CS103 problem sets!***
- Problem Set 8 grade distribution:

75th Percentile: **84 / 88 (95%)**
50th Percentile: **78 / 88 (89%)**
25th Percentile: **72 / 88 (82%)**



Please evaluate this course on Axess.

Your feedback really makes a difference.

Final Exam Logistics

- Our final exam is Monday, March 19th from 3:30PM – 6:30PM, location Hewlett 200 & 201 (no special last name assignments).
  - Sorry about how soon that is – the registrar picked this time, not us. If we had a choice, it would be on the last day of finals week.
- The exam is cumulative. You’re responsible for topics from PS1 – PS9 and all of the lectures.
- As with the midterms, the exam is closed-book, closed-computer, and limited-note. You can bring one double-sided sheet of 8.5” × 11” notes with you to the exam, decorated any way you’d like.

Preparing for the Final

- On the course website you'll find
  - ***six*** practice final exams, which are all real exams with minor modifications, with solutions, and
  - a giant set of 46 practice problems (EPP3), with solutions.
- Our recommendation: Look back over the exams and problem sets and redo any problems that you didn't really get the first time around.
- Keep the TAs in the loop: stop by office hours to have them review your answers and offer feedback.

Outline for Today

- ***Your Questions***
  - What do you want to know?
- ***Where to Go from Here***
  - What's next in CS theory?
- ***Final Thoughts!***

Your Questions

Your Questions

Ask a Question!

- We're happy to take questions on just about anything. Some possible topics:
  - Life advice!
  - Diversity in tech!
  - Growth mindsets!
  - CS103 concepts!
  - Opinions on things!
  - ***Or just about anything!***
- The one rule for today: only ask a question if you really want to know the answer. Please don't grandstand. ☺

Ask us at **PollEv.com/cs103** or upvote other questions you like!

Where to Go From Here

We've gone to the absolute limits of computing.

We've probed the limits of efficient computation.

Congratulations on making it this far!

What's next in CS theory?

Formal languages

What problems can be solved by computers?

Regular languages
Context-Free Languages
R and **RE**
P and **NP**

DFAs
NFAs
Regular Expressions
Context-Free Grammars
Recognizers
Deciders
Verifiers
Poly-time TMs/Verifiers

Function problems (CS254)
Counting problems (CS254)

What problems can be solved by computers?

Interactive proof systems (CS254)
Approximation algorithms (CS261/369A)
Average-case efficiency (CS264)
Randomized algorithms (CS265/254)
Parameterized complexity (CS266)
Communication complexity (CS369E)

Nondeterministic TMs (CS154)
Enumerators (CS154)
Oracle machines (CS154)
Space-Bounded TMs (CS154/254)
Machines with Advice (CS254/354)
Streaming algorithms (CS263)
μ-Recursive functions (CS258)
Quantum computers (CS259Q)
Circuit complexity (CS354)

How do we actually get the computer to effectively solve problems?

DFA design intuitions
Guess-and-check
Massive parallelism
Myhill-Nerode lower bounds
Verification
Polynomial-time reductions

How do we actually get the computer to effectively solve problems?

Algorithm design (CS161)
Efficient data structures (CS166)
Modern algorithmic techniques (CS168)
Approximation algorithms (CS261/CS369A)
Average-case efficient algorithms (CS264)
Randomized algorithms (CS265)
Parameterized algorithms (CS266)
Geometric algorithms (CS268)
Game-theoretic algorithms (CS364A/B)

What mathematical structures arise in computer science?

Sets
Propositional and First-Order Logic
Equivalence Relations
Strict Orders
Functions
Injections, Surjections, Bijections
Graphs
Planar and Bipartite Graphs
Polynomial-Time Reductions

What mathematical structures arise in computer science?

Groups, Rings, and Fields (Math 120, CS255)
Trees (Math 108, CS161)
Graphs (Math 107, Math 108)
Hash Functions (CS109, CS161, CS255)
Permutations (Math 120, CS255)
Monoids (CS149)
Lattices and Semilattices (CS143)
Control-Flow Graphs (CS143)
Vectors and Matrices (Math 113, EE103, CS205A)
Modal Logic (Phil 154, CS224M)
Mapping Reductions (CS154)

Where does CS theory meet CS practice?

Finite state machines
Regular expressions
CFGs and programming languages
Password-checking
Secure voting
Polynomial-time reducibility
NP-hardness and **NP**-completeness

Where does CS theory meet CS practice?

Compilers (CS143)
Computational logic (CS157)
Program optimization (CS243)
Data mining (CS246)
Cryptography (CS255)
Programming languages (CS258)
Network protocol analysis (CS259)
Techniques in big data (CS263)
Graph algorithms (CS267)
Computational geometry (CS268)
Algorithmic game theory (CS364)

A Whole World of Theory Awaits!

What's being done here at Stanford?

Algorithms ∩ Game theory

(Tim Roughgarden)

Learning patterns in randomness

(Greg Valiant)

Fairness and Computability

(Omer Reingold)

Approximating NP-hard problems

(Moses Charikar)

Optimizing programs... randomly

(Alex Aiken)

Computing on encrypted data

(Dan Boneh)

Interpreting structure from shape

(Leonidas Guibas)

Correcting errors automatically

(Mary Wootters)

So many options – what to do next?

Really enjoyed this class?

Give CS154 a try!

Interested in trying out CS?

Continue on to CS109!

Want to see this material come to life?

Check out CS143!

Want to tame infinity?

Dive into Math 161!

Like discrete structures?

Try Math 107 or Math 108!

Want to just go write code?

Take CS107!

Keep on exploring! There's so much more to learn!

Final Thoughts

A Huge Round of Thanks!

There are more problems to solve than there are programs capable of solving them.

There is so much more to explore and so many big questions to ask – ***many of which haven't been asked yet!***


Theory
Practice

You now know what problems we can solve, what problems we can't solve, and what problems we believe we can't solve efficiently.

Our questions to you:

What problems will you ***choose*** to solve?
Why do those problems matter to you?
And how are you going to solve them?