Today’s goal

• Review content from first half of course

• Connect recurring examples to broader CS themes and learning outcomes of CSE 20
Recurring examples in CSE 20

- Netflix ratings and machine learning
- RNA and DNA: genomics and bioinformatics
- Codes: secret messages and error correction
- “Under the hood” of computers (e.g. circuits, color representation, data structures)
Building secure web applications

How it works

Unlike most runtime security solutions, which try to defend against application-level attacks by analyzing or monitoring behavior, Intrinsic protects against attacks by enforcing that your Node.js code only executes as expected.

Intrinsic is a new virtualization technology that lives in the Node.js language runtime. It blocks all privileged operations that are not whitelisted by your security policies.

Protecting your app is simple: include the Intrinsic library, write security policies, and Intrinsic makes sure your app runs safely.

Deian Stefan
UCSD CSE
“clean-slate approach to building secure, low-level systems and applications (e.g., remote shells and web servers), even if building secure systems applications is notoriously difficult”
Consider the following algorithm to introduce redundancy in a string of 0s and 1s.

Create redundancy by repeating each bit three times

```
procedure redund3(a_{k-1} \cdots a_0: \text{a binary string})
for i := 0 to k - 1
  c_{3i} := a_i
  c_{3i+1} := a_i
  c_{3i+2} := a_i
return c_{3k-1} \cdots c_0
```

Decode sequence of bits using majority rule on consecutive three bit sequences

```
procedure decode3(c_{3k-1} \cdots c_0: \text{a binary string whose length is an integer multiple of 3})
for i := 0 to k - 1
  if exactly two or three of c_{3i}, c_{3i+1}, c_{3i+2} are set to 1
    a_i := 1
  else
    a_i := 0
return a_{k-1} \cdots a_0
```

Give a recursive definition of the set of outputs of the `redund3` procedure, $Out$,

**Basis step:** ______________

**Recursive step:** ______________

Roster method? Set builder notation?
Consider the message $m = 0001$ so that the sender calculates $\text{redu3}(m) = \text{redu3}(0001) = 000000000111$.

Introduce ___ errors into the message so that the signal received by the receiver is __________ but the receiver is still able to decode the original message.

What are correct ways to fill in the blanks?
A. 2 errors, received signal is 000000000001
B. 5 errors, received signal is 110111000111
C. 4 errors, received signal is 100010010101
D. More than one of the above
E. None of the above
Building a circuit for line 3 in *decode* procedure: given three input bits, we need to determine whether the majority is a 0 or a 1.

How many inputs and outputs for this circuit?
A. 1 input and 1 output
B. 3 inputs and 1 output
C. 1 input and 3 outputs
D. 3 inputs and 3 outputs
E. None of the above
Building a circuit for line 3 in *decode* procedure: given three input bits, we need to determine whether the majority is a 0 or a 1.

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Genome Sequencing

PyBamView is a python-based application that allows you to view BAM sequence alignments through your web browser. It was inspired by the samtools tview tool, and was motivated by the need to better visualize alignments with complex insertions/deletions across multiple samples, which is not handled well by current browsers such as IGV and the UCSC Genome Browser.

*New!* You can now generate alignment snapshots automatically on the command line using the snapbam utility, described here.

Melissa Gymrek
UCSD CSE/Medical School

“complex genetic variants that underlie human disease. We are particularly interested in repetitive DNA variants known as short tandem repeats (STRs) as a model for complex variation.”

https://mgymrek.github.io/pybamview/
Advances in cancer research using genomics
Recurring example: RNA strands

Recall that $S$ is defined as the set of all RNA strands, strings made of the bases in $B = \{\text{A, U, G, C}\}$. Consider the following predicates:

$Rep_{\text{AC}}(s, n) = \text{"The RNA strand has at least } n \text{ repeats of } \text{AC"}$

$Rep_{\text{AAC}}(s, n) = \text{"The RNA strand has at least } n \text{ repeats of } \text{AAC"}$
Translate to a formal statement, write its negation, and determine which is true.

If A has at least one repeat of AC then it has at least one repeat of AAC.

_________________________  Negation is: ____________________________

What is the logical structure of the statement?
A. Statement is a conditional statement; its negation is also a conditional statement.
B. Statement is a conditional statement; its negation is a conjunction.
C. Statement is a universal quantification; its negation is also a universal statement.
D. Statement is a universal quantification; its negation is an existential quantification.
E. None of the above
Translate to a formal statement, write its negation, and determine which is true.

It is sufficient for a strand to have at least 3 repeats of AAC for it to have at least 2 repeats of AC.

Negation is:
Translate to a formal statement, write its negation, and determine which is true.

For at least one strand, it has at least 2 repeats of AC exactly when it has at least 2 repeats of AAC.

_____________________________  Negation is: ________________________________
See you tomorrow

You can do this.