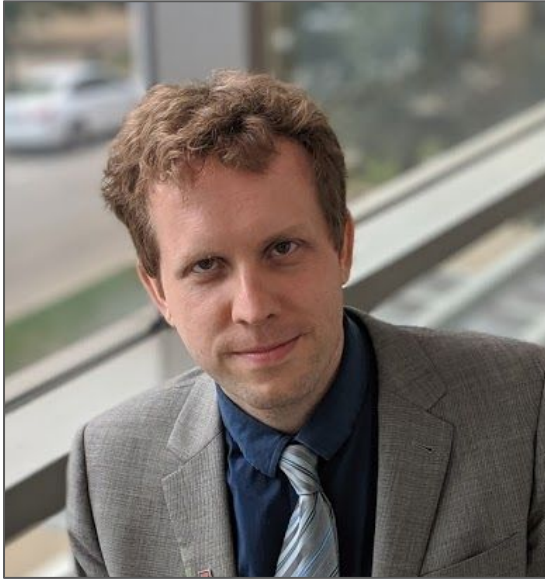


Welcome to CS 240 + Binary Digits

CS 240 - The University of Illinois

Wade Fagen-Ulmschneider
August 24, 2021

No good party starts without introductions...



Wade Fagen-Ulmschneider (waf)

Teaching Associate Prof. of Computer Science
Grainger College of Engineering

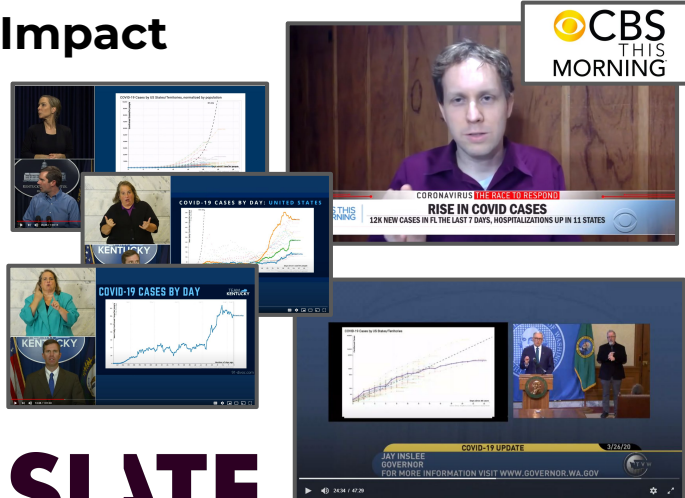
Nerding out in life...

Industry



Morgan Stanley

Impact



SLATE

POPULAR MECHANICS

SALON

The Washington Post

Vox

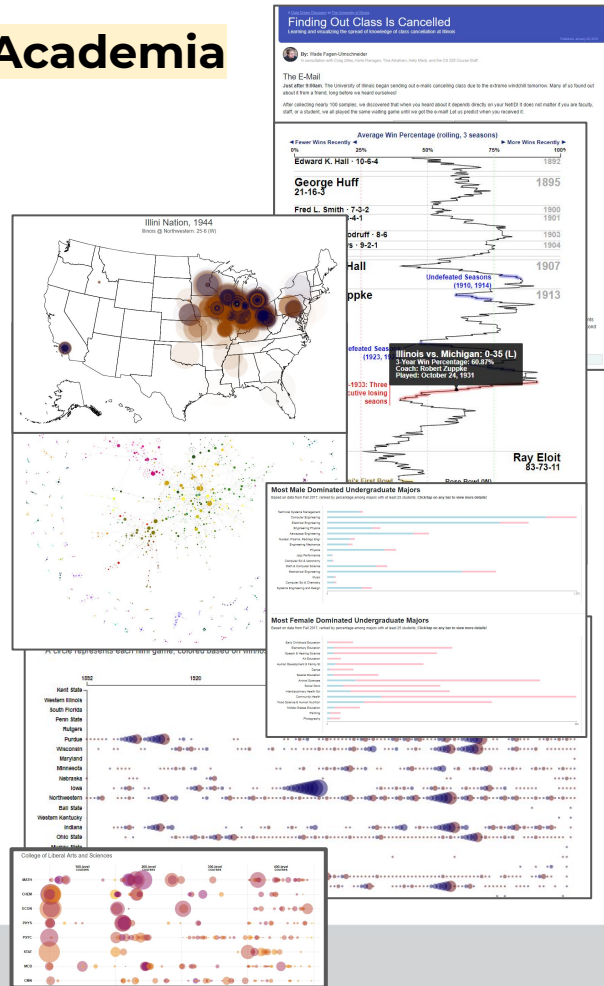
Bloomberg

GIZMODO

THE VERGE

MAAS Science

Academia



Course Staff:

You:

You:

You:

You:

Overview: **You Already Know**

Overview: **You Already Know**

C++ Programming (CS 225)

Overview: **You Already Know**

C++ Programming (CS 225)

Data Structures (CS 225)

Overview: **You Already Know**

C++ Programming (CS 225)

Data Structures (CS 225)

Algorithm Analysis (CS 173)

Overview: **You Already Know**

C++ Programming (CS 225)

Data Structures (CS 225)

Algorithm Analysis (CS 173)

Programming Skills (CS 125/126/225)

Overview: **After CS 240**

Overview: **After CS 240**

Foundational Computer Architecture

Overview: **After CS 240**

Foundational Computer Architecture

Operating System Design

Overview: **After CS 240**

Foundational Computer Architecture

Operating System Design

Multiprogramming and Resource Sharing

Overview: **After CS 240**

Foundational Computer Architecture

Operating System Design

Multiprogramming and Resource Sharing

Cloud-based Infrastructure

Overview: **After CS 240**

Foundational Computer Architecture

Operating System Design

Multiprogramming and Resource Sharing

Cloud-based Infrastructure

Building Cloud-scale Applications

Course Structure

Course Structure

★ **Lecture: Tuesday/Thursdays**

Course Structure

★ Lecture: Tuesday/Thursdays

★ Weekly **MPs** and **PL Homework**

Course Structure

- ★ Lecture: Tuesday/Thursdays
- ★ Weekly **MPs** and **PL Homework**
- ★ Two Exams in the CBTF

Course Structure

- ★ Lecture: Tuesday/Thursdays
- ★ Weekly **MPs** and **PL Homework**
- ★ Two Exams in the CBTF
- ★ Final Course Project

Everything Else:

<https://courses.grainger.illinois.edu/cs240/>

Foundations of Computer Systems

The background of the slide features a photograph of a statue, likely Alma Mater, standing on a pedestal. A crowd of people is gathered around the base of the statue. The entire image is covered with a semi-transparent orange filter. The title text is centered over the image in a white, bold, sans-serif font.

Computer Systems Foundations

Computer Systems Foundations

#1: Data

Computer Systems Foundations

#2: Central Processing Unit

Computer Systems Foundations

#3: Memory and Storage

Computer Systems Foundations

#4: Peripherals

Computer Systems Foundations

#5: Operating System

Computer Systems Foundations

#6: Processes

System-Level Abstractions

The background of the slide features a photograph of a statue, likely Alma Mater, standing on a pedestal. The statue is surrounded by a crowd of people, and the scene is set against a backdrop of trees. The entire image is overlaid with a solid orange color, which serves as a background for the white text.

System Level Abstractions

System Level Abstractions

#1: Virtual Machine

System Level Abstractions

#2: Containers

System Level Abstractions

#3: Nodes / Servers in the “Cloud”

Representing Data

The background of the slide features a photograph of a statue, likely the Alma Mater statue at the University of Wisconsin-Madison, standing on a pedestal. A large crowd of people is gathered in front of the statue. The entire image is covered with a semi-transparent orange filter. The title 'Representing Data' is centered over the image in a large, white, sans-serif font.

Representing Data

All data within a computer is:

$$1_2 =$$

10

$$10_2 =$$

10

$$11_2 =$$

10

$$100_2 =$$

10

$$\begin{array}{rcl} & 2 & = \\ & 1_2 & = \\ 10 & 2 & = \\ 11 & 2 & = \\ 100 & 2 & = \end{array} \quad \begin{array}{l} 10 \\ 10 \\ 10 \\ 10 \\ 10 \end{array}$$

$$101\ 1000_2 =$$

10

Place Value of Digits

1 0 1 1 0 0 0₂

2^6 2^5 2^4 2^3 2^2 2^1 2^0

Place Value of Digits

1	0	1	1	0	0	0 ₂
64	32	16	8	4	2	1 ₁₀

Place Value of Digits

1 0 1 1 0 0 0₂

× 64 32 16 8 4 2 1₁₀

Place Value of Digits

	1	0	1	1	0	0	0	
								2
×	64	32	16	8	4	2	1	
								10
<hr/>								
	64	0	16	8	0	0	0	
								10

Place Value of Digits

1 0 1 1 0 0 0₂

64 32 16 8 4 2 1₁₀

64 + 0 + 16 + 8 + 0 + 0 + 0₁₀

Place Value of Digits

1 0 1 1 0 0 0₂

64 32 16 8 4 2 1₁₀

64 + 0 + 16 + 8 + 0 + 0 + 0₁₀

=88₁₀

$$4_{10} = 2$$

$$7_{10} = 2$$

$$18_{10} = 2$$

$$18_{10} = 0b$$

$$11_{10} = 0b$$

$$33_{10} = 0b$$

Bit Manipulation



Bit Manipulation

AND, &

A = 1100

B = & 1010

Bit Manipulation

OR, |

A = 1100

B = | 1010

Bit Manipulation

XOR, ^

A = 1100

B = ^ 1010

Bit Manipulation

NOT, !, ~

$$A = \underline{1100}$$

$$!A =$$

$$\begin{array}{rcl} A & = & 110011 \\ B & = & \text{\textcolor{red}{\&}} \quad \underline{\quad 11} \end{array}$$

$$\begin{array}{rcl} A & = & 110011 \\ B & = & \text{\textcolor{red}{|}} \quad \underline{\quad 11} \end{array}$$

$$\begin{array}{rcl} A & = & 110011 \\ B & = & \text{\textcolor{red}{^}} \quad \underline{\quad 11} \end{array}$$

$$\begin{array}{rcl} A & = & \text{\textcolor{red}{!}} \quad \underline{110011} \end{array}$$

A = 101

B = & 010

A = 101

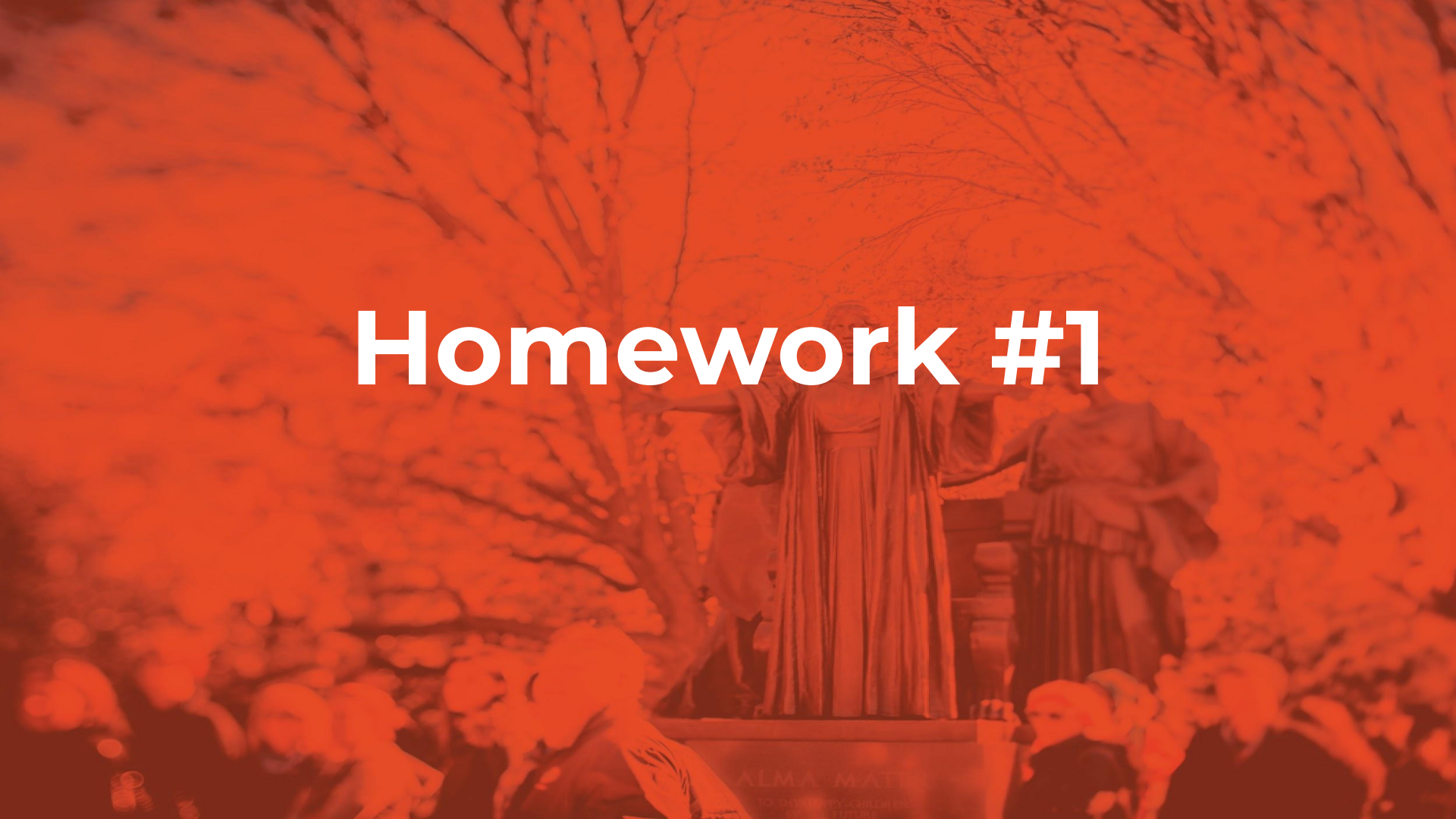
B = | 010

A = 101

B = ^ 010

A = ! 101

Homework #1



Dream Computer