

Handling Scene Detection of Lecture Videos With Annotations

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Research Mentor: Professor Lawrence Angrave

Motivation

Currently, there are limited alternatives to video format lectures—thus many educational materials are not universally accessible.

In response, we ask this: given a video lecture, how do we extract its key frames and create a concise PDF?

ClassTranscribe

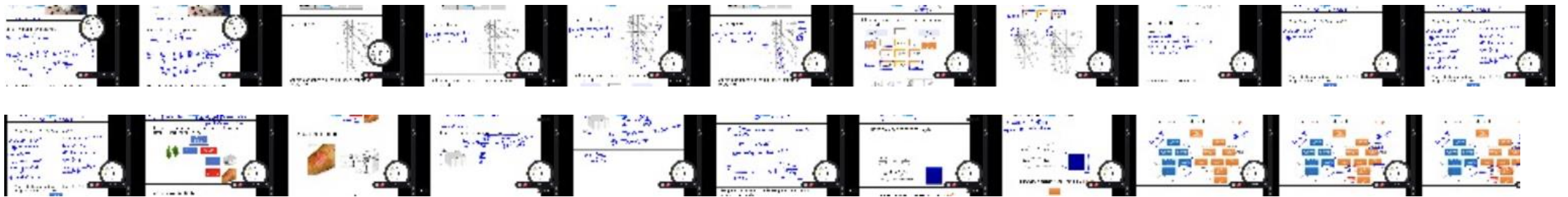


Problem context

Scene detection attempts to find semantic boundaries between segments of a video

However, existing research (Li, ASEE 2022) does not apply well to engineering lecture videos

How would you segment this video into chapters?



test1_bio360_2_12_2022.mp4

How would you segment this?

Slides from a BIOE360 on February 12th, 2022

1

Convection-diffusion in a stagnant gas

GE

$$\frac{\partial c}{\partial t} + u \frac{\partial c}{\partial z} = D_{AB} \frac{\partial^2 c_A}{\partial z^2} + \dot{V}_A$$

u = 0

Initial concentration of A in B is 0

Initial convective stream of A and B

Stagnant gas B

Evaporating liquid A

00:01:57

1:58

3

Convection-diffusion in a stagnant gas

GE

$$\frac{\partial c}{\partial t} + u \frac{\partial c}{\partial z} = D_{AB} \frac{\partial^2 c_A}{\partial z^2} + \dot{V}_A$$

$$u \frac{\partial c}{\partial z} = D_{AB} \frac{\partial^2 c_A}{\partial z^2}$$

BCs

$c_A = c_{A1}$ at $z = z_1$ (vapor pressure)

$c_A = c_{A2}$ at $z = z_2$ (conc. of blowing air)

Initial concentration of A in B is 0

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Stagnant gas B

Evaporating liquid A

00:03:44

3:45

5

Rearrange and integrate (text)

Final solution

$$\frac{1 - c_A/c}{1 - c_{A1}/c} = \left[\frac{1 - c_{A2}/c}{1 - c_{A1}/c} \right]^{\frac{z - z_1}{z_2 - z_1}}$$

Initial concentration of A in B is 0

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Evaporating liquid A

Distance [stagnant gas]

Concentration

00:06:46

6:46

2

Convection-diffusion in a stagnant gas

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Initial concentration of A in B is 0

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00:02:09

2:10

4

Convection-diffusion in a stagnant gas

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Evaporating liquid A

00:03:45

3:46

6

last case

Convection-diffusion at a surface: Convective mass transfer coefficient

Bulk Fluid

Solid

c_{A2}

c_{A1}

$N_{A1-2} = h_m A (c_{A1} - c_{A2})$

conc. of A in the fluid at the surface

bulk flow conc.

00:09:06

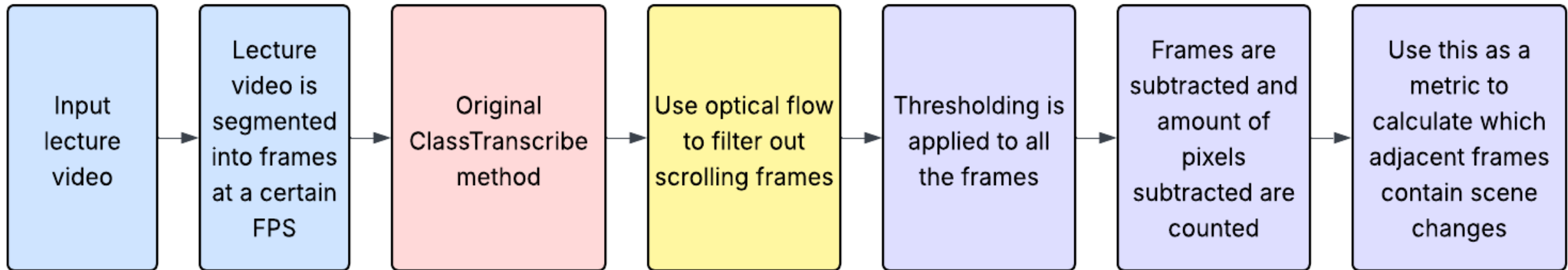
9:06

Our Approach

Segmenting video into proper format

Handling Scrolling

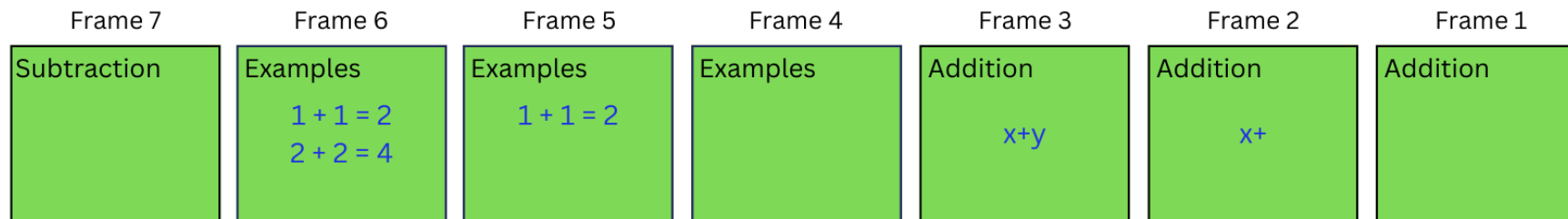
Handling Annotations



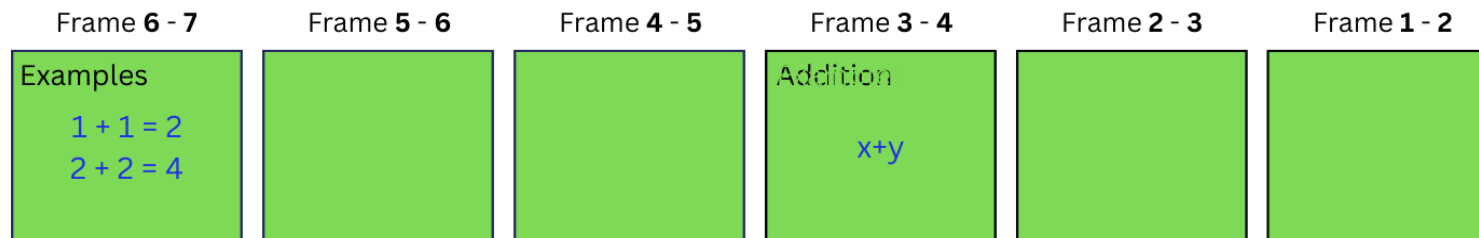
Handing annotations and scrolling

through a process of masking and subtracting the frames.

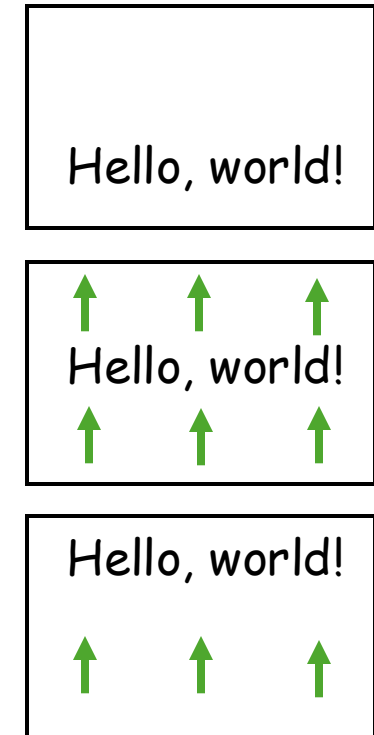
Masking + Subtraction (backwards)



Subtraction results



Scrolling



Purpose of masking

If remaining pixels (non-green pixels here) are related to the information on the screen, not masking leaves misleading pixels

Slide 38 – 39 =



Sequential Pattern Mining

- What kind of patterns are sequential?
- Sequential – The order really matters. You can not swap two items in a sequence and have the same sequence.
- Example: The English language is sequential : Subject -> Verb -> Object.
progress, doctor reacts accordingly -> more/less drugs
- Other points:
 - For Sequential Pattern Mining, the time at which the items occur is **not** considered.
 - Time Series Analysis does take into account the time at which an item occurred.

38

Sequential Pattern Mining

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38

39

Sequential Pattern Examples

- Application of Sequential pattern Mining
 - Customer shopping** → Purchase a laptop first, then a digital camera, and then a smartphone.
 - Medical treatments** → Go to the doctor, get drugs, doctor monitors progress, doctor reacts accordingly -> more/less drugs
 - Natural disasters** -> Before the disaster, during the disaster, after the disaster.
 - Scientific Experiments** → Step 1, Step 2, Step 3.
 - Stocks Markets** → Stocks go up and down together.
 - Biological sequences, DNA /Protein** → If you change the order of proteins, it is a different gene.

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Our Masking Methods

Convection-diffusion in a stagnant gas

GE

$$\frac{\partial C}{\partial t} + u \frac{\partial C}{\partial z} = D_{AB} \frac{\partial^2 C_A}{\partial z^2} + \rho_A$$

$$u \frac{\partial C}{\partial z} = D_{AB} \frac{\partial^2 C_A}{\partial z^2}$$

BCs $C_A = C_{A1}$ at $Z = Z_1$ (Vapor pressure)
 $C_A = C_{A2}$ at $Z = Z_2$ (conc of blowing air)

Selected Represented Frame

Convection-diffusion in a stagnant gas

GE

$$\frac{\partial C}{\partial t} + u \frac{\partial C}{\partial z} = D_{AB} \frac{\partial^2 C_A}{\partial z^2} + \rho_A$$

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Thresholding method, $a_{x,y} < t$

Convection-diffusion in a stagnant gas

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BCs $C_A = C_{A1}$ at $Z = Z_1$ (Vapor pressure)
 $C_A = C_{A2}$ at $Z = Z_2$ (conc of blowing air)

Brute force method, $p_{x,y} - b_{x,y} < t$

Convection-diffusion in a stagnant gas

GE

$$\frac{\partial C}{\partial t} + u \frac{\partial C}{\partial z} = D_{AB} \frac{\partial^2 C_A}{\partial z^2} + \rho_A$$

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BCs $C_A = C_{A1}$ at $Z = Z_1$ (Vapor pressure)
 $C_A = C_{A2}$ at $Z = Z_2$ (conc of blowing air)

Spectral Clustering method,
 $O(mnk)$

Thresholding

$$a_{x,y} < t$$

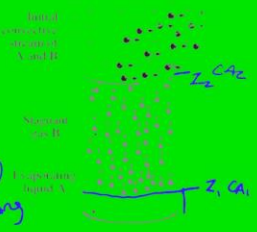
Convection-diffusion in a stagnant gas

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Initial concentration of A in B is 0

Initial convective stream of A and B

Stagnant gas B

Evaporating liquid A

z_1, C_{A1}

z_2, C_{A2}

Thresholding on a lecture frame

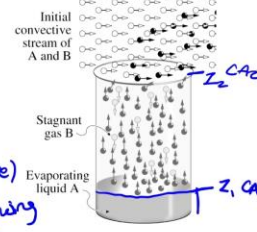
Convection-diffusion in a stagnant gas

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Initial concentration of A in B is 0

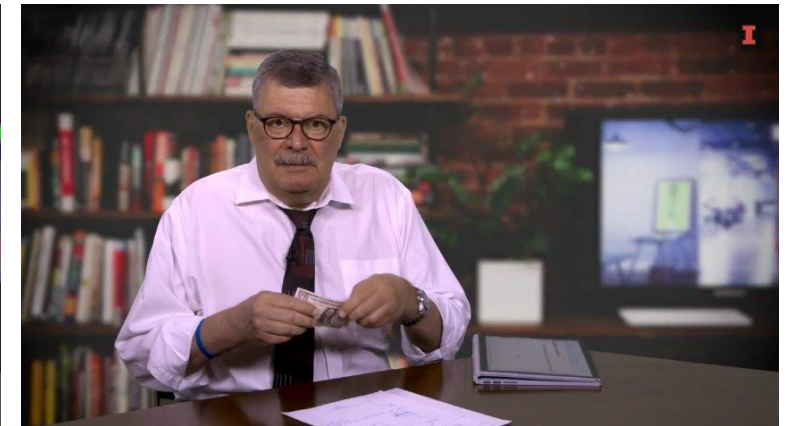
Initial convective stream of A and B

Stagnant gas B

Evaporating liquid A

z_1, C_{A1}

z_2, C_{A2}



Thresholding on a non-lecture formatted frame

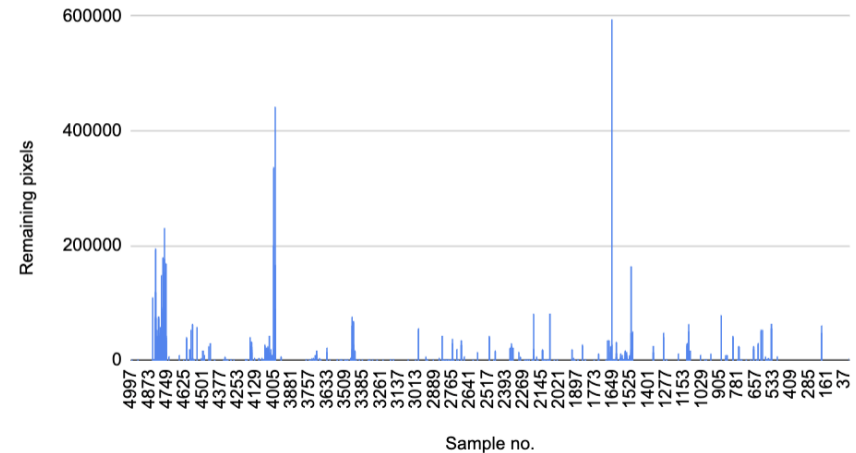
Mask comparison

Currently, we're using a brute force subtraction method.

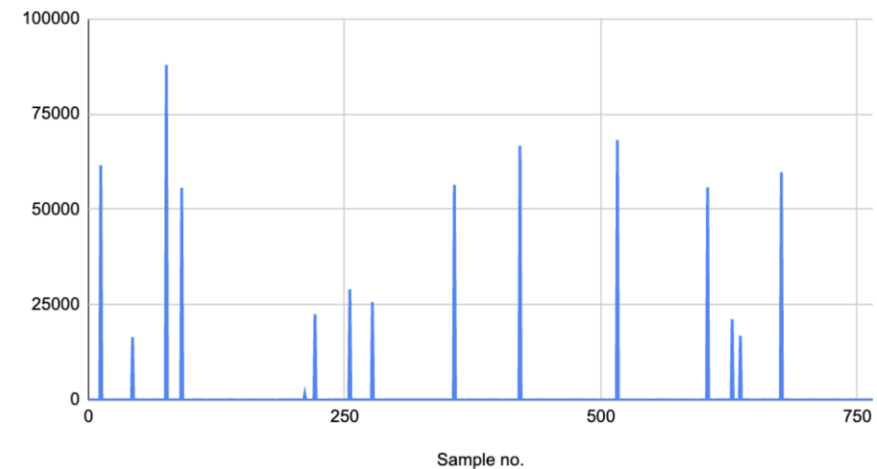
Next, we are improving our method to pick out the significant outliers from our data.

Current output

CS361 2-2-2021 pixels remaining by sample number



IE300 8-24-2020 pixels remaining by frame



Future Improvements

Broader background color support

**Integration with scrolling methods +
ClassTranscribe**

Thank you for listening!

Questions?

Ashley Li
(ashleyl7@Illinois.edu)

Enya Chen
(enya2@Illinois.edu)

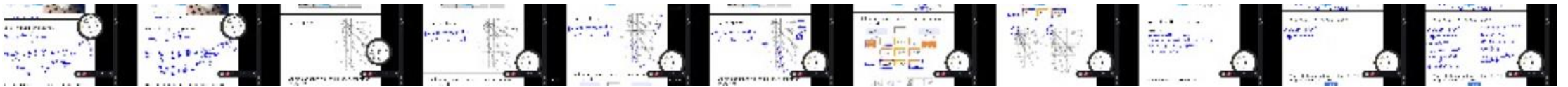
Charitha Nannapaneni
(cn29@Illinois.edu)

Subtraction in depth

There are more or less four cases:

1. The slide has not changed
2. The slide is being annotated
3. The slide has changed
4. (The slide has changed to blank)

start



end

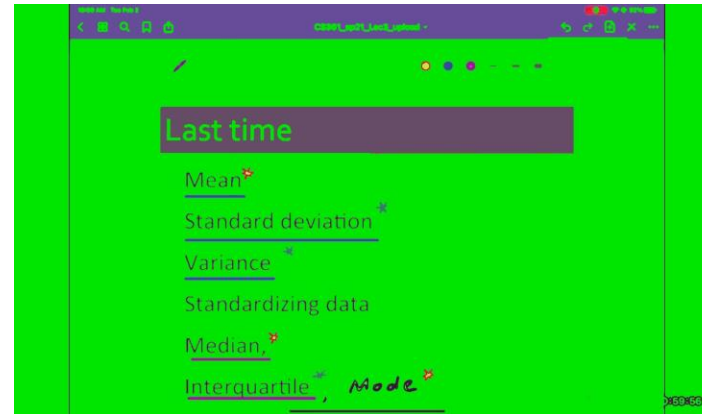
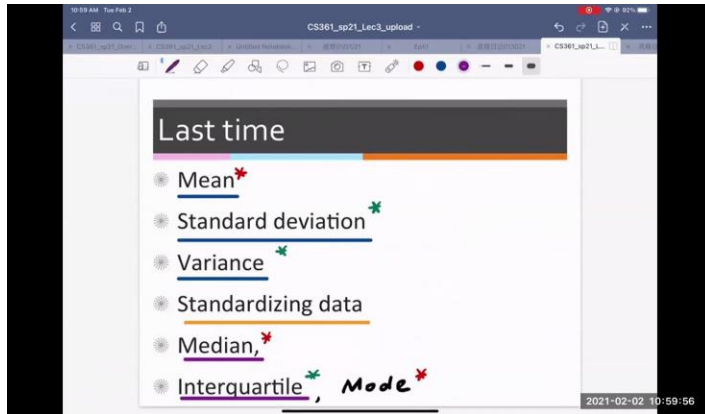
Case 1: The slide has not changed

Frames

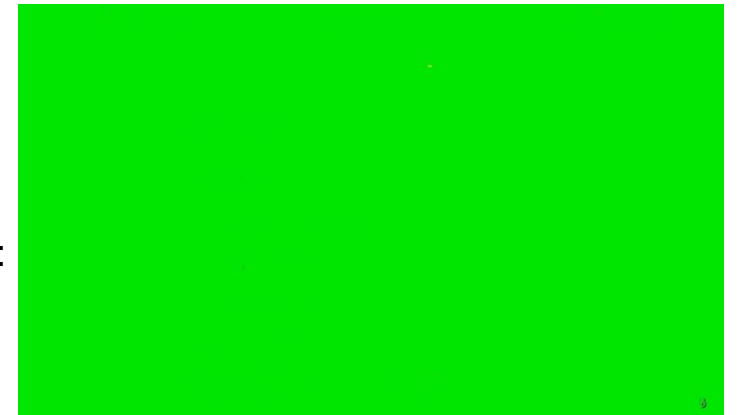
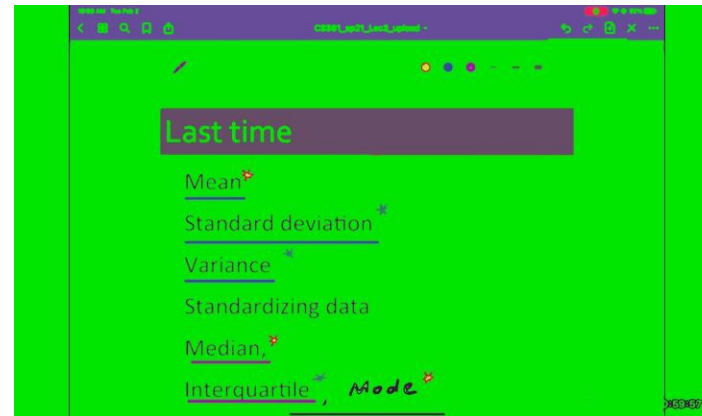
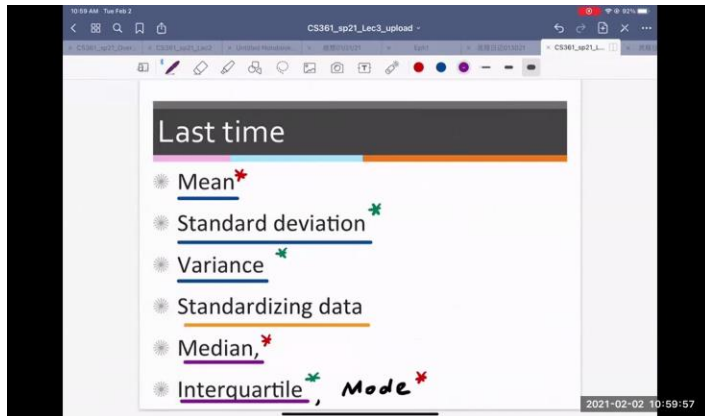
Masks

Subtraction

218



219



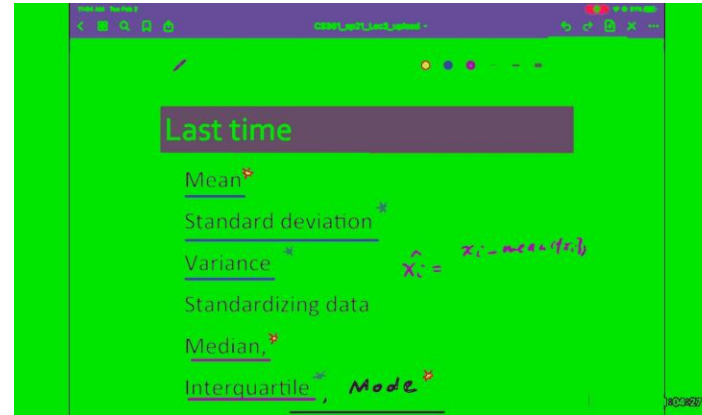
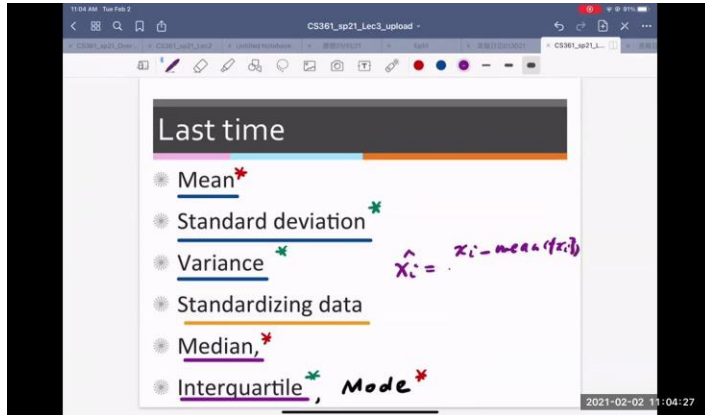
Case 2: The slide is being annotated

Frames

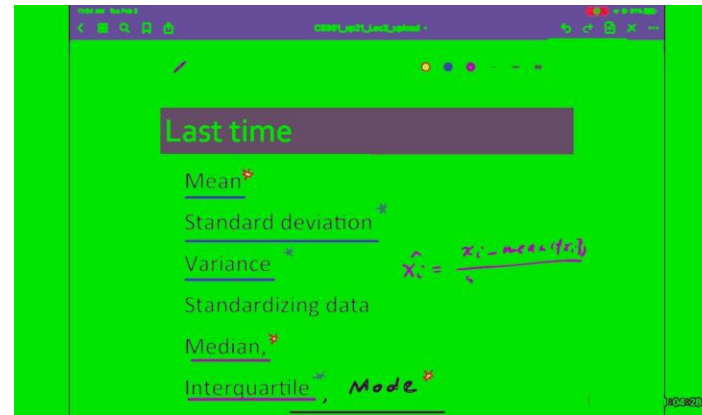
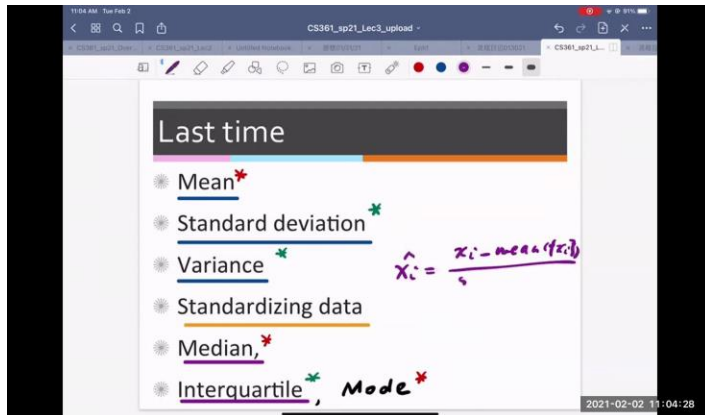
Masks

Subtraction

489



490



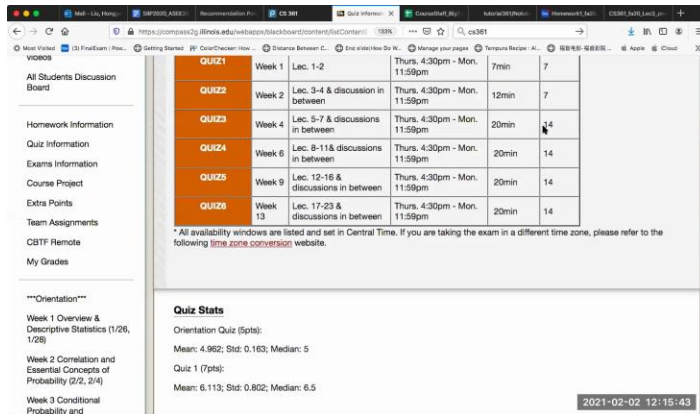
Case 3: The slide has changed

Frames

Masks

Subtraction

4765



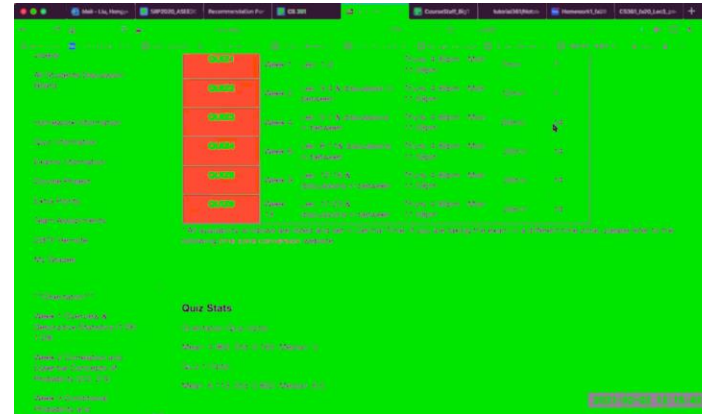
4765

QUIZ1	Week 1	Lec. 1-2	Thurs. 4:30pm - Mon. 11:59pm	7min	7
QUIZ2	Week 2	Lec. 3-4 & discussion in between	Thurs. 4:30pm - Mon. 11:59pm	12min	7
QUIZ3	Week 4	Lec. 5-7 & discussions in between	Thurs. 4:30pm - Mon. 11:59pm	20min	14
QUIZ4	Week 6	Lec. 8-11 & discussions in between	Thurs. 4:30pm - Mon. 11:59pm	20min	14
QUIZ5	Week 9	Lec. 12-16 & discussions in between	Thurs. 4:30pm - Mon. 11:59pm	20min	14
QUIZ6	Week 13	Lec. 17-23 & discussions in between	Thurs. 4:30pm - Mon. 11:59pm	20min	14

* All availability windows are listed and set in Central Time. If you are taking the exam in a different time zone, please refer to the following [time zone conversion website](#).

Quiz Stats
Orientation Quiz (5pts):
Mean: 4.962; Std: 0.163; Median: 5
Quiz 1 (7pts):
Mean: 6.113; Std: 0.802; Median: 6.5

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4765

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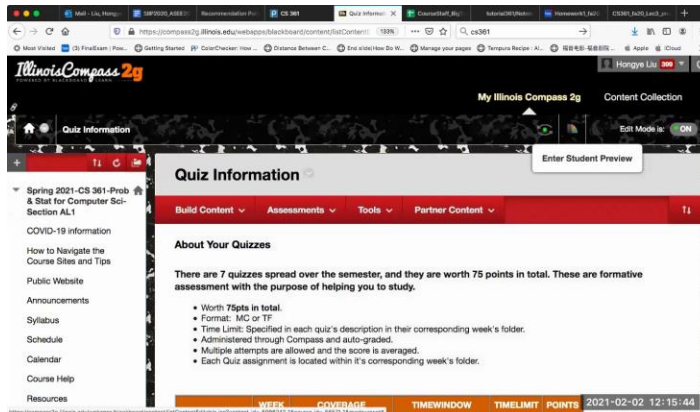
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4766



4766

My Illinois Compass 2g

Quiz Information

Build Content Assessments Tools Partner Content

About Your Quizzes

There are 7 quizzes spread over the semester, and they are worth 75 points in total. These are formative assessment with the purpose of helping you to study.

- Worth 75pts in total.
- Format: MC or TF
- Time Limit: Specified in each quiz's description in their corresponding week's folder.
- Administered through Compass and auto-graded.
- Multiple attempts are allowed and the score is averaged.
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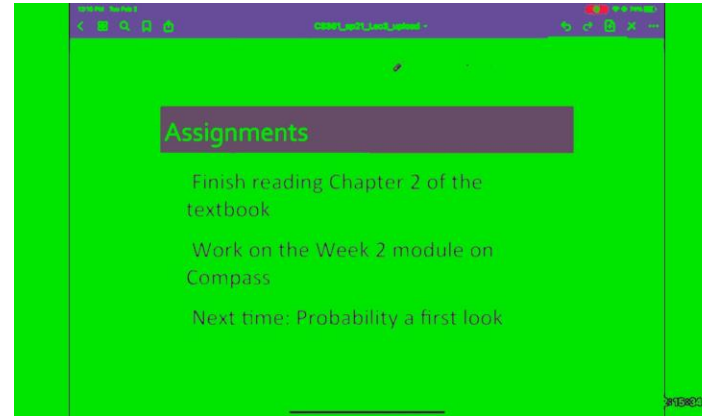
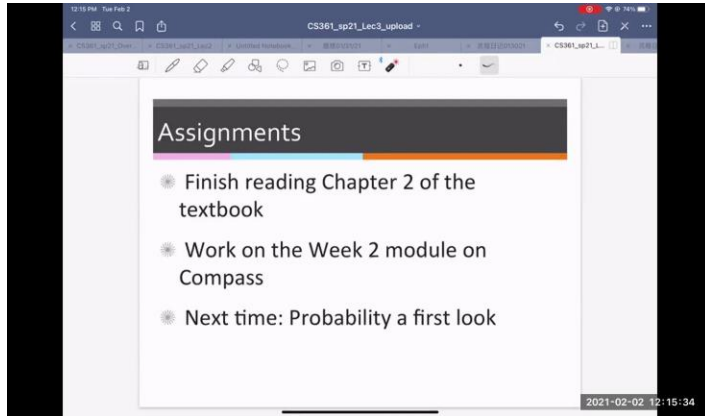
(Case 4: The slide has changed to blank)

Frames

Masks

Subtraction

4756



4757

