Biometrics

COMP 388-002/488-002 Computer Science Topics

Daniel Moreira

Fall 2024

LOYOLA
UNIVERSITY CHICAGO

Welcome

COMP 388-002/488-002 Computer Science Topics
Biometrics

Daniel Moreira (Instructor)
Contact: dmoreira1@luc.edu
Office: 310 Doyle Center

Fiona Nicdao (TA)
Contact: fnicdao@luc.edu

Course Hours
Lectures: MON and WED, 4:15 to 5:30 PM, 408 Mundelein Center
Office Hours: MON and WED evenings, and FRI afternoons
310 Doyle Center or Zoom, by appointment (https://tinyurl.com/2v6eme5p)

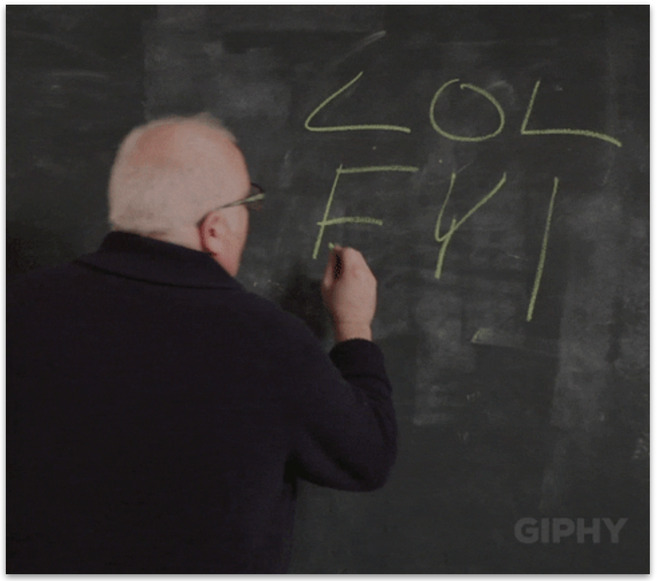
Communication
Sakai: https://sakai.luc.edu/x/9WVTcd
Webpage: https://danielmoreira.github.io/teaching/biometrics-aut24/

Today we will…

Get to know what is ahead of you
in the course.

About me

Computer Scientist
PhD from the University of Campinas (Brazil)
Theme: Sensitive-Video Analysis



Loyola University Chicago
Assistant Professor
Joined on August 15, 2022

Research
Media Forensics, Biometrics, Computer Vision, Machine Learning
Webpage: https://danielmoreira.github.io
(see following slides)

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Sensitive-Video Analysis
https://danielmoreira.github.io/project/sma/

The Problem

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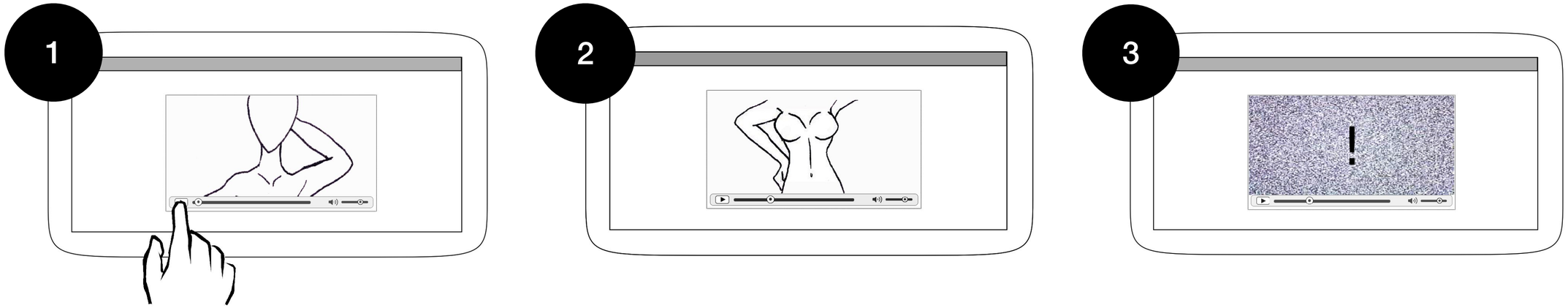
Sensitive Video

“Motion pictures whose content may inflict harm (e.g., trauma, shock, or fear) to particular audiences (e.g., children or unwary spectators), due to the inappropriateness of content.”

Can a computer localize sensitive scenes within a video timeline?



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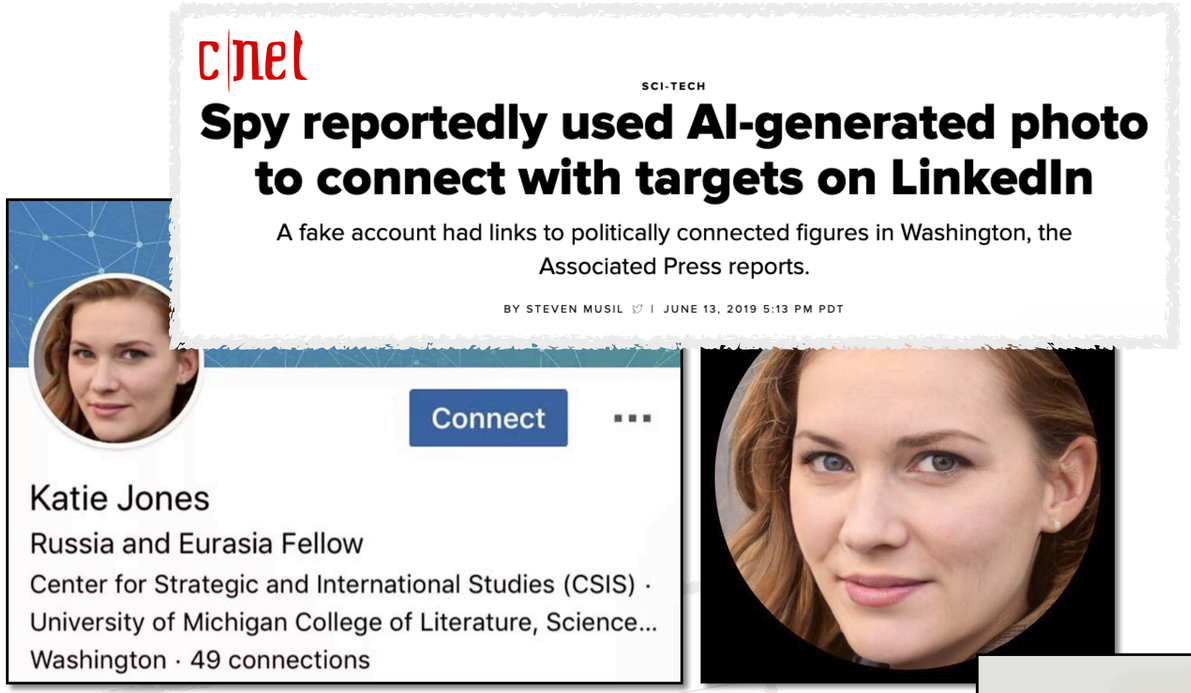
The Notorious B.I.G.
NY scene rapper
Media Forensics
https://danielmoreira.github.io/project/medifor/
Kurt Cobain
Grunge scene musician

The Problem



https://www.youtube.com/watch?v=p7-B8S734T4

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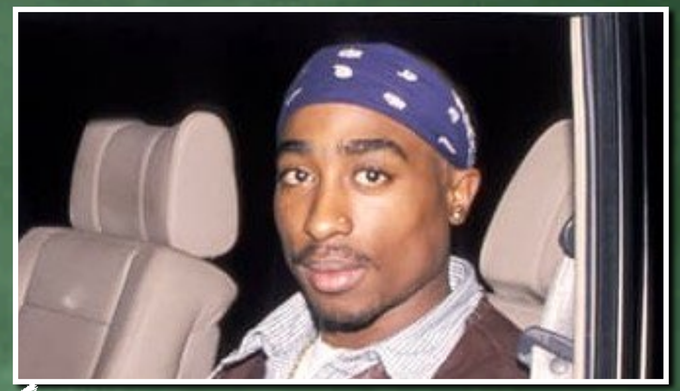
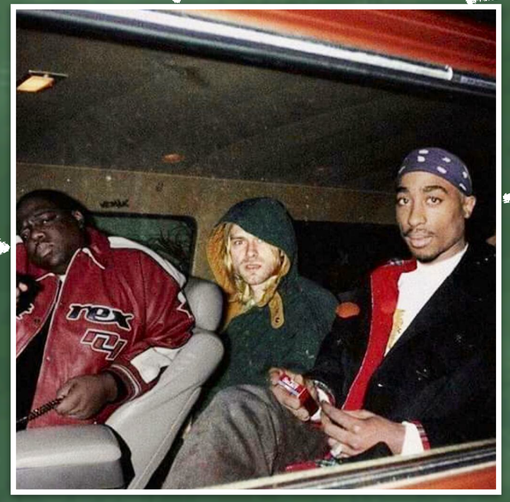
The Notorious B.I.G.
NY scene rapper
HANGING OUT?
Kurt Cobain
Grunge scene musician

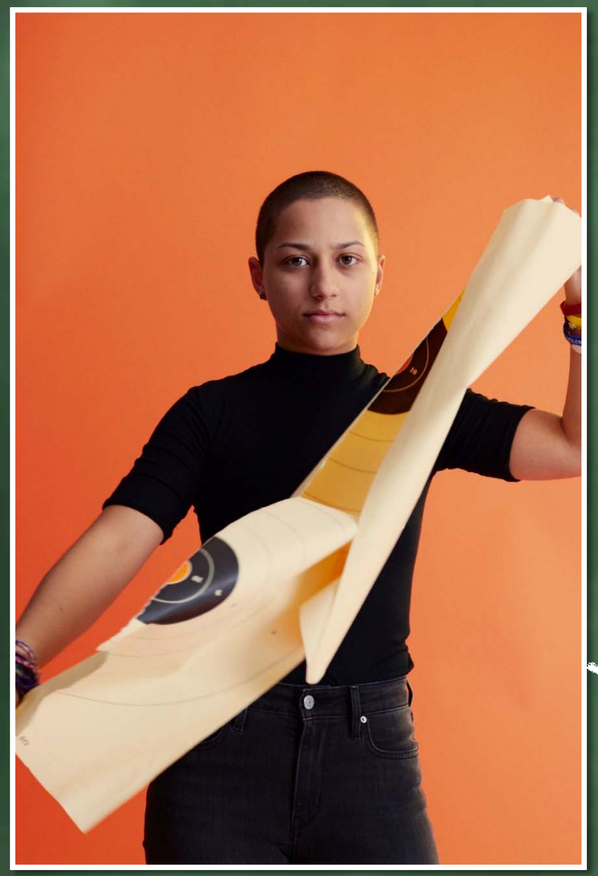

rex

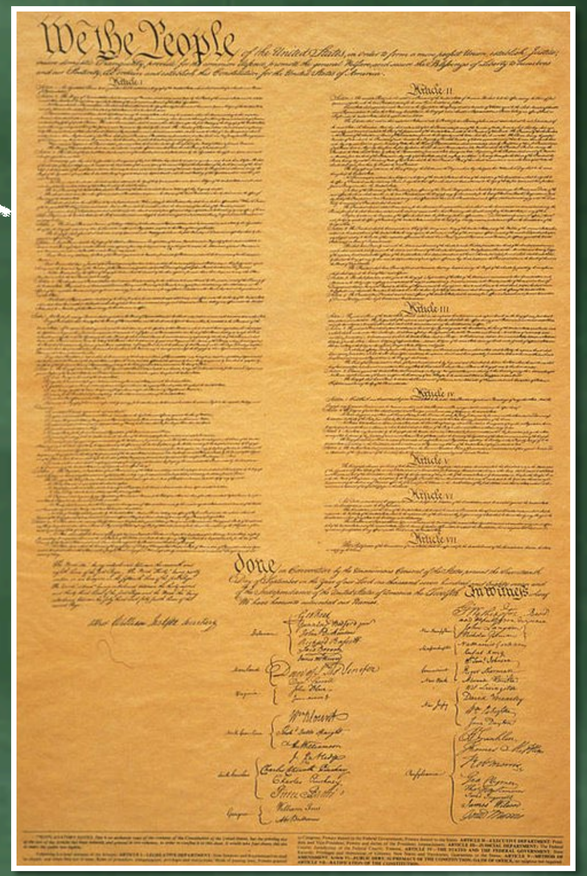

Tupac Shakur
LA scene rapper



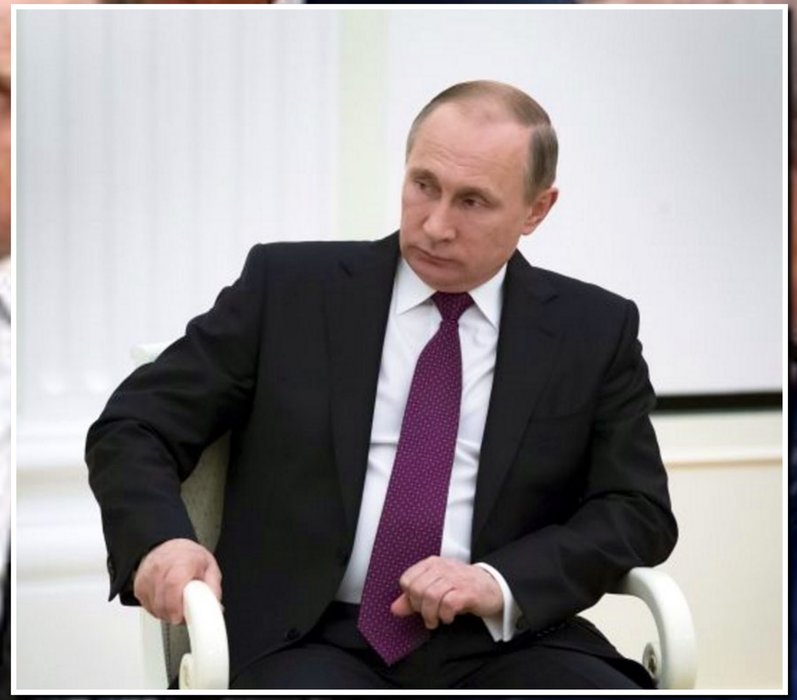


Provenance Graph






Russian Federation
Turkey



Russian Federation

Turkey

Scientific Integrity

https://danielmoreira.github.io/project/sciint/

The Problem

nature

Retraction Note | Published: 15 April 2015

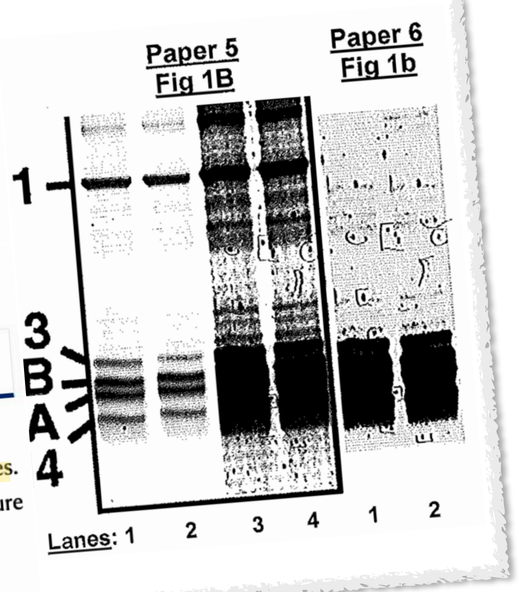
Retraction Note: Histone methylation by the *Drosophila* epigenetic transcriptional regulator Ash1

Nature **521**, 110 (2015) | Cite this article

27k Accesses | **34** Altmetric | Metrics

The Original Article was published on 09 October 2002

The authors and the University of [redacted] wish to retract this Letter owing to inappropriate image manipulation in the published figures. The figure panels affected are Figure 1b, d, Figure 2b, e, Figure 3a and Figure 4d. *Nature* has not received a response from [redacted] to approve this retraction.



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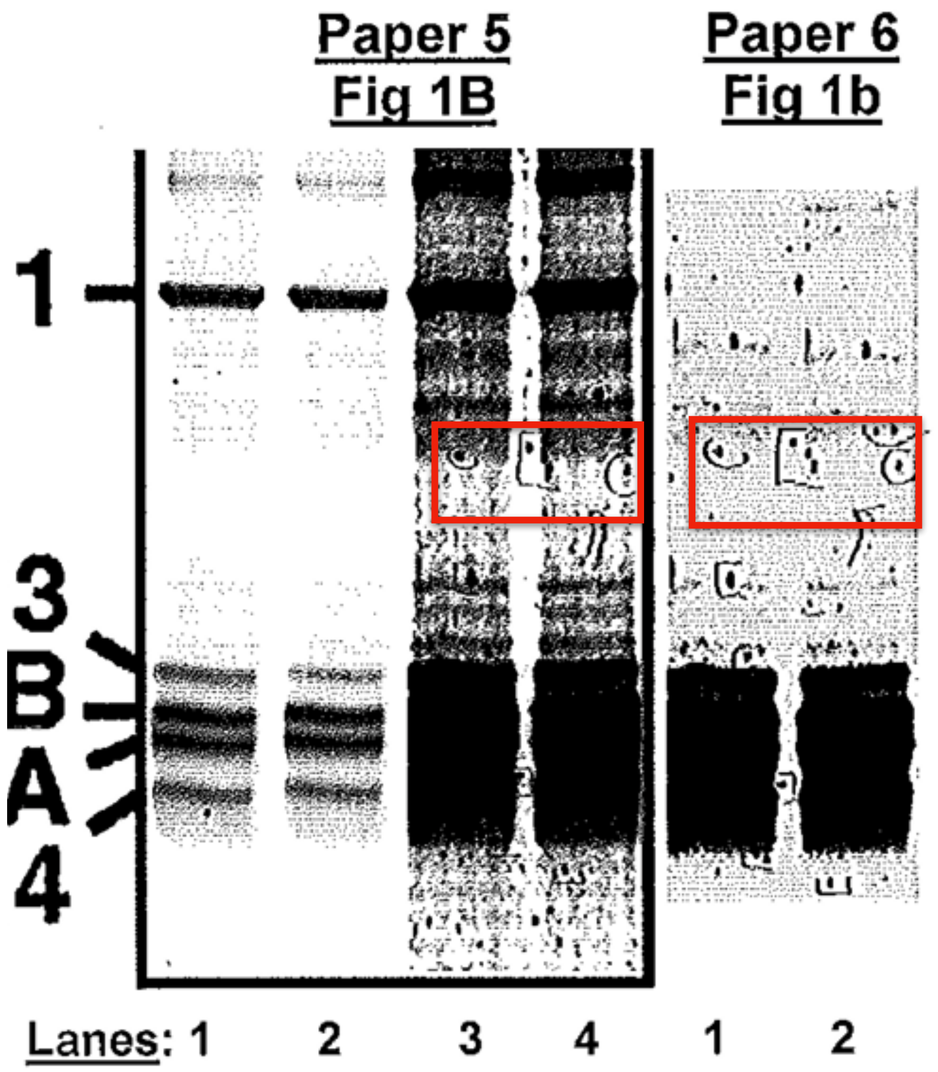

CORRECTIONS & AMENDMENTS

RETRACTION

doi:10.1038/nature14421

Retraction: Histone methylation by the *Drosophila* epigenetic transcriptional regulator Ash1

[redacted]

Nature **419,** 857–862 (2002); doi:10.1038/nature01126

The authors and the University of [redacted] wish to retract this Letter owing to inappropriate image manipulation in the published figures. The figure panels affected are Figure 1b, d, Figure 2b, e, Figure 3a and Figure 4d. *Nature* has not received a response from [redacted] to approve this retraction.

Additional information

The online version of the original article can be found at 10.1038/nature01126

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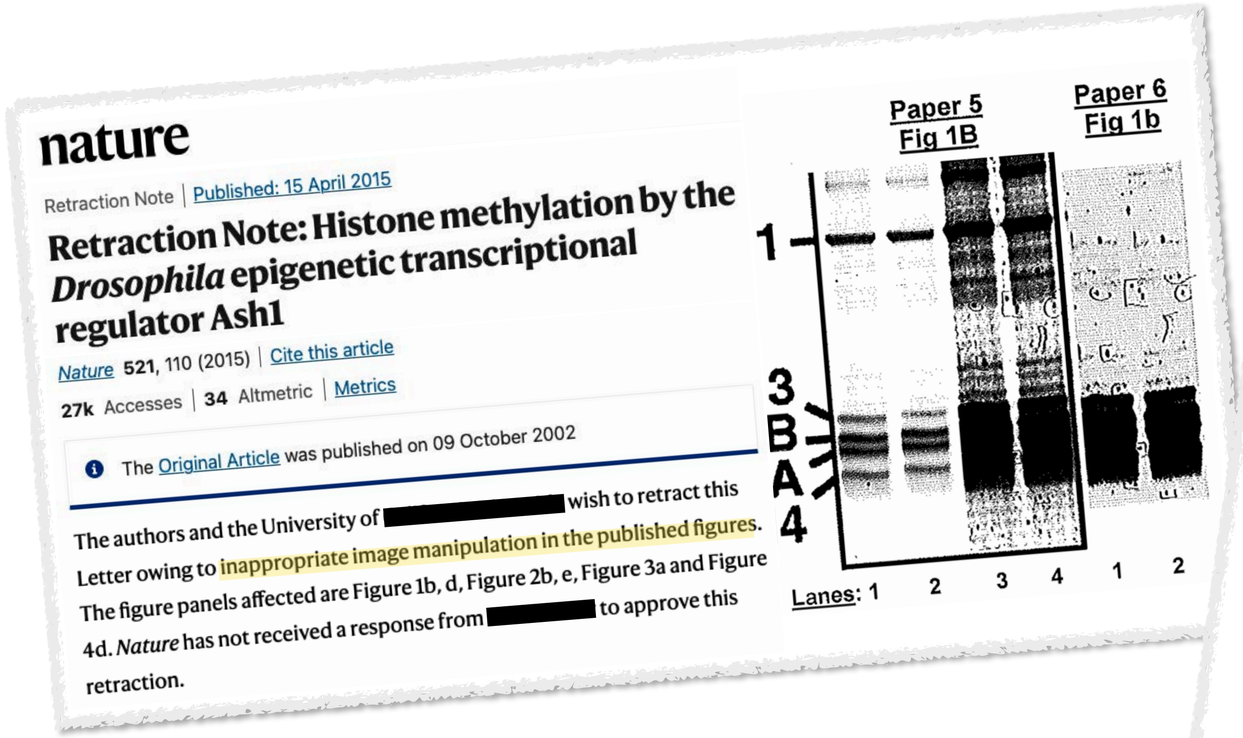
The Problem



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Paper 5 Fig 1B

Paper 6 Fig 1b

1
3
B
A
4

Lanes: 1 2 3 4 1 2

HEALTH

SEC Investigating Cassava Sciences, Developer of Experimental Alzheimer's Drug

Cassava, one of best-performing U.S. stocks this year, denies claims that it manipulated research results

THE WALL STREET JOURNAL.

By Dave Michaels and Joseph Walker

Updated Nov. 17, 2021 4:55 pm ET

Neuroscience 2005;135:247–261, Figure 12a.

Biol Psych 2010;67:522-530, Figure 1a.

Striatum

Spinal cord

Adenylyl cyclase type-II

Actin

Adenylyl cyclase type-IV

Morphine

Vehicle

NLX

Morphine + NLX

2005

2010

Vertical stretch

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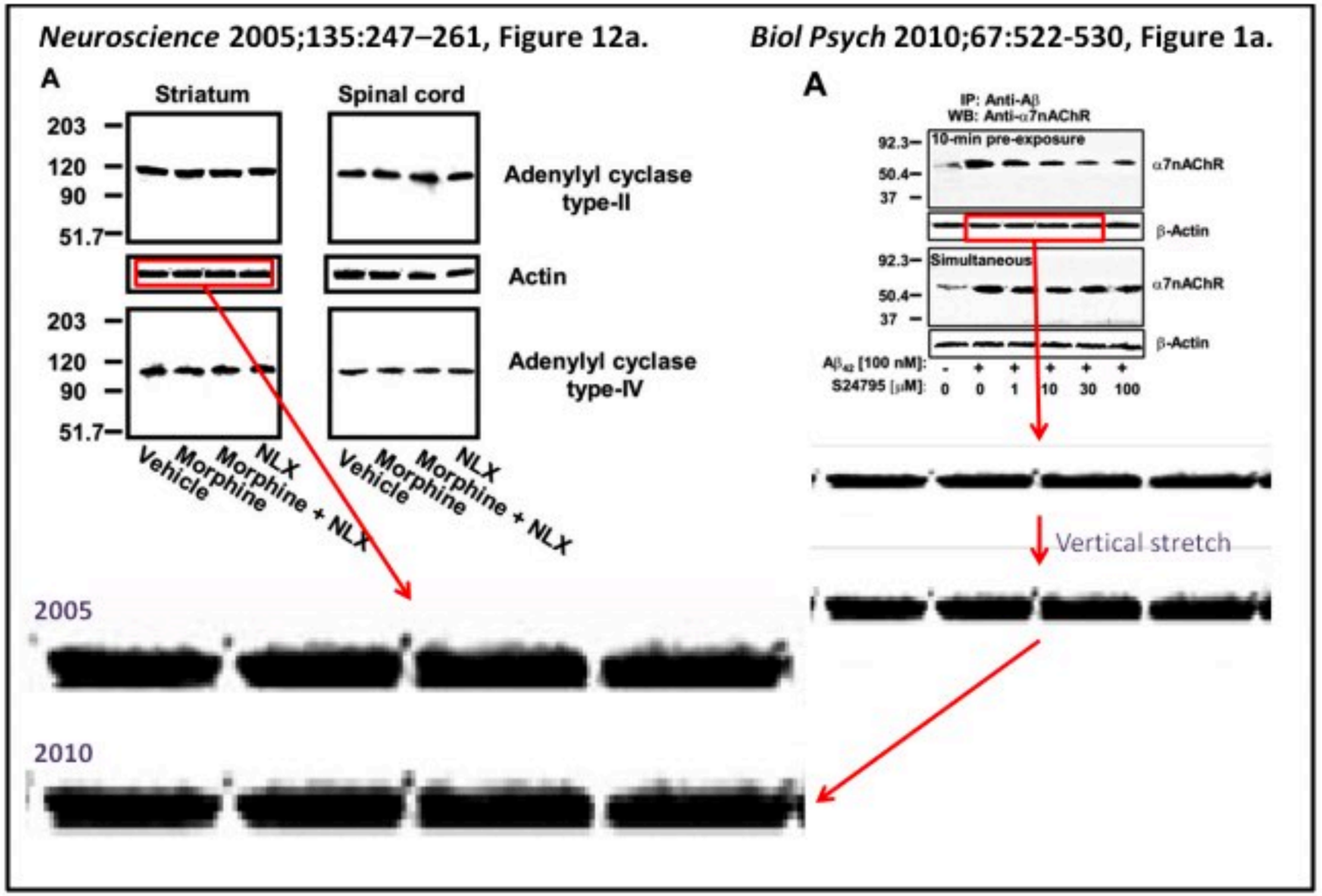

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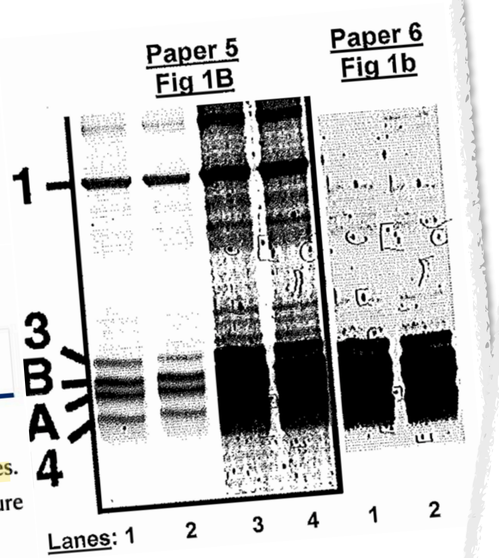

HEALTH

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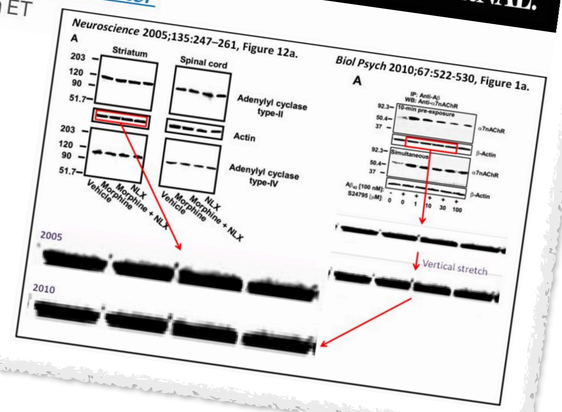
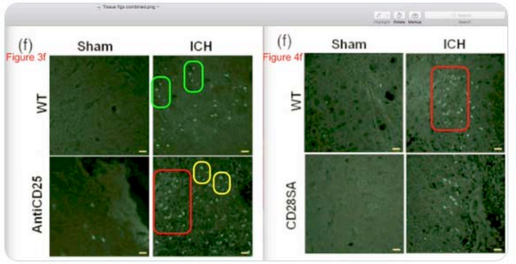


Elisabeth Bik
@MicrobiomDigest

Retraction of a paper by authors of The Third Military Medical University, Zhengzhou University, and @JohnsHopkins, 5 months after posting this to @PubPeer. pubpeer.com/publications/4...

3:17 PM · Oct 2, 2022 · Twitter Web App

3 Retweets **41** Likes



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The Problem

REUTERS GRAPHICS

Speed Science

By Manas Sharma, Simon Scarr and Kate Kelland

The risks of swiftly spreading coronavirus research

153 studies have been published on the new coronavirus

92 were not peer reviewed

First study issued mentions possible link to snakes

WITHDRAWN

Suggested links to HIV

WITHDRAWN

PUBLISHED FEBRUARY 19, 2020

Retraction Watch Tracking retractions as a window into the scientific process

December 30, 2020 Ivan Oransky RW announcements

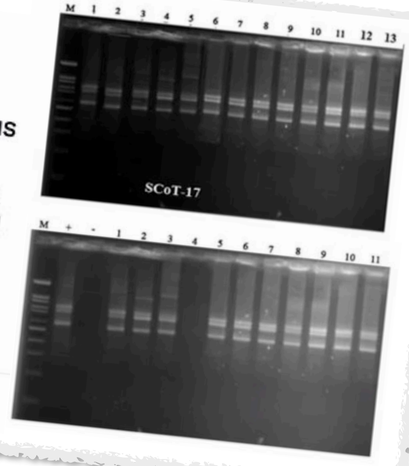
List of retracted COVID-19 papers grows past ~~70~~ 343

Norbert Holstein
@dr_norb

Holy moly. 😳 I just found that a journal is under serious attack of a paper mill. I found 6 papers with ill-fitting locations and coordinates (incl. technically impossible cordinates), sometimes copy & paste in the figures and always citing the same 4-5 papers.
@MicrobiomDigest

8:50 AM · Jun 27, 2022 · Twitter Web App

10 Retweets **1** Quote Tweet **68** Likes



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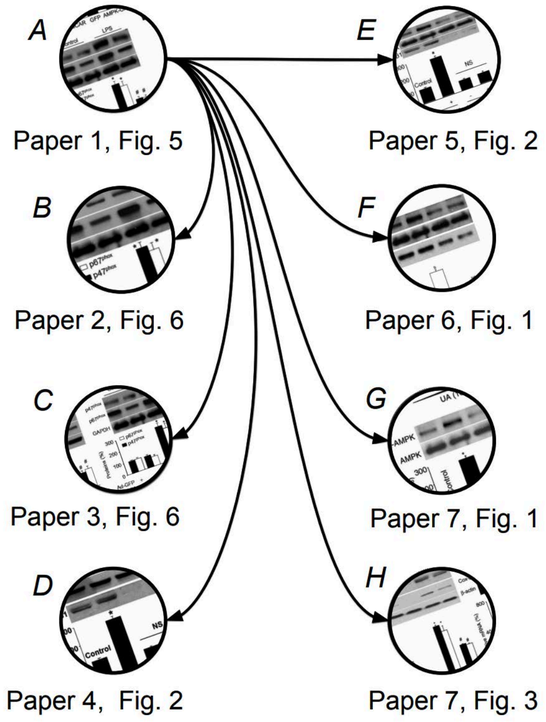
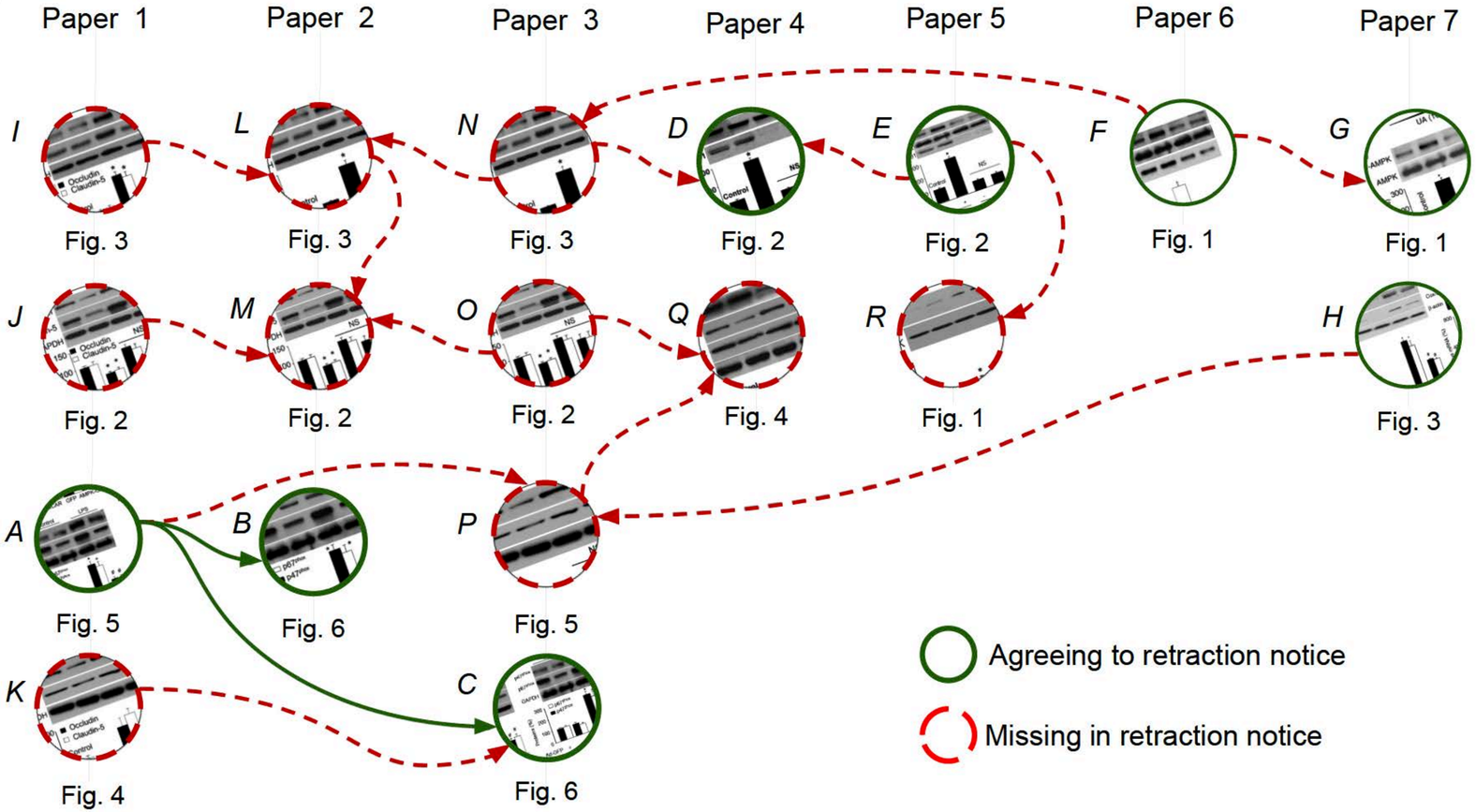
Provenance Analysis

Ground truth
(according to retraction notice)



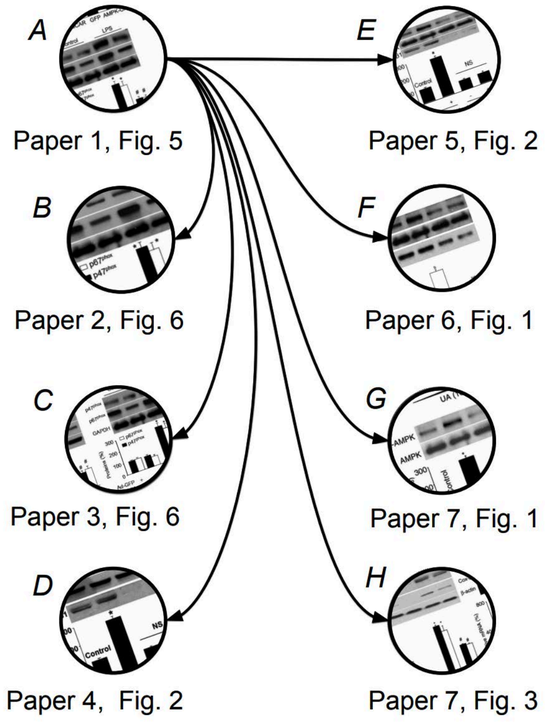
Our findings



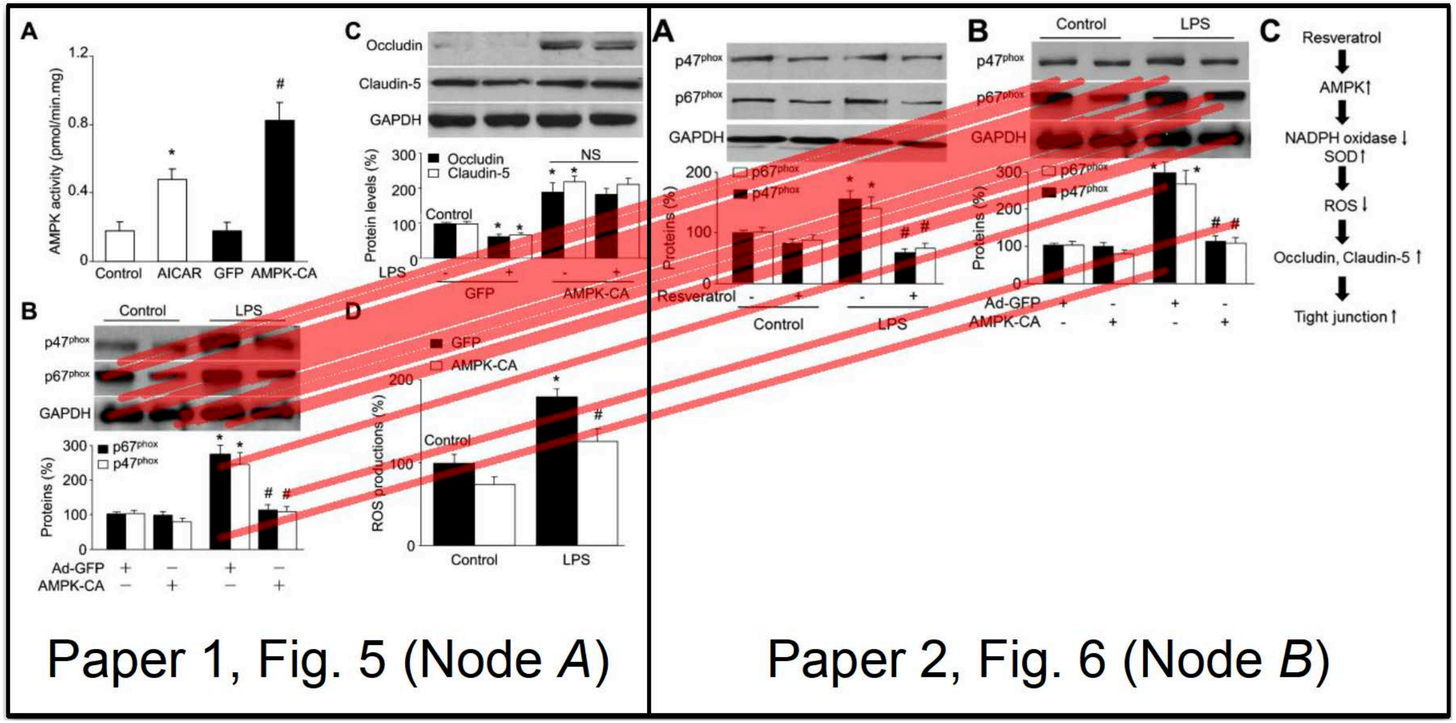
10.1371/journal.pone.0190562

Provenance Analysis

Ground truth
(according to retraction notice)



Our findings
(in accordance with retraction notice)



10.1371/journal.pone.0190562

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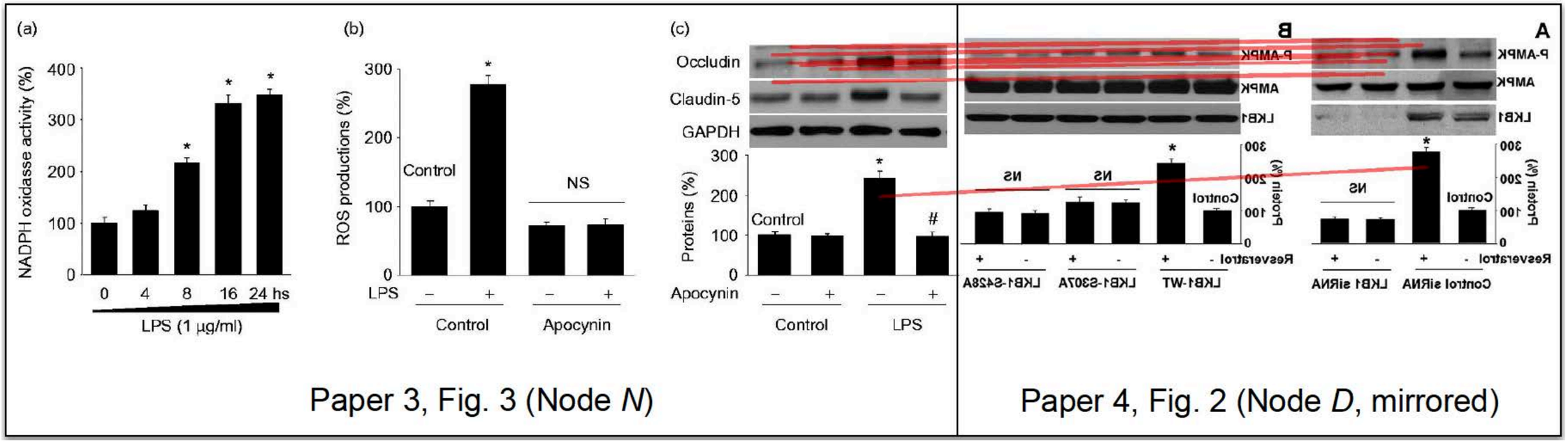
Provenance Analysis

Our findings
(not reported in the retraction notice)



Paper 3, Fig. 3 (Node *N*)

Paper 4, Fig. 2 (Node *D*, mirrored)

10.1371/journal.pone.0190562

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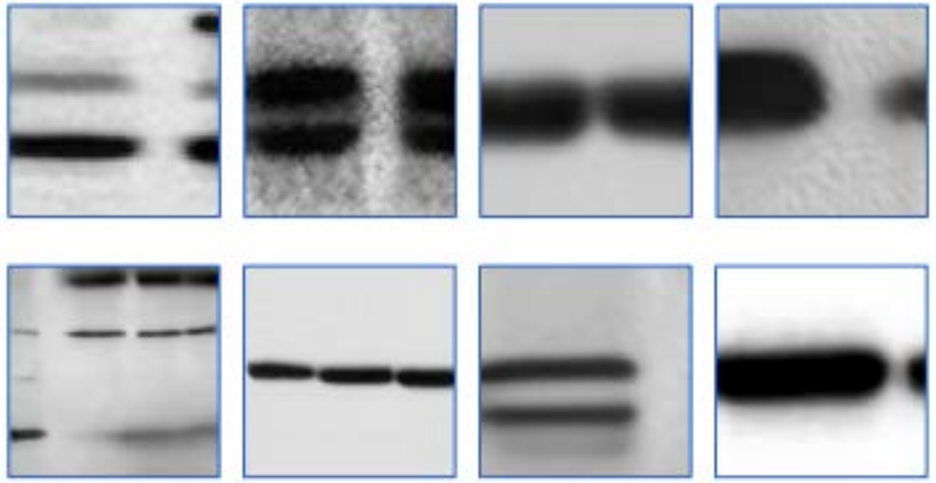
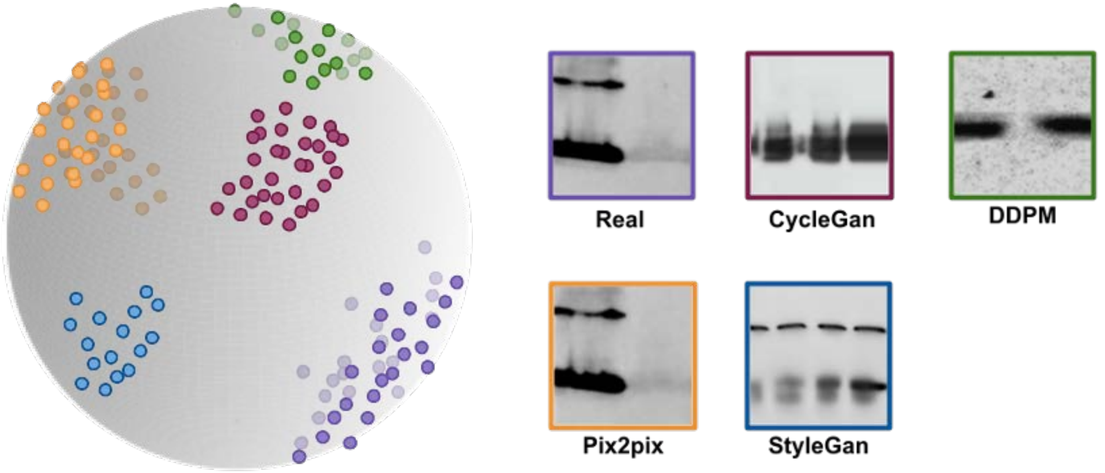
Synthetic Image Detection





Mandelli et al.
Forensic Analysis of Synthetically Generated Western Blots
IEEE Access

Synthesis of Realistic Example Faces

https://danielmoreira.github.io/project/srefv/

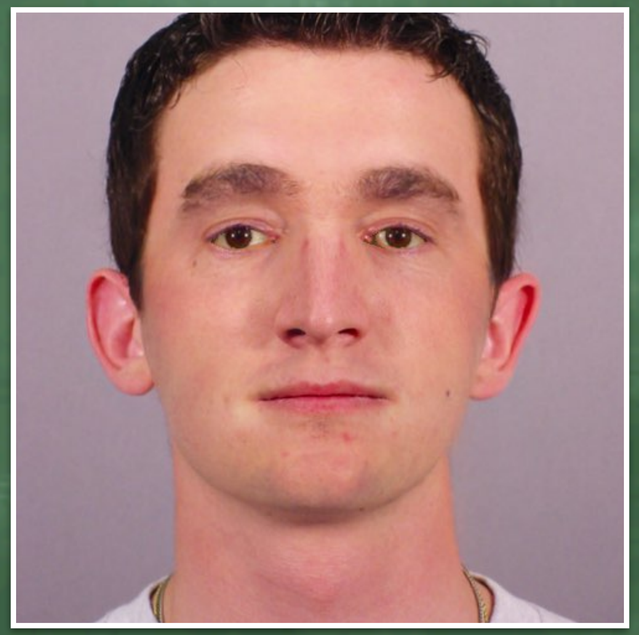
Does this person exist?

No
(nose and mouth replaced)

No
(eyes replaced)

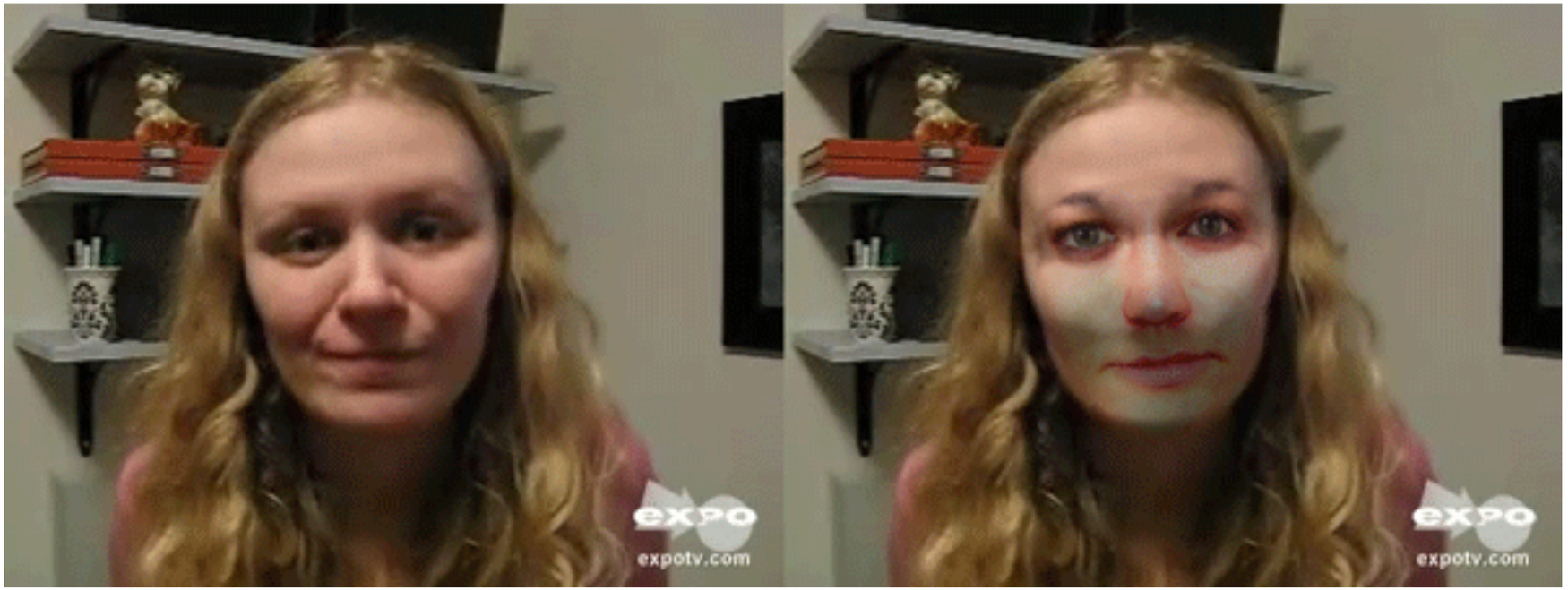
Yes
(original)

No
(eyes, nose and mouth replaced)



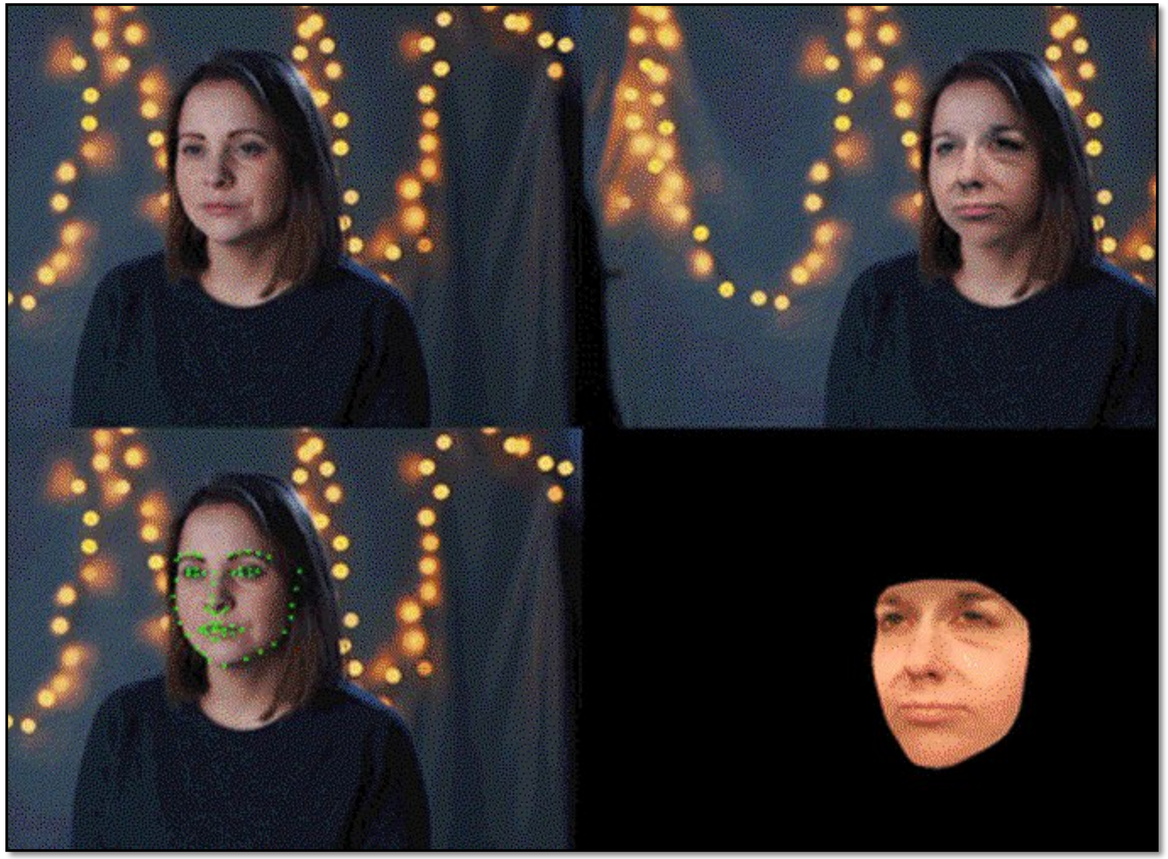
First Steps

Video Replacement



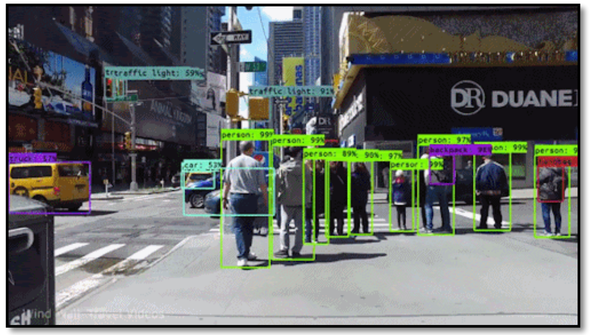
What’s Next?

Synthetic Controlled Diversity



Controlled replacements of gender, age, and ethnicity, with synthetic identities (to ensure privacy).

Challenge: keep everything (e.g., emotions, sentiments, reactions) but identity.

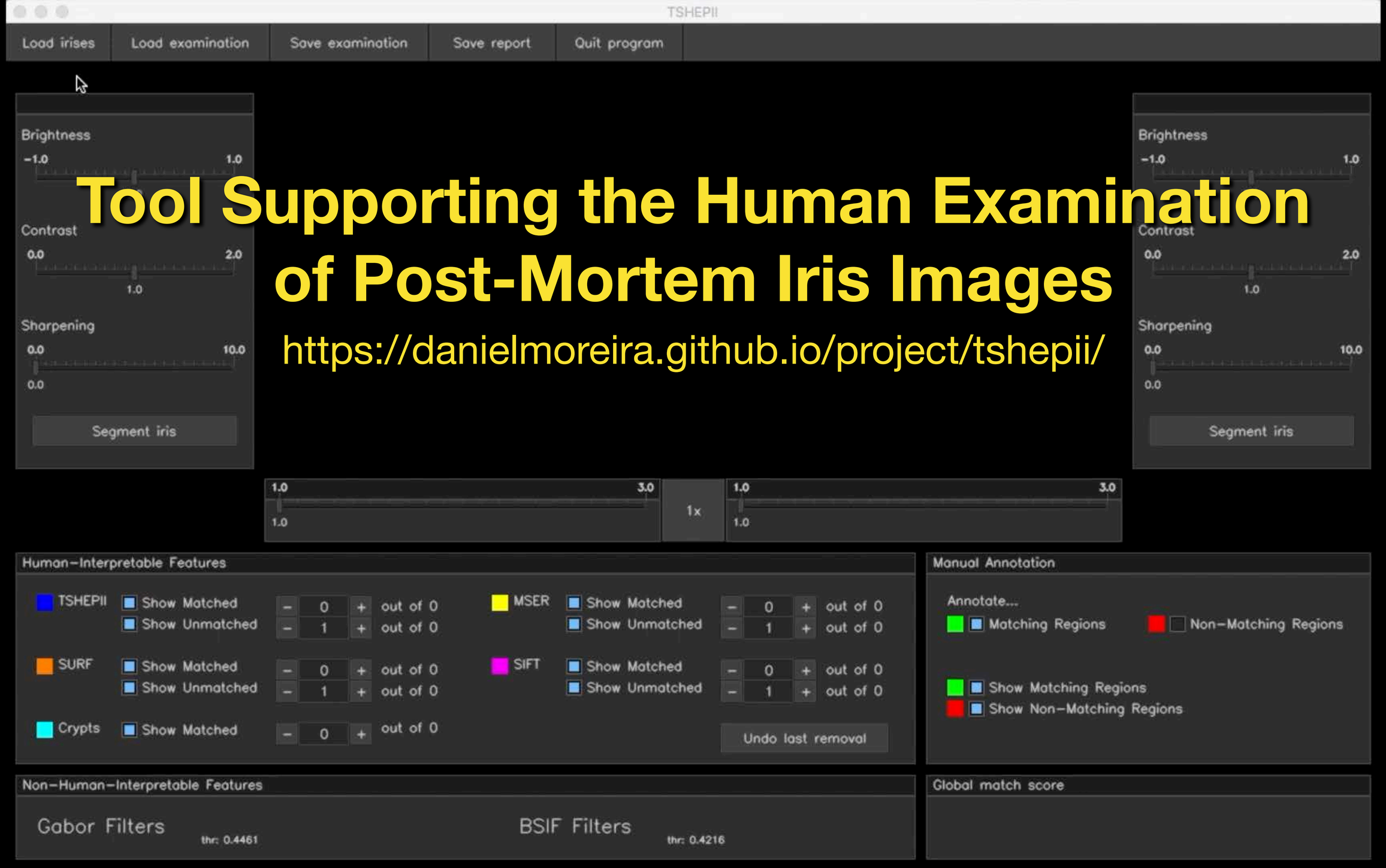



TSHEPII
Load irises
Load examination
Save examination
Save report
Quit program
0008_R_2_1.png
Brightness
−1.0
1.0
Contrast
0.0
2.0
1.1
Sharpening
0.0
10.0
1.0
0008_R_3_1.png
Brightness
−1.0
1.0
Contrast
0.0
2.0
1.0
Sharpening
0.0
10.0
2.0
Tool Supporting the Human Examination of Post-Mortem Iris Images
https://danielmoreira.github.io/project/tshepii/
WARNING
Manual Annotation
Annotate...
out of 3
Non−Human−Interpretable Features
Gabor Filters
0.4585
impostor
genuine
9/11

The Problem

Interpretable Iris Recognition

How to convince people who do not possess image processing expertise?



Tool Supporting the Human Examination of Post-Mortem Iris Images

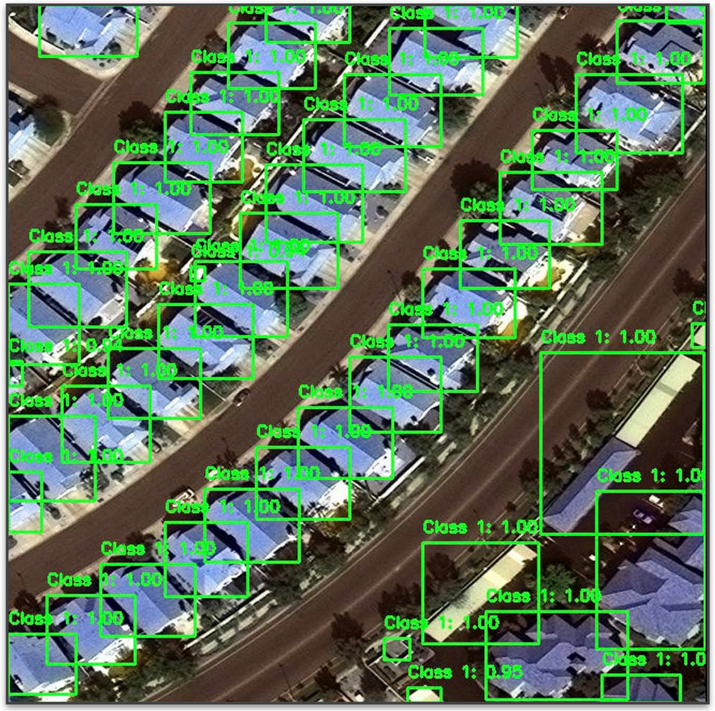
https://danielmoreira.github.io/project/tshepii/

Overhead Imagery Settlement Classification in the Nigerian Landscape

Ask me at dmoreira1@luc.edu.

The Problem

Manage Resources against Malaria



IN PROGRESS

Segment, count, and classify households into *formal*, *informal*, and *slum* unities.

Plan distribution of resources according to such information to fight Malaria.

How about you?

Background
11 graduate and 1 undergraduate student

What is your major?

tinyurl.com/
4yu228t6

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How about you?

Expectations
Given your (future) career, what are your course expectations?

bit.ly/
47SNMAC

How about you?

Accommodation Needs
Please reach out to me in private ASAP.
We'll make things work.

Today's Attendance

Please fill out the form

https://tinyurl.com/ycrbu92v

About the topic

Biometrics
What comes to your mind?

bit.ly/
45sHVQA

What is Biometrics?

7.9 billion people

Who is this person?

Is this person Jane Doe?

What is Biometrics?

7.9 billion people

Who is this person? *(Identification)*

Is this person Jane Doe? *(Verification)*

What is Biometrics?

7.9 billion people

Who is this person? *(Identification)*

Is this person Jane Doe? *(Verification)*

Biometrics aims at *identifying* or *verifying* the claimed identity of an individual based on their *physical*, *chemical,* or *behavioral* traits.

What is Biometrics?

In this course, we aim at **computer-aided Biometrics**.

We'll focus on **software solutions** rather than hardware.

But we'll get to use some **devices**, I promise.

What is Biometrics?

Identity verification through:

✓ A unique trait of yours.

physical

chemical

behavioral

✗ Not something you **have**.

✗ Not something you **know**.

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Why use Biometrics?

Consumers prefer biometric authentication to traditional passwords, Visa says

Jan 6, 2020 | Chris Burt

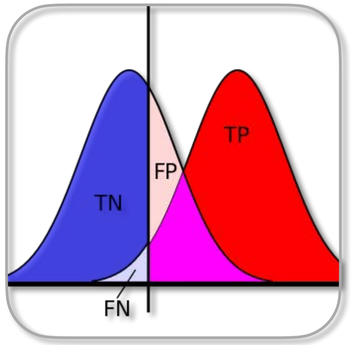
CATEGORIES Biometrics News | Financial Services

Almost 70 percent of U.S. shoppers did not go through with an online purchase because they either forgot the password, couldn't log in or couldn't receive a one-time passcode, according to research conducted by Visa, while another report from Verizon found that as many as 80 percent of data breaches are caused by compromised and weak passwords.

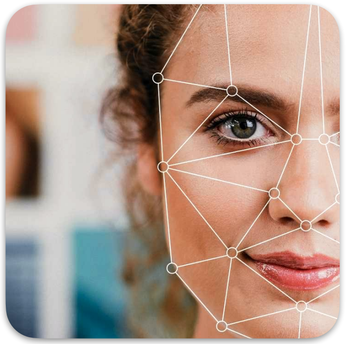
https://www.biometricupdate.com/202001/consumers-prefer-biometric-authentication-to-traditional-passwords-visa-says

Course Overview

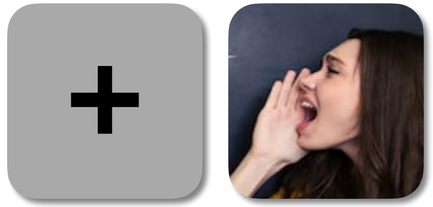
Content



Basics
Concepts
Metrics
Metric implementation



Core Traits (3)
Concepts
Baseline implementation
Data collection
Evaluation
Attacks
Assignments



Alternative Traits and Fusion
Concepts

Invited Talks (2)
State of the art
Future work

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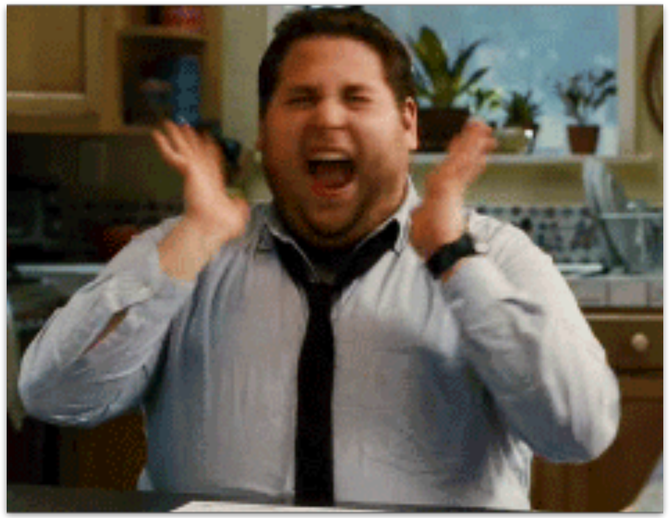
Course Overview

Structure *(tentative)*
23 lectures
4 in-class coding days with data collection
2 invited talks

Workload
4 assignments
2 exams (midterm and final)
1 project with written report and presentation

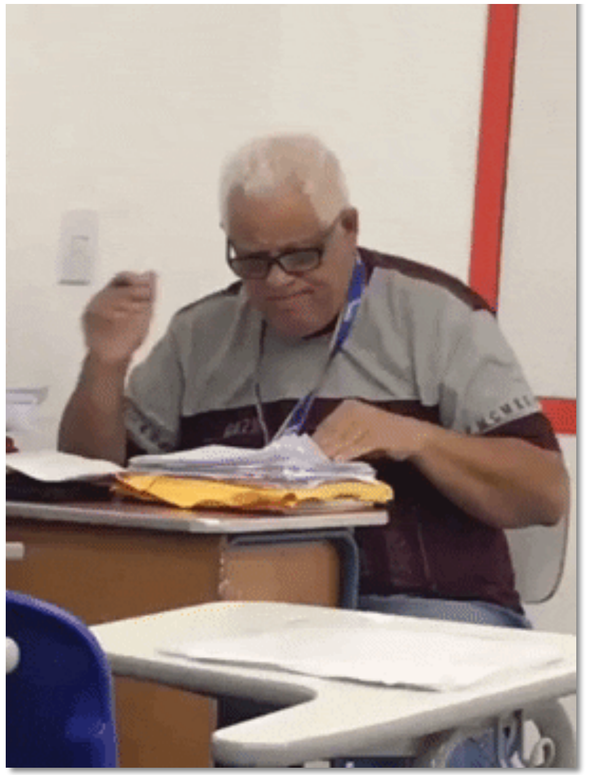


Course Overview

Grading

	Undergraduate	Graduate
Assignments (4)	40%	25%
Exams (2)	50%	40%
Project	10% (extra)	25%
Participation	10%	10%
On the News	1% (extra)	1% (extra)

A [96, 100)	B+ [88, 92)	C+ [76, 80)	D+ [64, 68)
A- [92, 96)	B [84, 88)	C [72, 76)	D [60, 64)
	B- [80, 84)	C- [68, 72)	F (0, 60)



Course Overview

Grading

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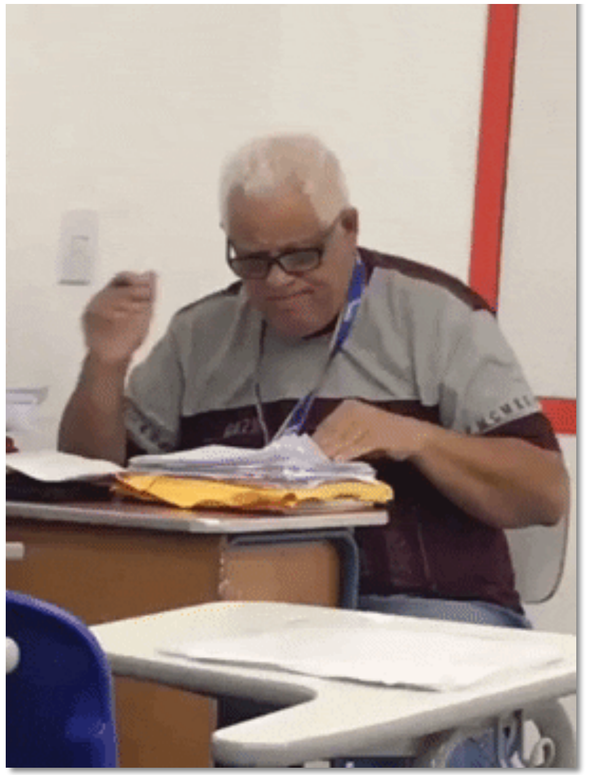
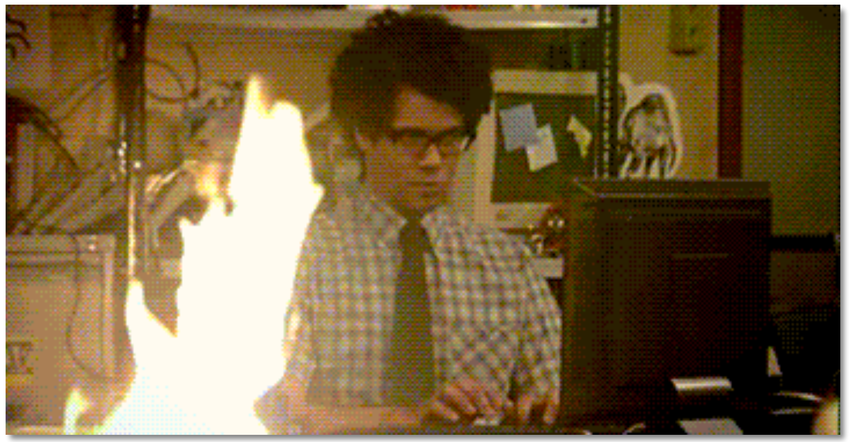


Course Overview

Assignments
Individual take-home activities
Submission through Sakai

Late policy: -10% of the maximum possible grade for each day of delay.



Assignment 1	Assignment 2	Assignment 3	Assignment 4
Metric Collection	Fingerprint Recognition	Face Recognition	Iris Recognition

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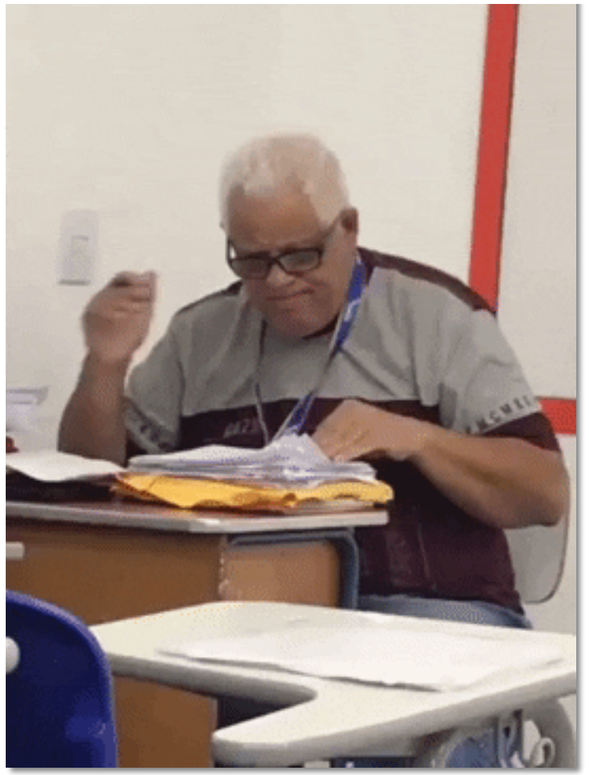


Course Overview

Exams

10/02: in-class written midterm
12/09 (?): in-class written final

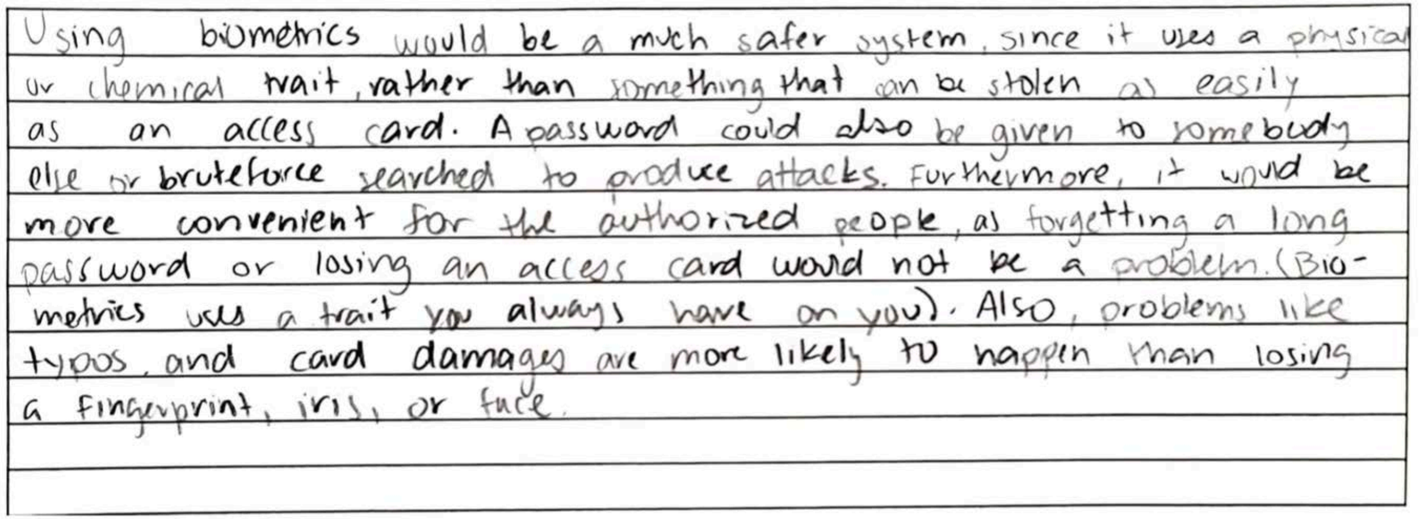
One-page cheat sheet is allowed.

Course Overview

Exams

Style example.

[Question 1] (2 points)
Suppose you were hired by a bank company to coordinate the deployment of an access management system to control the entrance of authorized people into the many vaults spread among different branches. The bank directors have heard about Biometrics but are not certain about the benefits of using it. They think using simple access cards and long passwords is as effective and much cheaper than using a biometric system. If it is your duty to change their mind, **what would you say to convince them**?


Using biometrics would be a much safer system, since it uses a physical or chemical trait, rather than something that can be stolen as easily as an access card. A password could also be given to somebody else or bruteforce searched to produce attacks. Furthermore, it would be more convenient for the authorized people, as forgetting a long password or losing an access card would not be a problem. (Biometrics uses a trait you always have on you). Also, problems like typos, and card damages are more likely to happen than losing a fingerprint, iris, or face.

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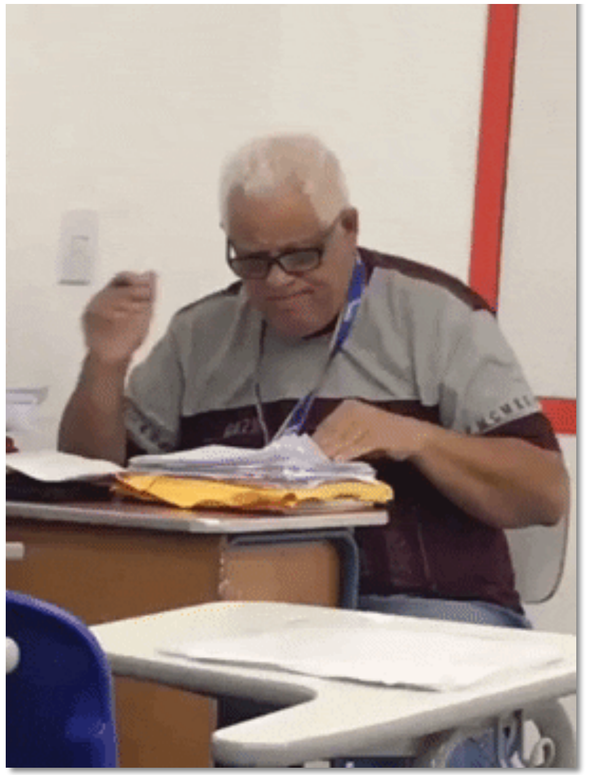
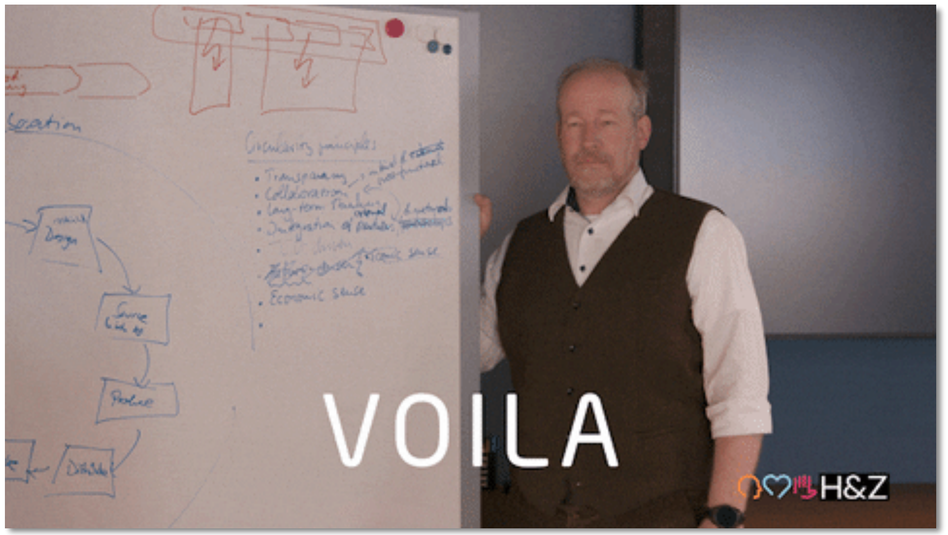


Course Overview

Project

Work alone or in pairs.
Provide a written report and
perform a presentation.

Optional to undergraduate students
(it will grant extra points).



Course Overview

Project

Possible Topics

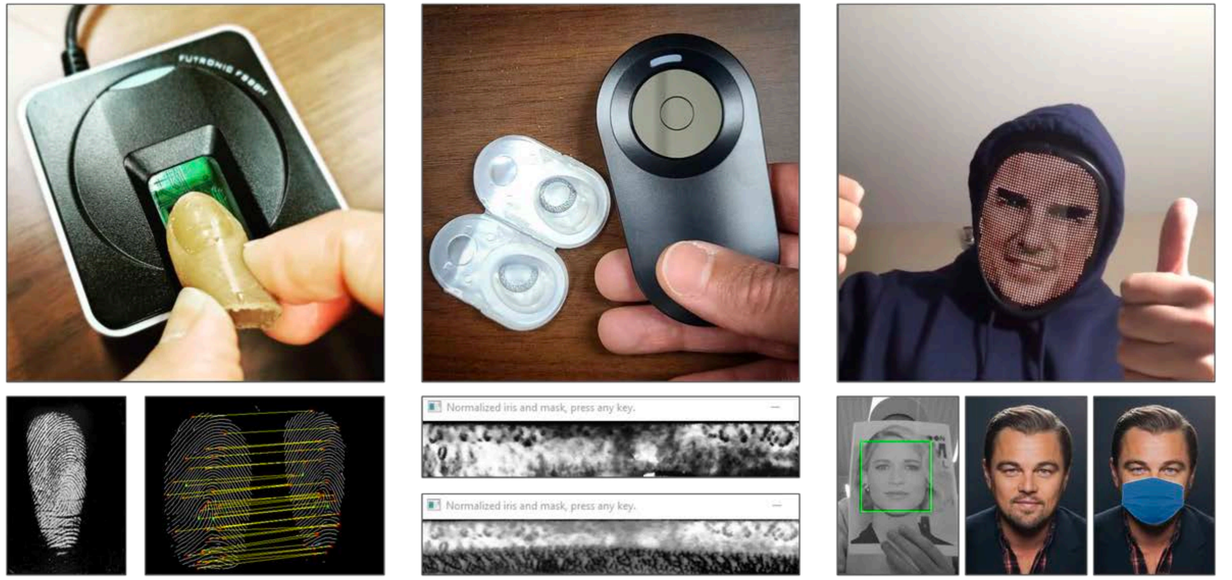
Presentation attack
(performance, detection, and mitigation)
of fingerprint, face, or iris recognition.

Implementation of recognition of traits
other than fingerprints, face, and iris.

Course Overview

Project

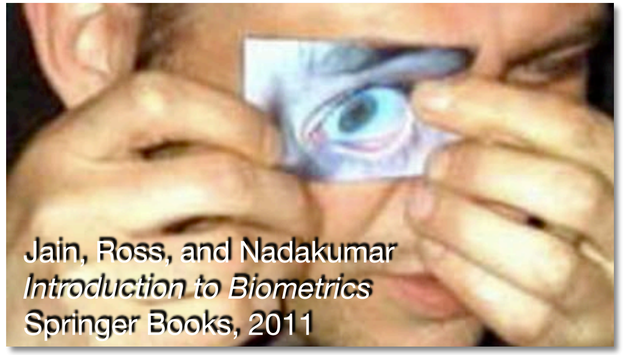
Possible Topics *(continued)*



Implementation of a complete class attendance system.

Presentation and implementation of state-of-the-art scientific publications.

Discussion about the ethical aspects of Biometrics and surveillance.



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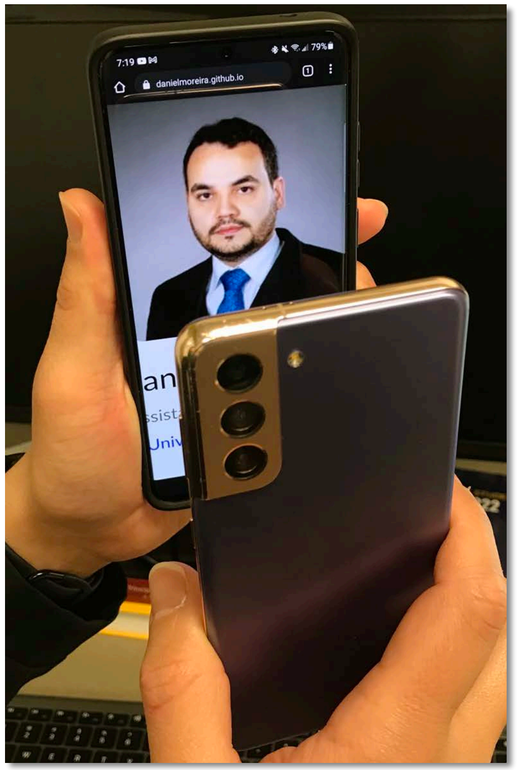

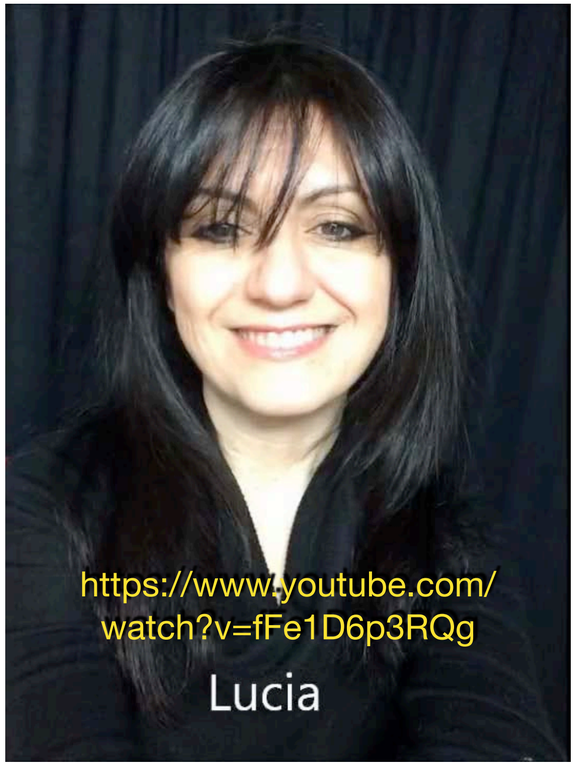

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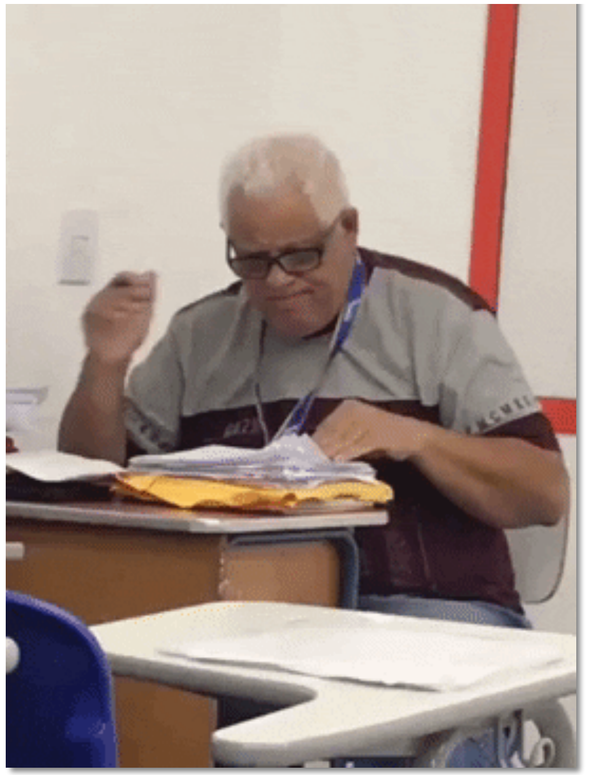


Course Overview

Participation

Class Attendance
Every presence counts.
It is possible to get extra points based on interest and proactivity.

Course Overview

Participation

***Today-I-missed* Statements**
Submit **on Sakai** after every class.
Answer one of

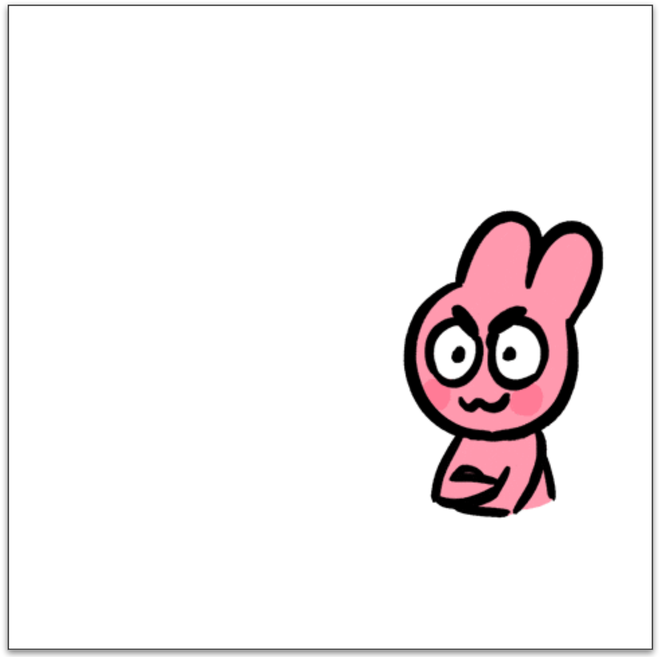
What is your biggest question after class?
or
What was the most interesting point you learned today?

Course Overview

Participation

Grace Cards
Life happens, each student has 3 GCs.

Avoid losing points because of
class absence or late-delivered assignments
(they grant one-week extensions).



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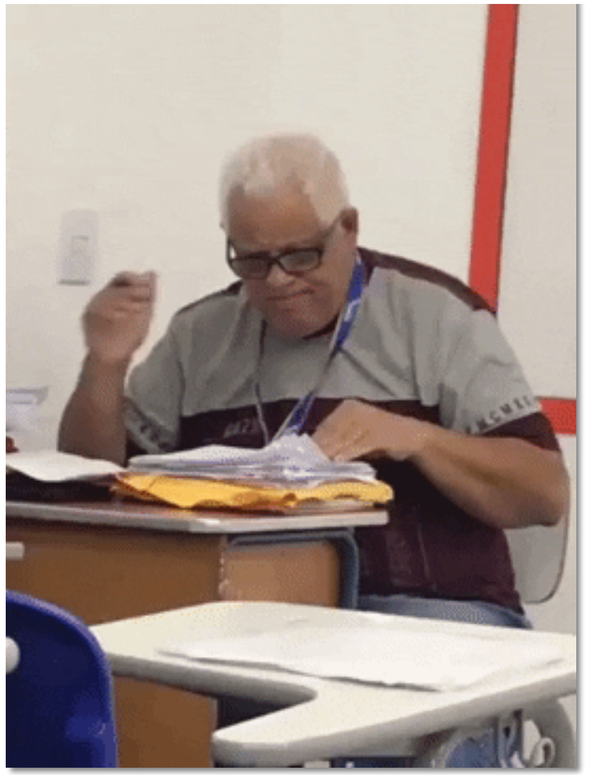

Course Overview

Biometrics on the News

Share with us any news you find that are related to Biometrics.

Get extra points for doing that.

Course Overview

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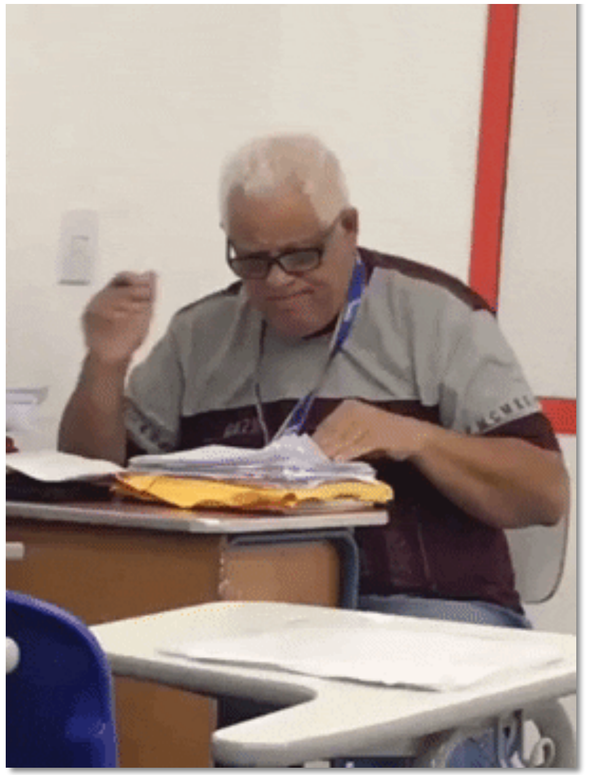


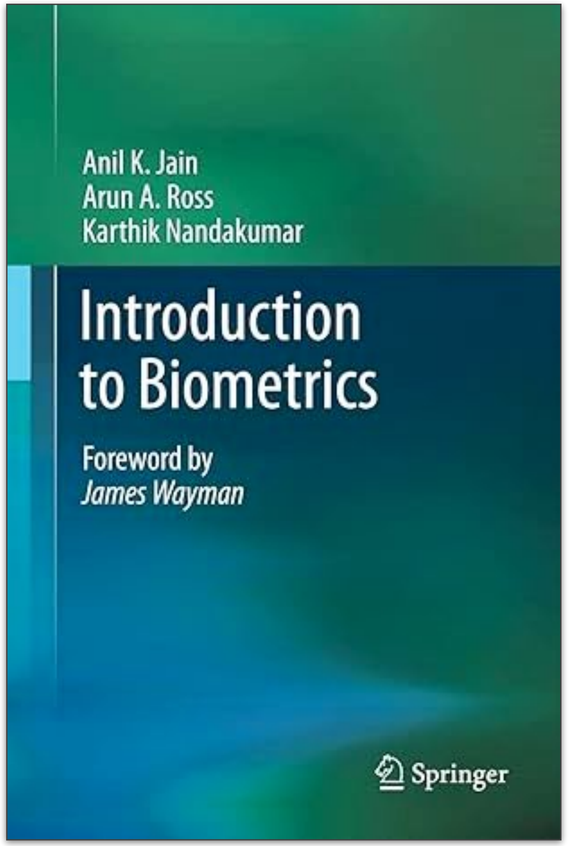
Code of Honor
Please refer to https://tinyurl.com/5n6ru62s.
Break it and get an F.

Course Overview

Bibliography

Jain, Ross, and Nandakumar
Introduction to Biometrics
Springer Books, 2011

Jain, Flynn, and Ross
Handbook of Biometrics
Springer Books, 2008



Course Overview

Pre-requisites

Essential
Programming, basic prob & stats,
and data structures

Desired
Python, Numpy, OpenCV

Not sure?
Please talk to me in private.

Course Overview

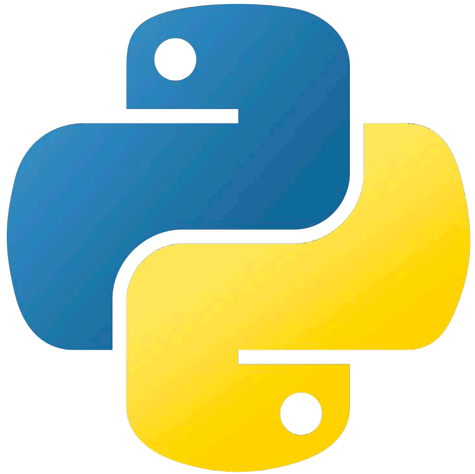
Data Collection

We'll collect only **our own biometric** data (instructor's and students').
Our data **will only be used** for the purpose of the course.
Our data **will not be shared** with anybody outside the course.
Our data **will be deleted** after the course.

During assignments, folks in need of other publicly available biometric databases are welcome to contact me, so we can take care of privacy and copyright issues.

Course Overview

Why Python?
High-level enough
General-purpose enough
Good code readability

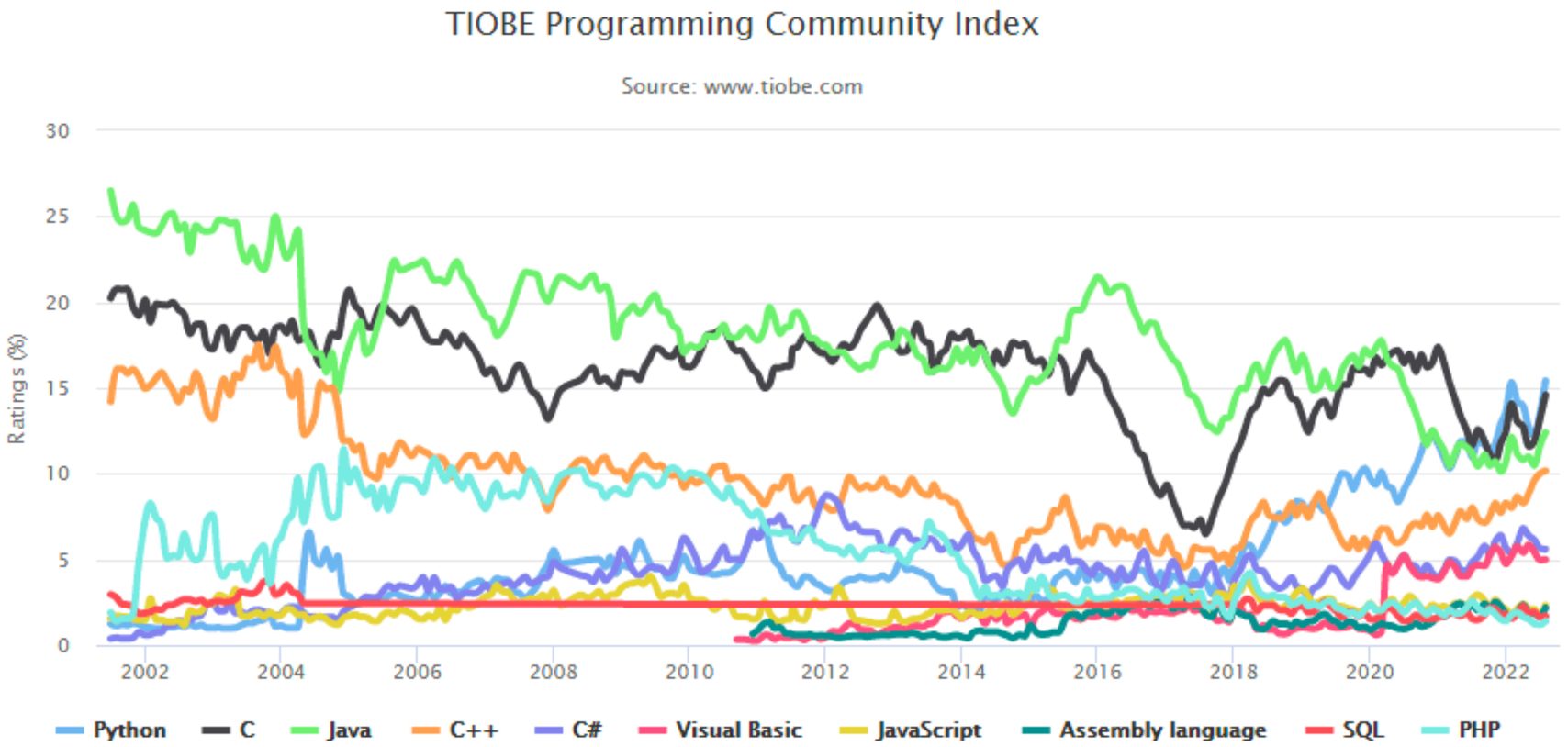


High productivity in data processing
(easy to manipulate strings, lists, and dictionaries).

Large supporting community.
Good libraries supporting scientific computing
(e.g., Numpy, ScyPy, Matplotlib).

Course Overview

Why Python?
Increasing popularity



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Course Overview

Jupyter Notebooks
Interactive computing

Adoption of the *notebook* interface:
Multiple cells for (1) explanation,
(2) coding, and (3) output of results.

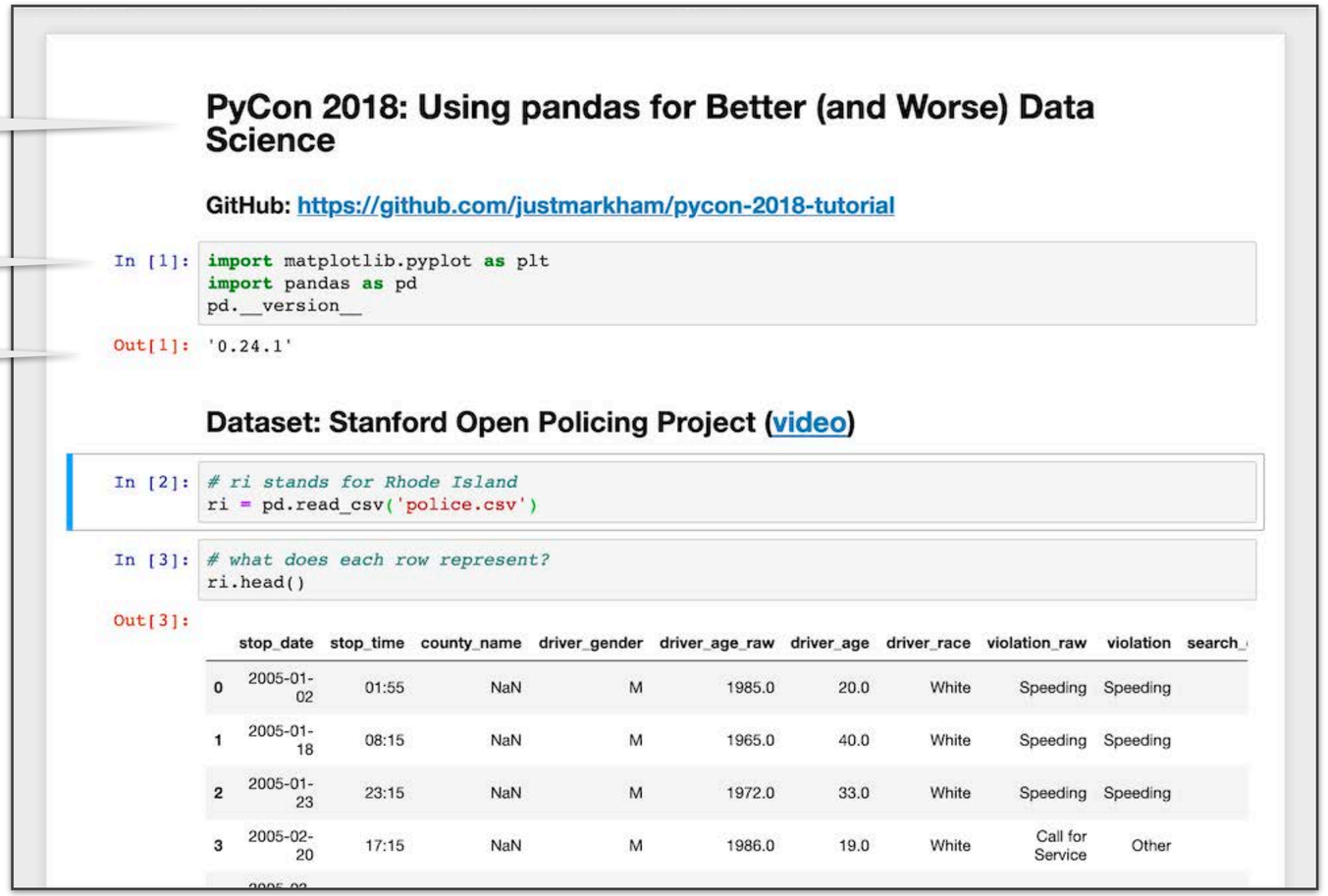
Course Overview

Jupyter Notebooks

explanation

coding

output



PyCon 2018: Using pandas for Better (and Worse) Data Science

GitHub: https://github.com/justmarkham/pycon-2018-tutorial

```
In [1]: import matplotlib.pyplot as plt
        import pandas as pd
        pd.__version__
```

```
Out[1]: '0.24.1'
```

Dataset: Stanford Open Policing Project (video)

```
In [2]: # ri stands for Rhode Island
        ri = pd.read_csv('police.csv')
```

```
In [3]: # what does each row represent?
        ri.head()
```

Out[3]:

	stop_date	stop_time	county_name	driver_gender	driver_age_raw	driver_age	driver_race	violation_raw	violation	search_
0	2005-01-02	01:55	NaN	M	1985.0	20.0	White	Speeding	Speeding	
1	2005-01-18	08:15	NaN	M	1965.0	40.0	White	Speeding	Speeding	
2	2005-01-23	23:15	NaN	M	1972.0	33.0	White	Speeding	Speeding	
3	2005-02-20	17:15	NaN	M	1986.0	19.0	White	Call for Service	Other	

Course Overview

Jupyter Notebooks

explanation

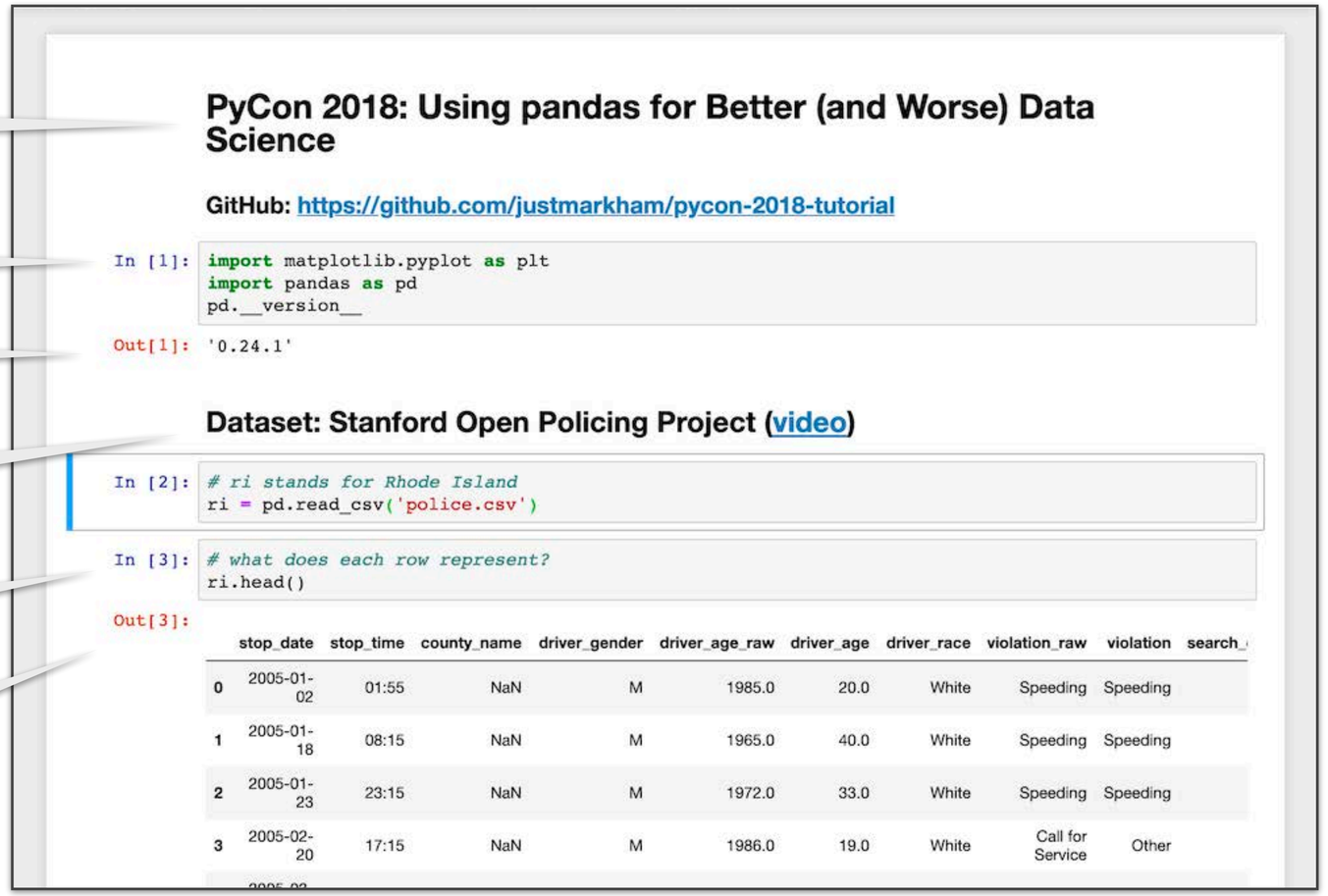
coding

output

explanation

coding

output



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Course Overview

Google Colab
https://colab.research.google.com/

You'll need a Google account.

Select "New Notebook" on the bottom right of the form.

Do your first "Hello World!"

Course Overview

Local Installation?
Please come to office hours (https://tinyurl.com/2v6eme5p).

Local installation of Python and Jupyter.

Any operating system.
Use your CPU.

Your Next Tasks

Relax
Any issues? Please come and talk to me.

Sakai is up!
Please visit it as soon as possible.
Important announcements will be made there.

Start filling out your *Today-I-missed* Statement
Please visit https://sakai.luc.edu/x/HAZC1P.