



Interpretation of Events from Heterogenous Data

How to Connect Existing Pieces of Evidence in Space & Time

Anderson Rocha (Associate Professor)

Microsoft Research Faculty Fellow

Google Faculty Research Awardee

Tan Chin Tuan Fellow

IEEE Senior Member

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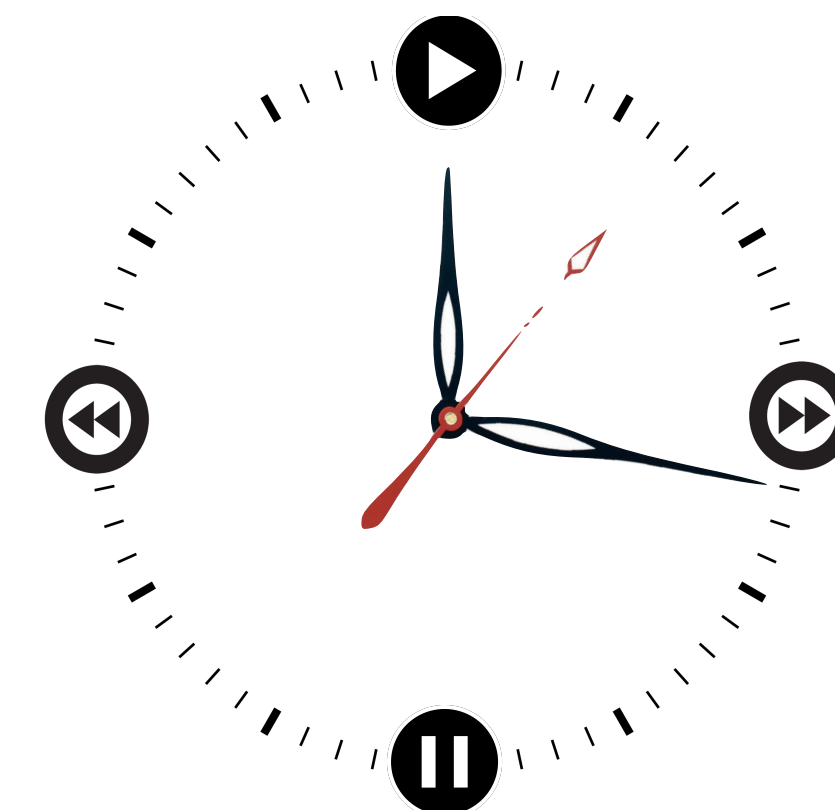
Reasoning for Complex Data (RECOD) Lab.

Institute of Computing,

University of Campinas (Unicamp)

Av. Albert Einstein, 1251 – Cidade Universitária

CEP 13083-970 • Campinas/SP – Brasil



Photographs carry a high **persuasive power**

When seeing an impacting photo, we **immerse** in a parallel world

But how can we ensure **trustworthiness**
in such powerful medium?

Death of *Alan Kurdi*, likely the **most impacting** photo of 2015, the
“Year of the Refugees” – © Nilüfer Demir



Israeli-Palestinian Conflicts – 2013 World Press Photo of the Year.
Is it real? – © Paul Hansen







SHARIAH
FOR THE
NETHERLANDS
ISLAM WILL BE SUPERIOR

ISLAM
WILL DOMINATE
THE WORLD
FREEDOM CAN GO TO HELL

ISLAM
WILL
CONQUER
EUROPE

ENEMY OF ISLAM
GEERT WILDERS
DESERVES ISLAMIC
PUNISHMENT

ISLAM
WILL DOMINATE
THE WORLD

RT
NEWS

And to complicate

...**The Era of Post-Truth**

T _ H E
F A K _ _ _ E
_ N E W S
M A C H I N E

—
INSIDE A TOWN GEARING
UP FOR 2020

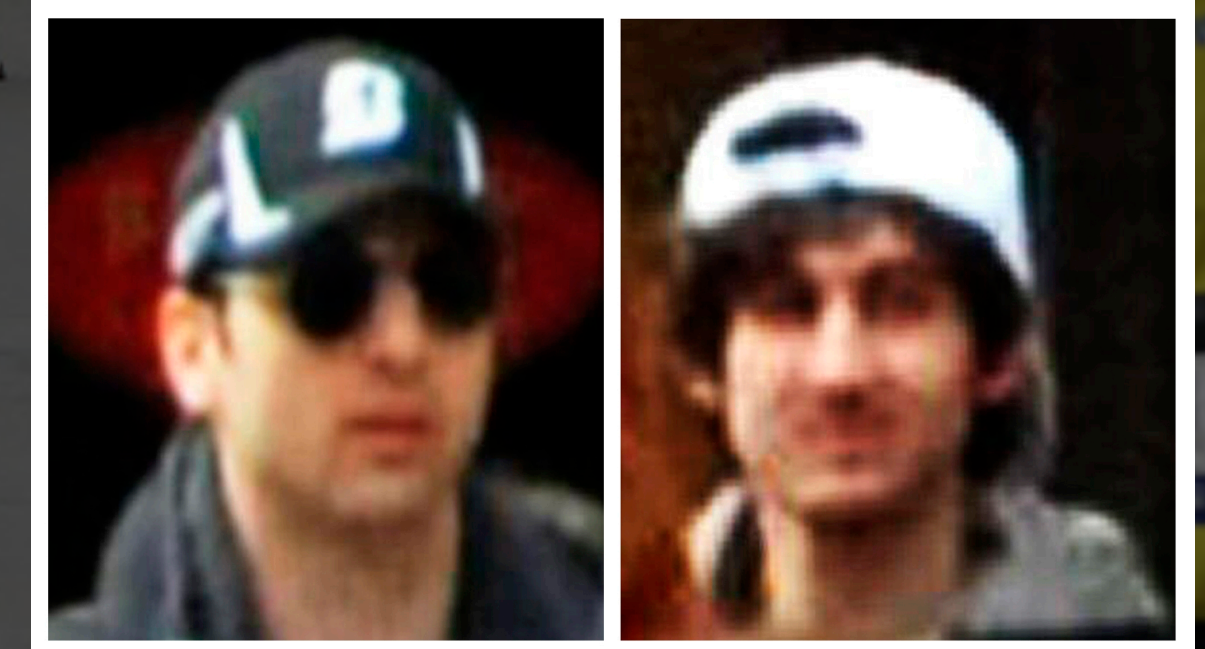


And to complicate

...**Terrorist Threats**



Boston Marathon Bombing

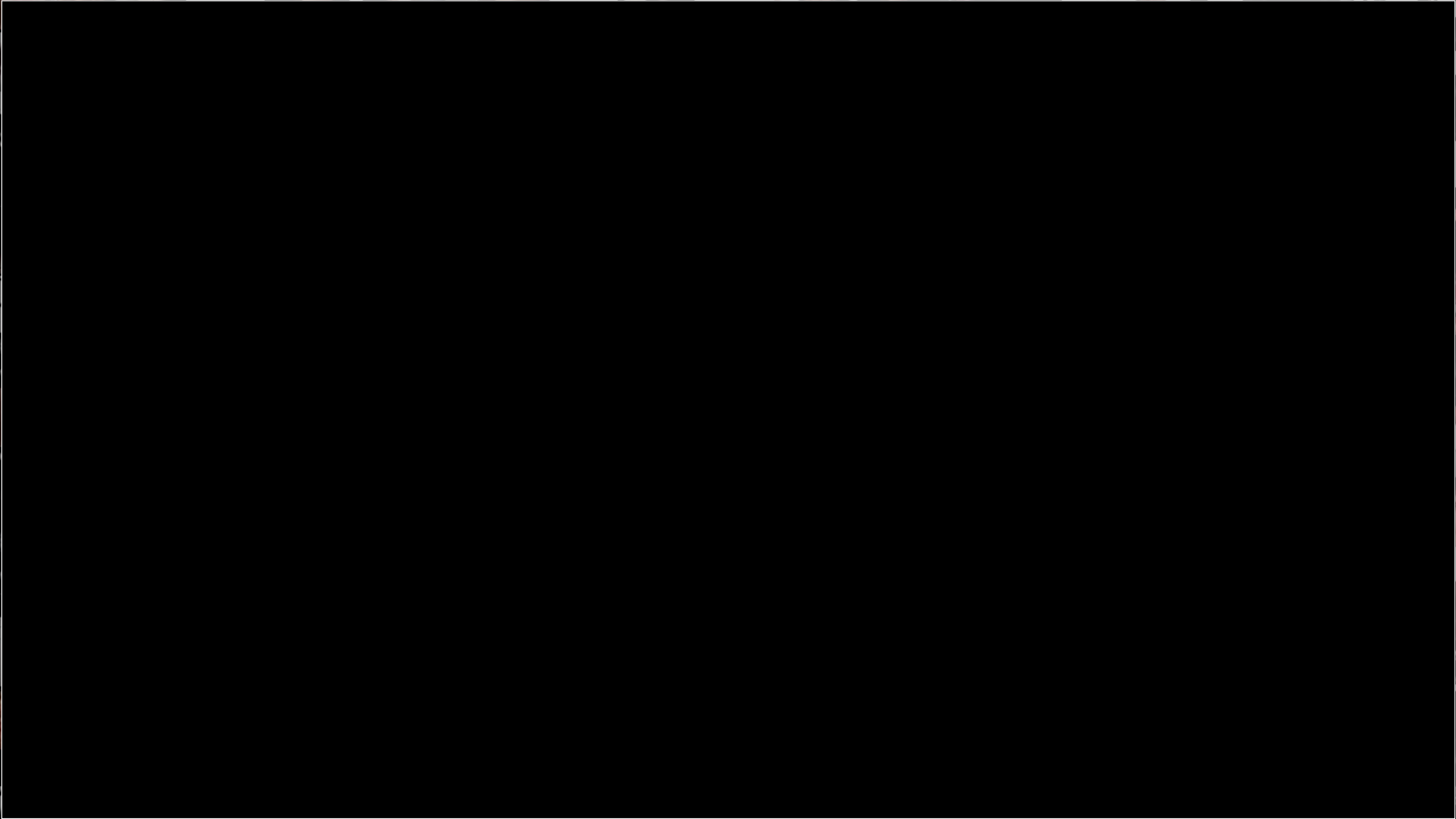


Boston Marathon Bombing

And to complicate

...online

exploitation of **children**



What can we do?

Digital Forensics

Machine Learning

Reasoning for Complex Data

8th Anniversary



Prof. Anderson **Rocha**



Prof. Eduardo **Valle**



Prof. Adin **Rivera**



Prof. Ricardo **Torres**



Prof. Sandra **Avila**



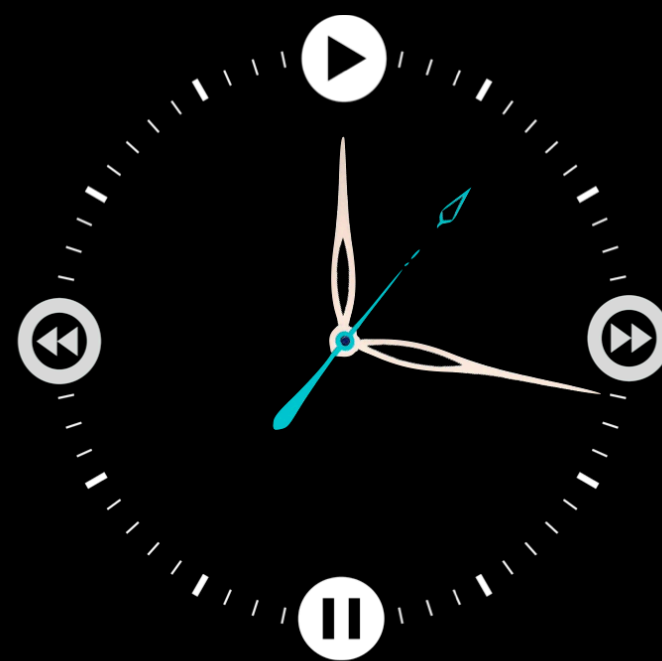
Prof. Siome **Goldenstein**



Prof. Jacques **Wainer**

3

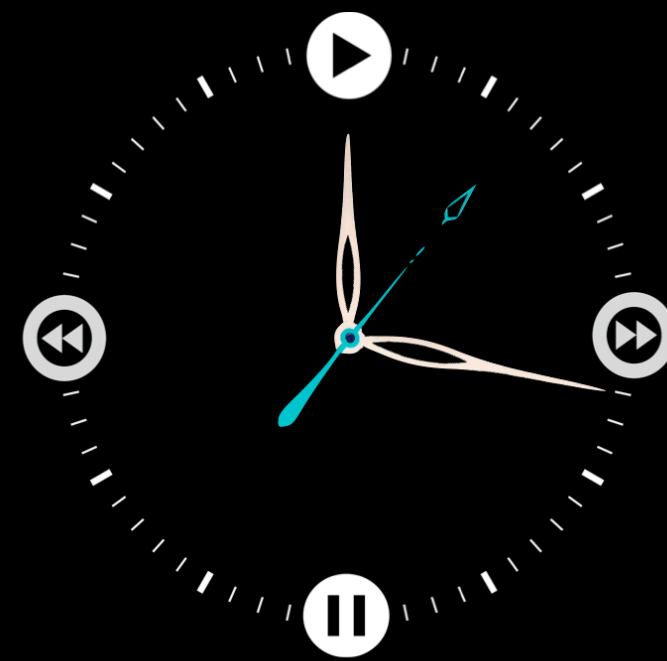
Investigations of Interest



Déjà Vu



MediFor



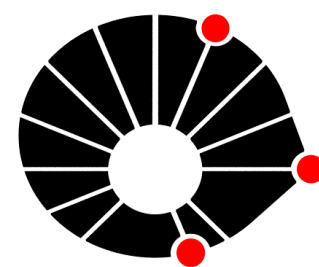
Déjà Vu



MediFor



DEEP Eyes



Digital Forensics



* A. Rocha, W. Scheirer, T. E. Boult, and S. Goldenstein. *Vision of the unseen: Current trends and challenges in digital image and video forensics*. ACM Computing Surveys, 43(4) 26:1-26:42, 2011.

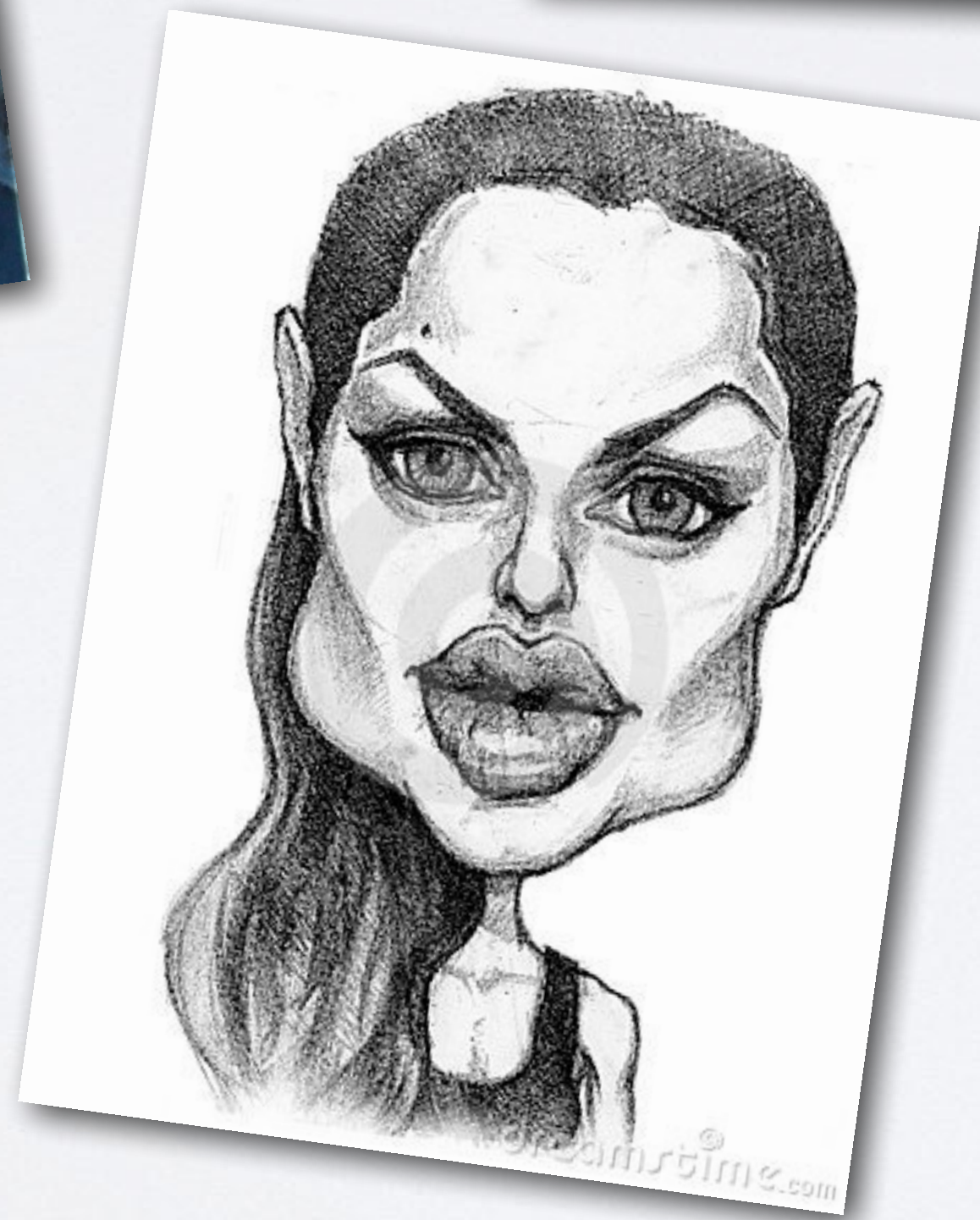
Digital Forensics



© A. Rocha

* COSTA, Filipe; SILVA, Ewerton; ECKMANN, Michael; SCHEIRER, Walter J.; ROCHA, Anderson. *Open set source camera attribution and device linking*. Elsevier Pattern Recognition Letters, (PRL), v. 39, pp. 91–101, 2014.

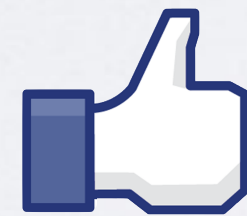
Digital Forensics



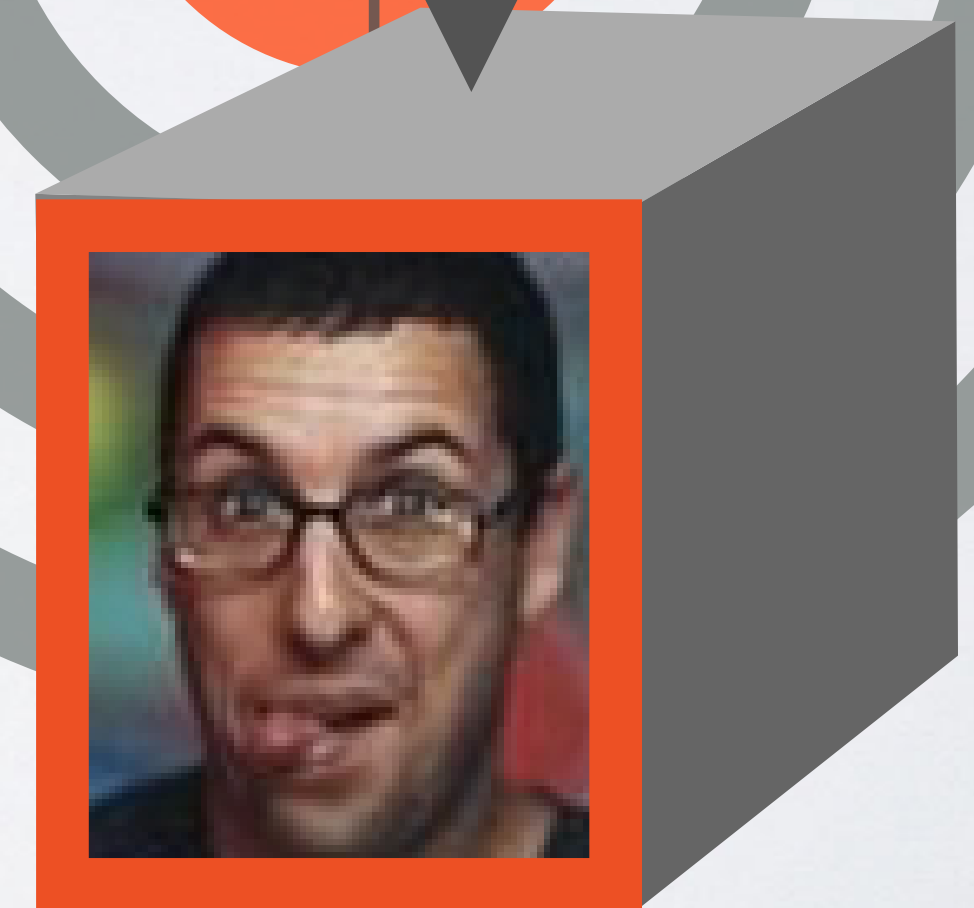
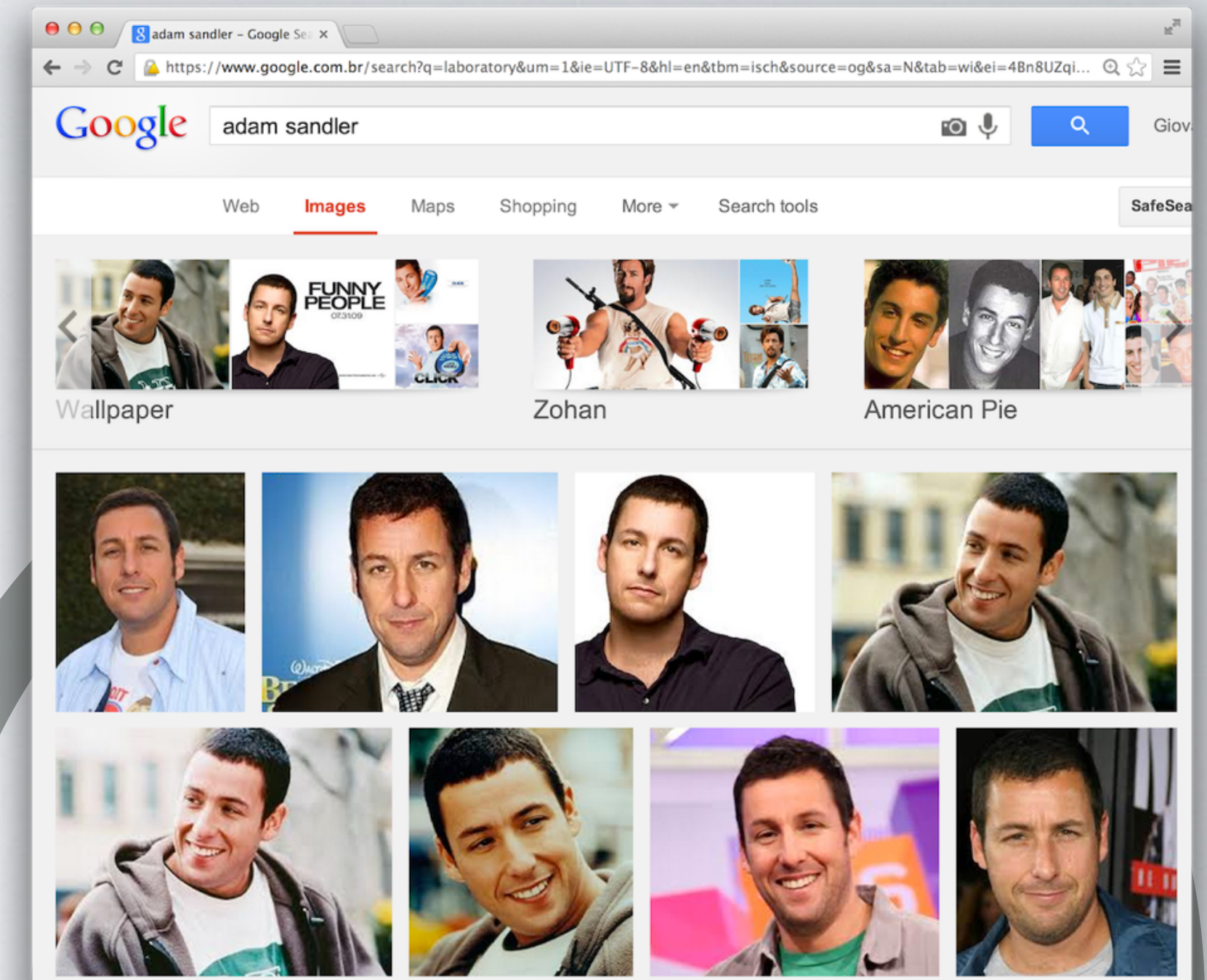
http://fc01.deviantart.net/fs6/i/2006/352/0/9/Adam_Sandler_Caricature_2_by_drawmyface.jpg
http://vectorboom.com/Articles/Caricatures/Alec_Baldwin_by_kgreene.jpg
http://thumbs.dreamstime.com/thumblarge_594/1301255135RvQKpZ.jpg
<http://aidobonsai.files.wordpress.com/2011/05/caricaturas-de-jogadores-ronaldinho-gaucha.jpg>

Unconstrained Scenario

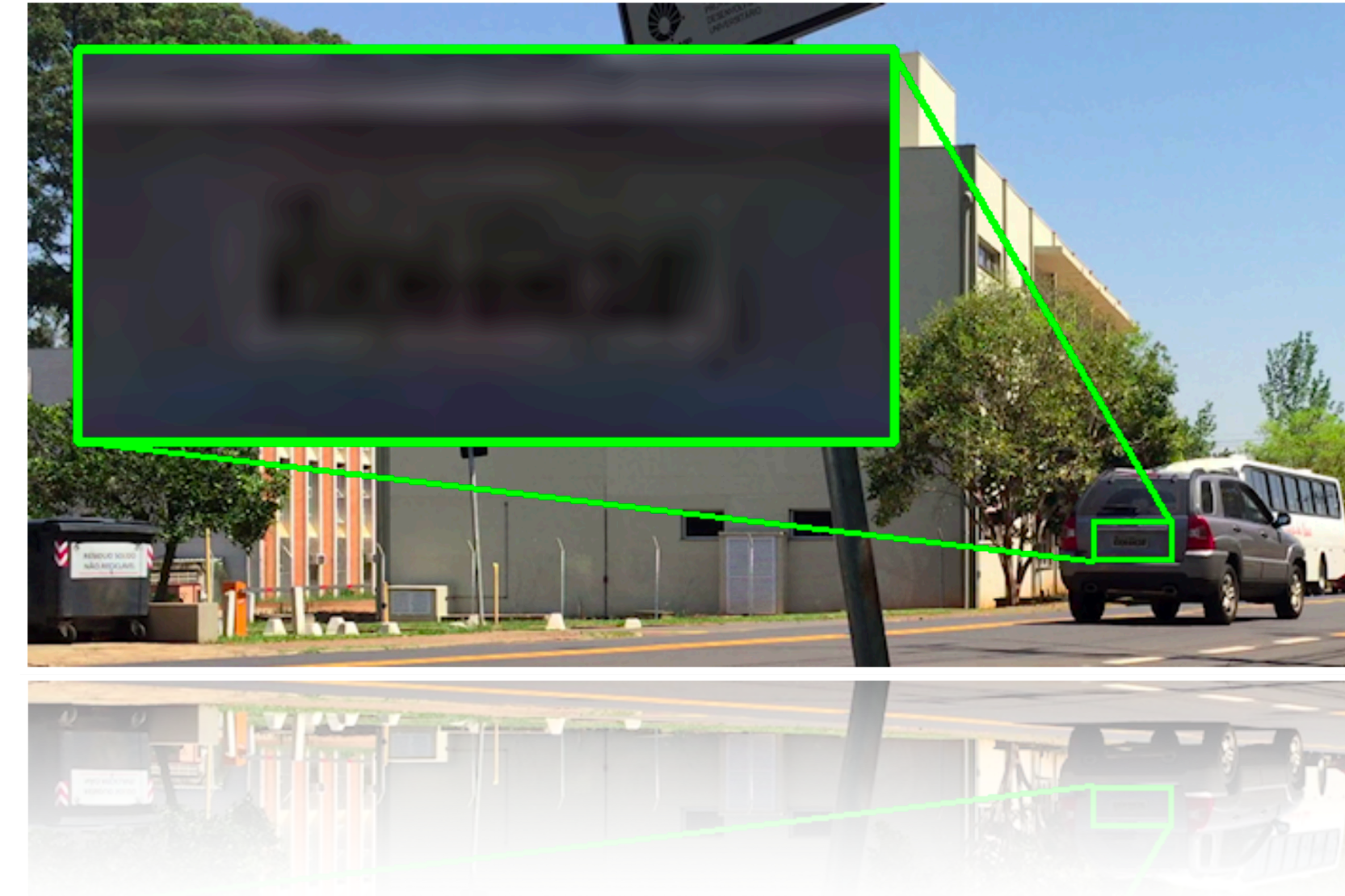
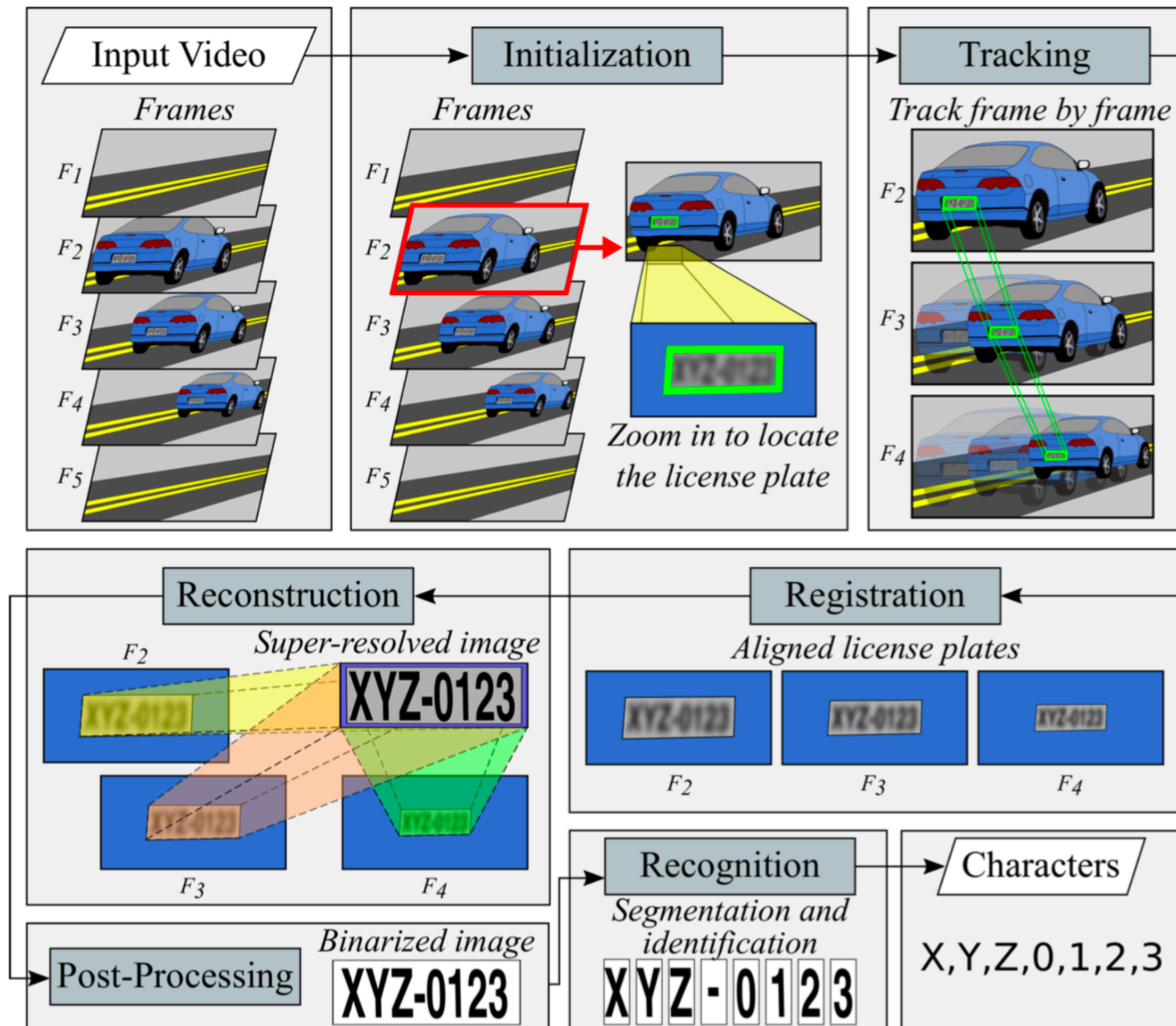
BIG DATA +
HETEROGENEOUS



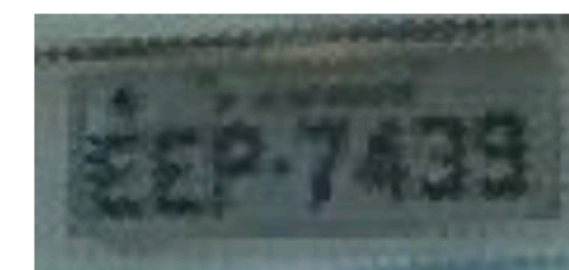
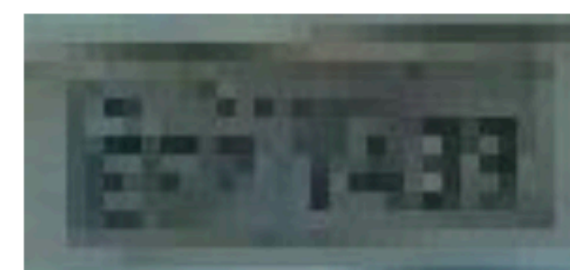
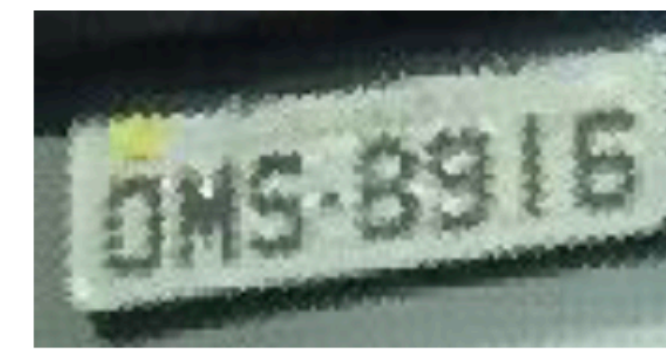
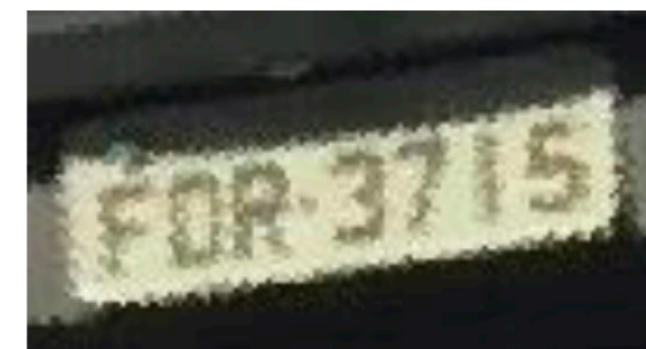
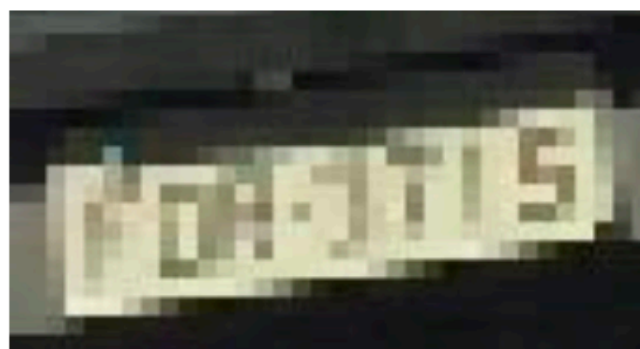
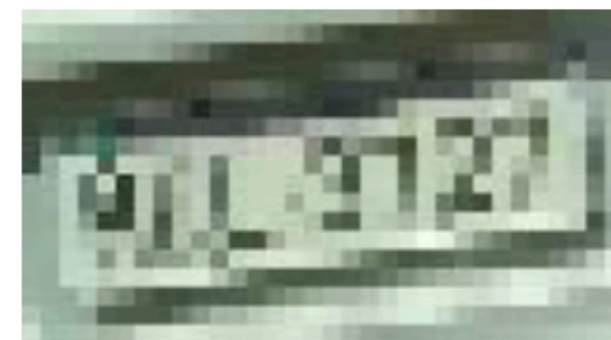
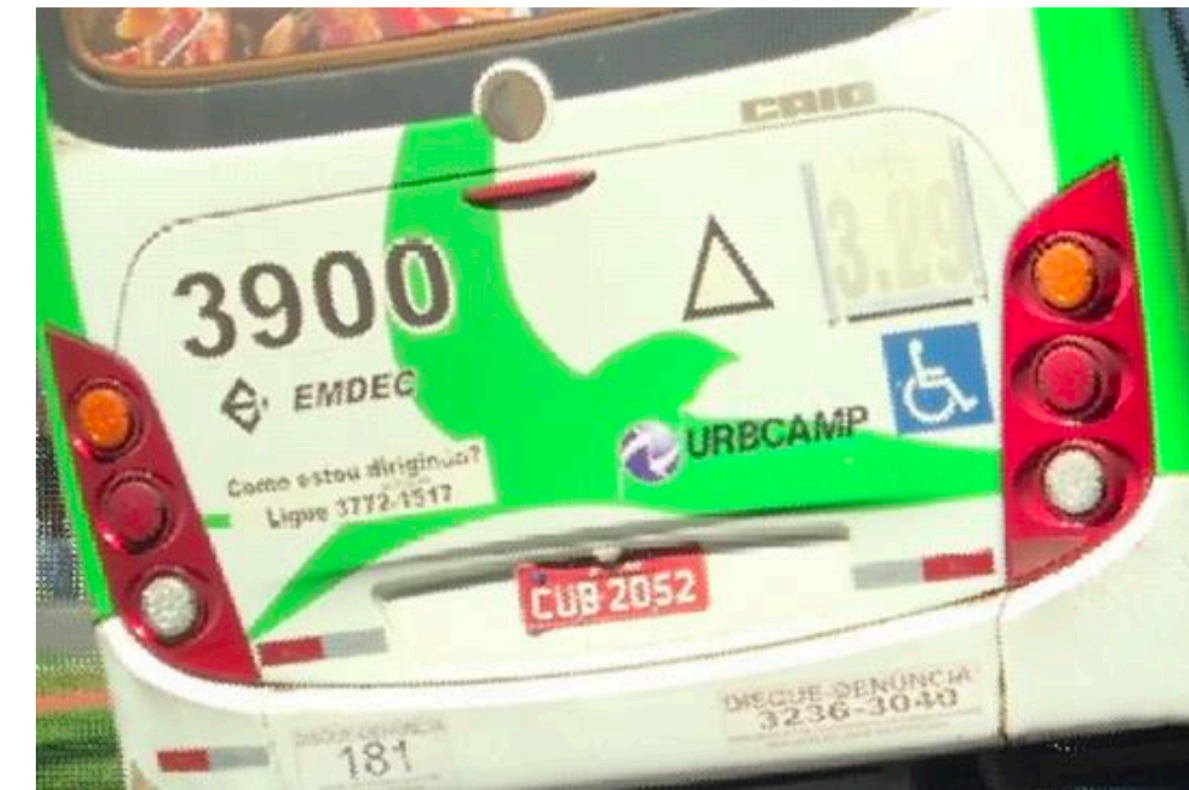
FAMILIAR FACE RECOGNITION



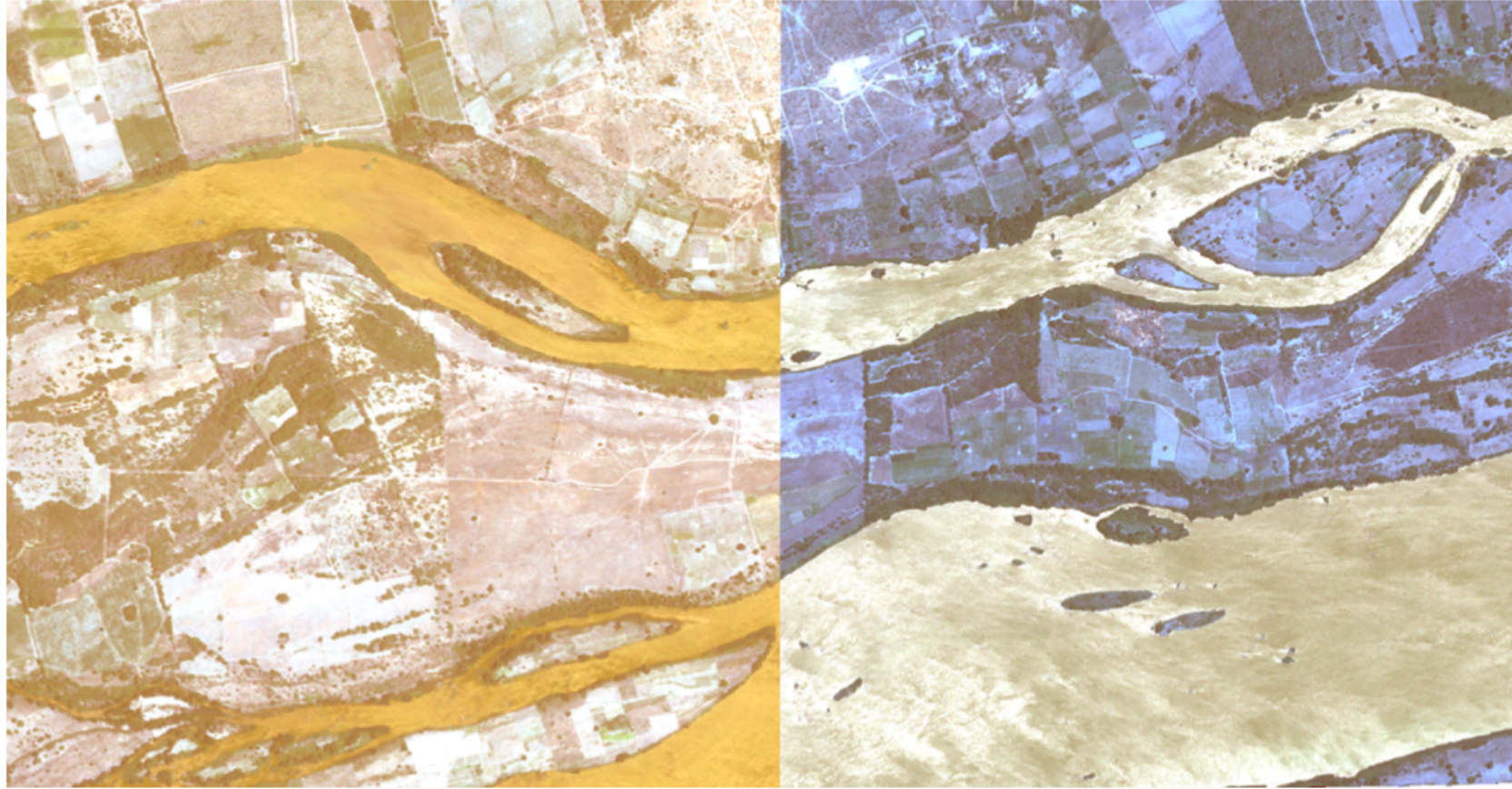
Super-Resolution



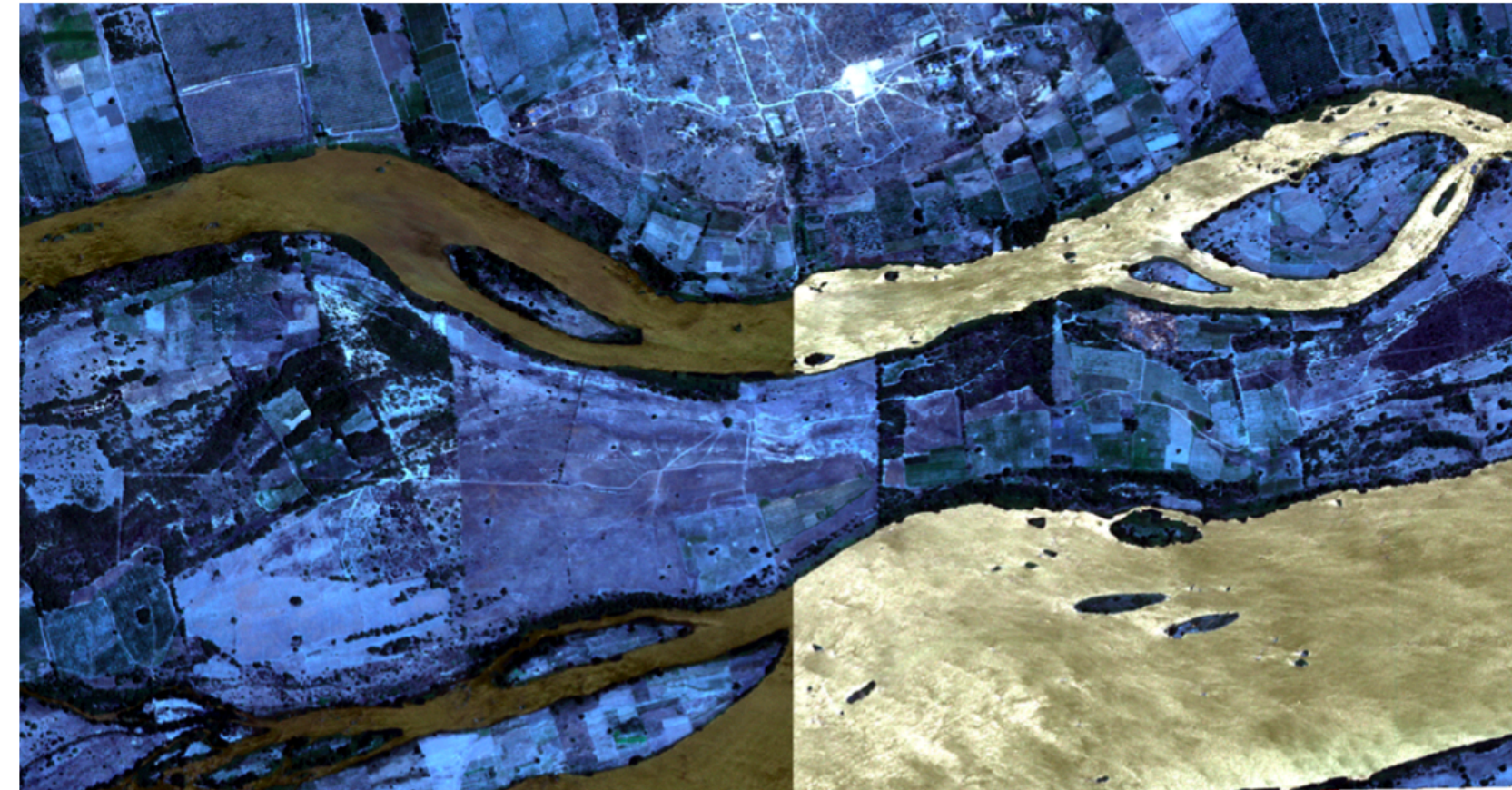
Super-Resolution



Remote Sensing



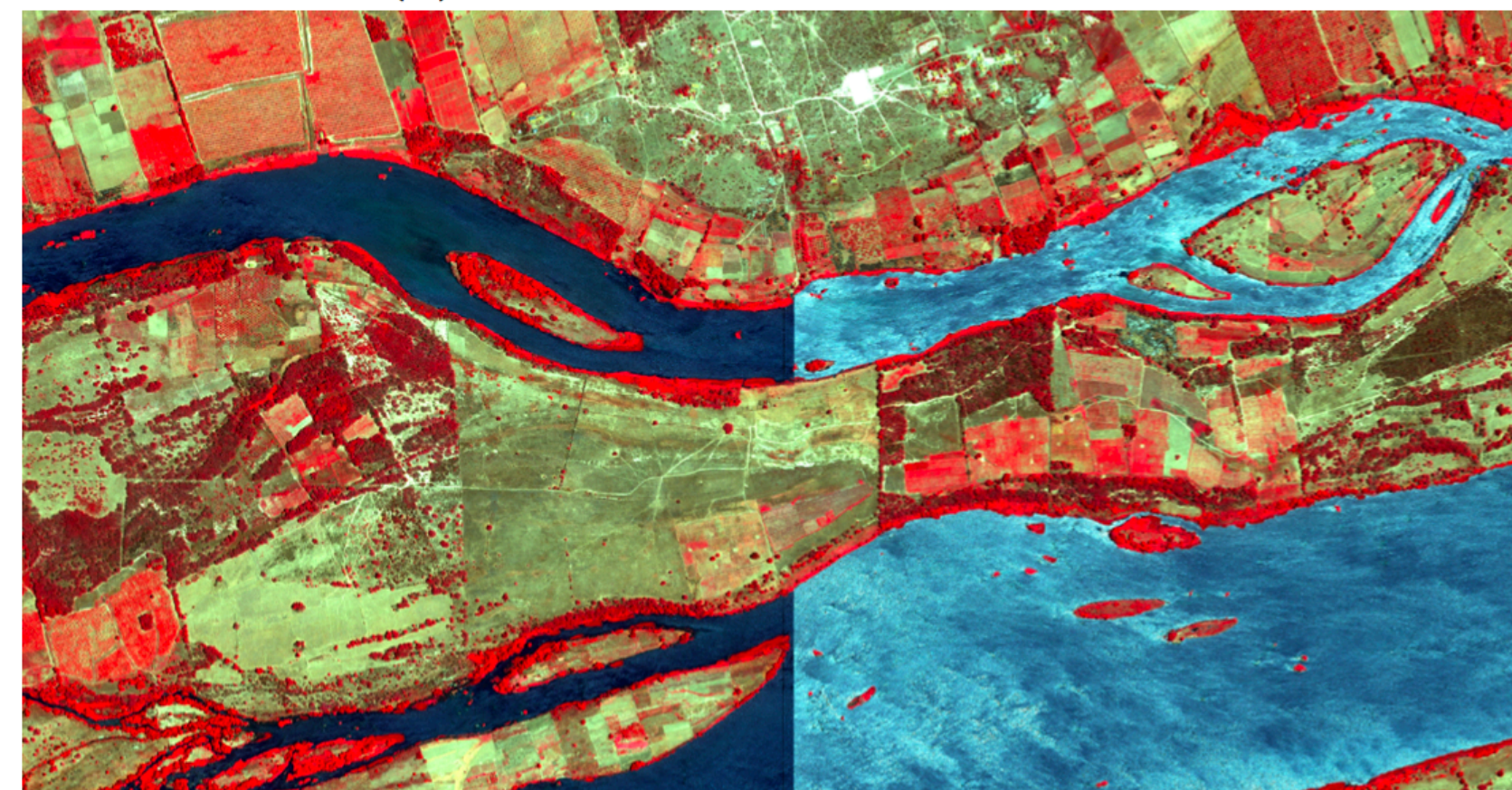
(a) Original



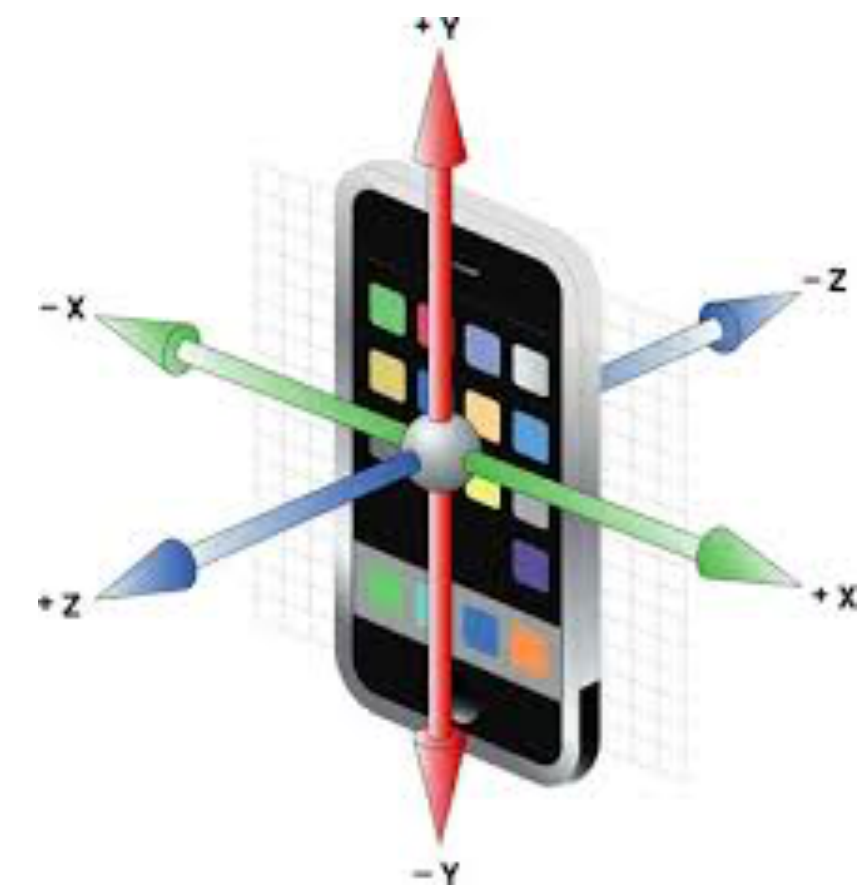
(b) Radiometric Normalized



(c) Radiometric normalized Near Infrared channel

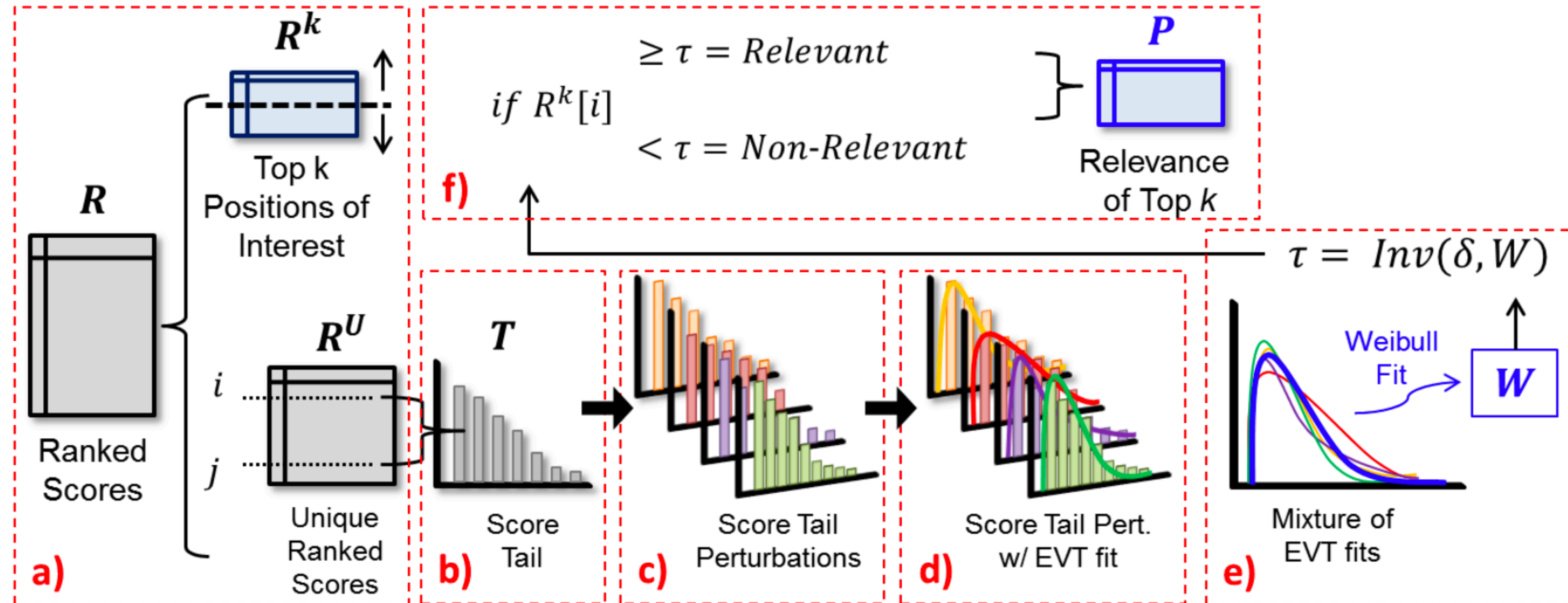


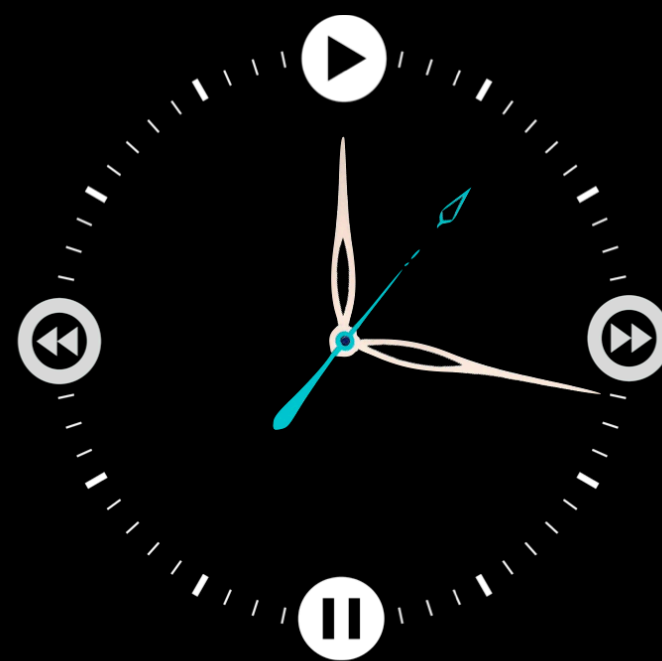
(d) Radiometric Normalized False Color representation



Behavioral Biometrics

Retrieval Quality Analysis





Déjà Vu



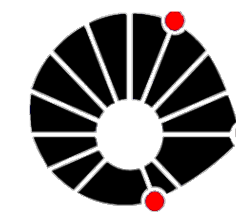
Media Forensics Integrity Analytics
Space Coherence Analysis
Integrity Analytics
Forgery Localization
Adversarial Setting
Data-driven Solutions
Multimedia Analytics
Physical Integrity
Electrical Network Frequency
Forgery Detection
Semantic Analysis
Semantic Disinformation
Counter-forensics
Multimedia Phylogeny
Laundering
Media Forensics

MediFor



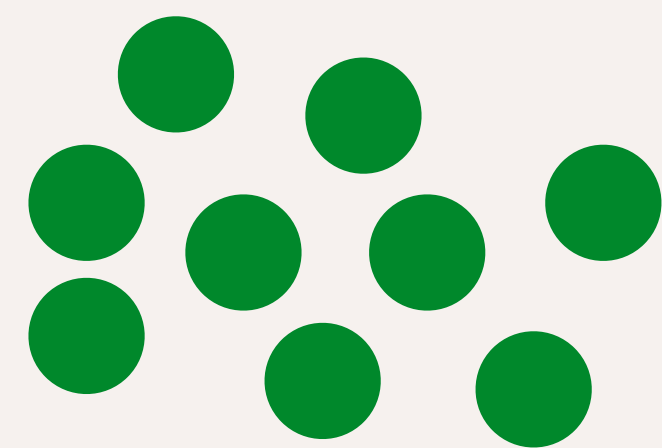
POLITECNICO
MILANO 1863

NYU·poly



Input

Initial Pool of Images
and / or Videos
(World Dataset)



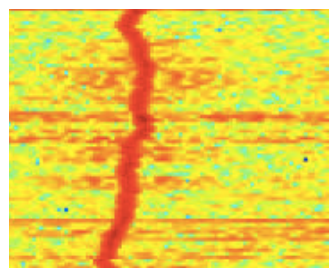
Query Image
and / or Video



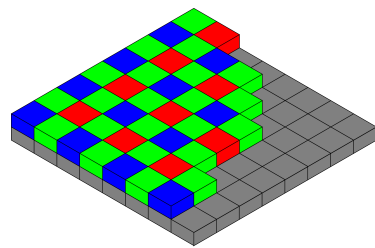
Possible Additional
Hypotheses
(xpos, ypos, trange
EXIF, metadata, etc.)



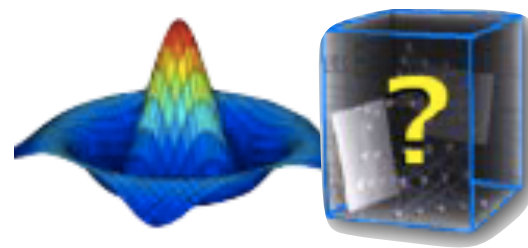
Forgery
Detection



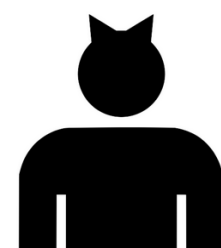
ENF Analysis



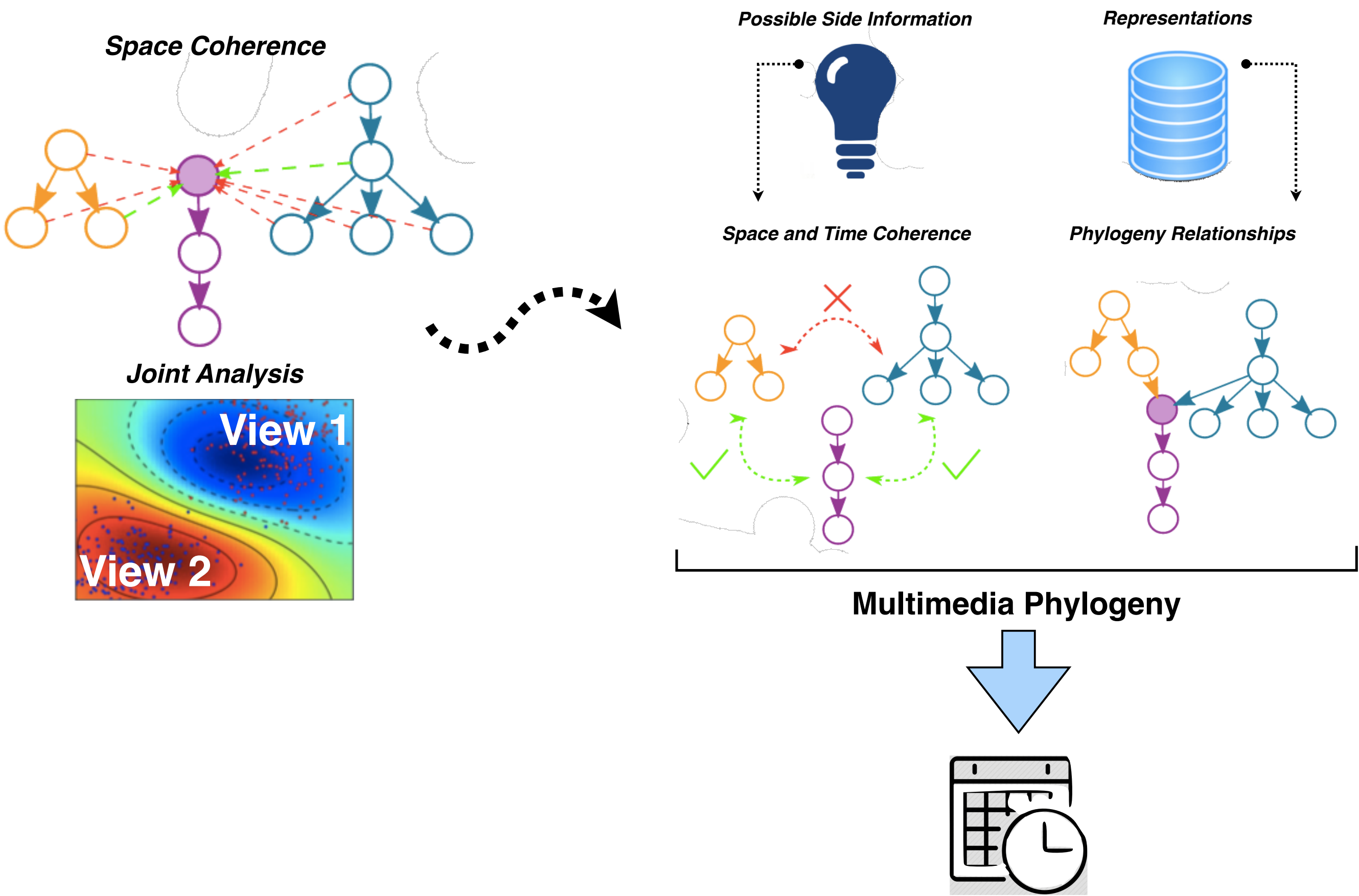
Sensor
Attribution

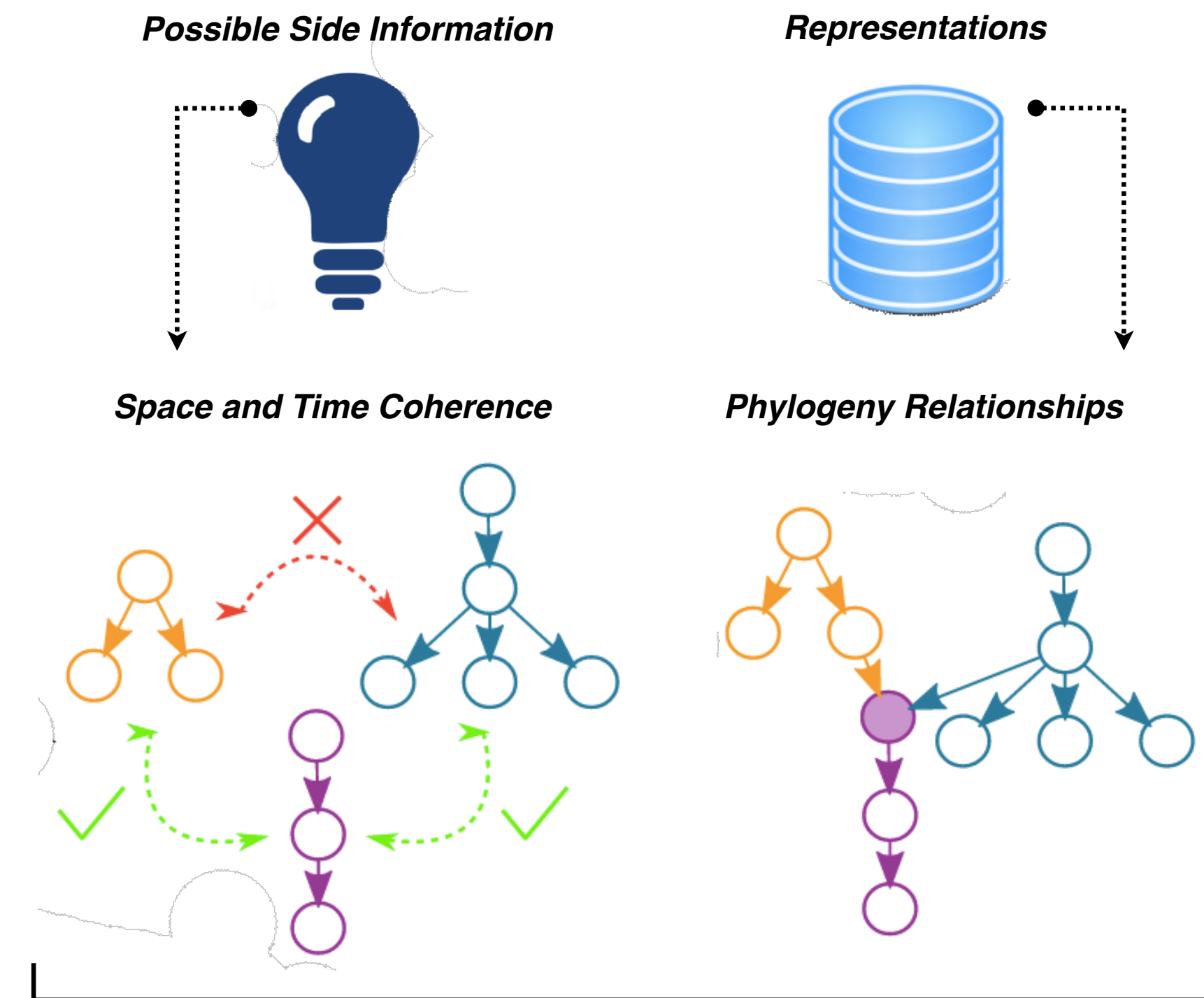
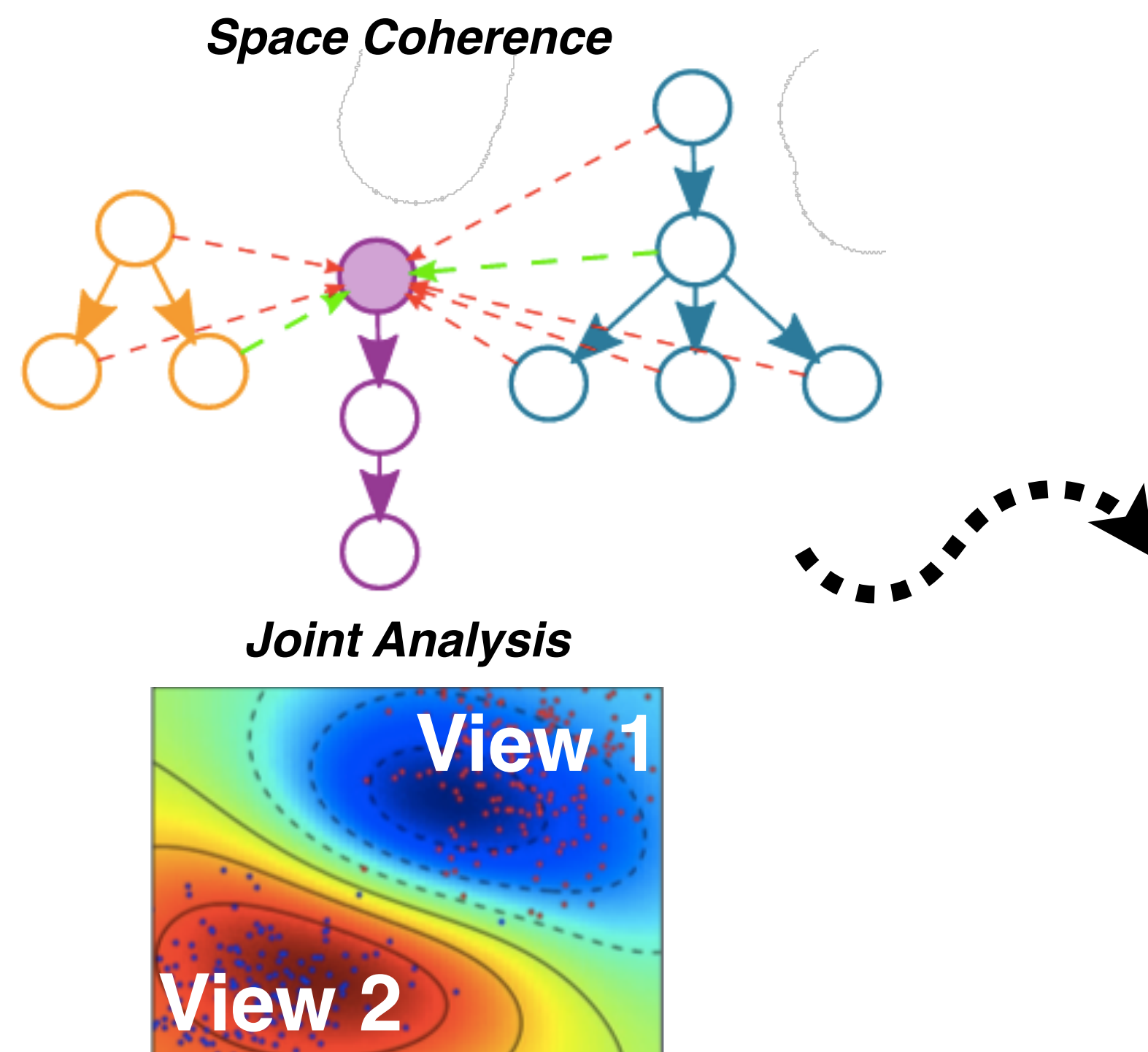


Data-driven Learning

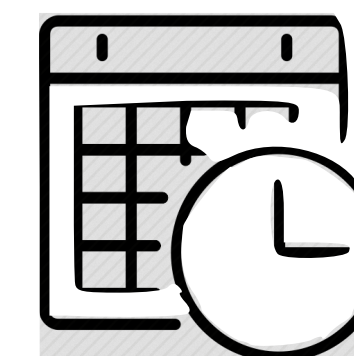
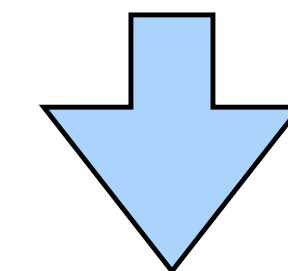


Adversary-aware
Forensics



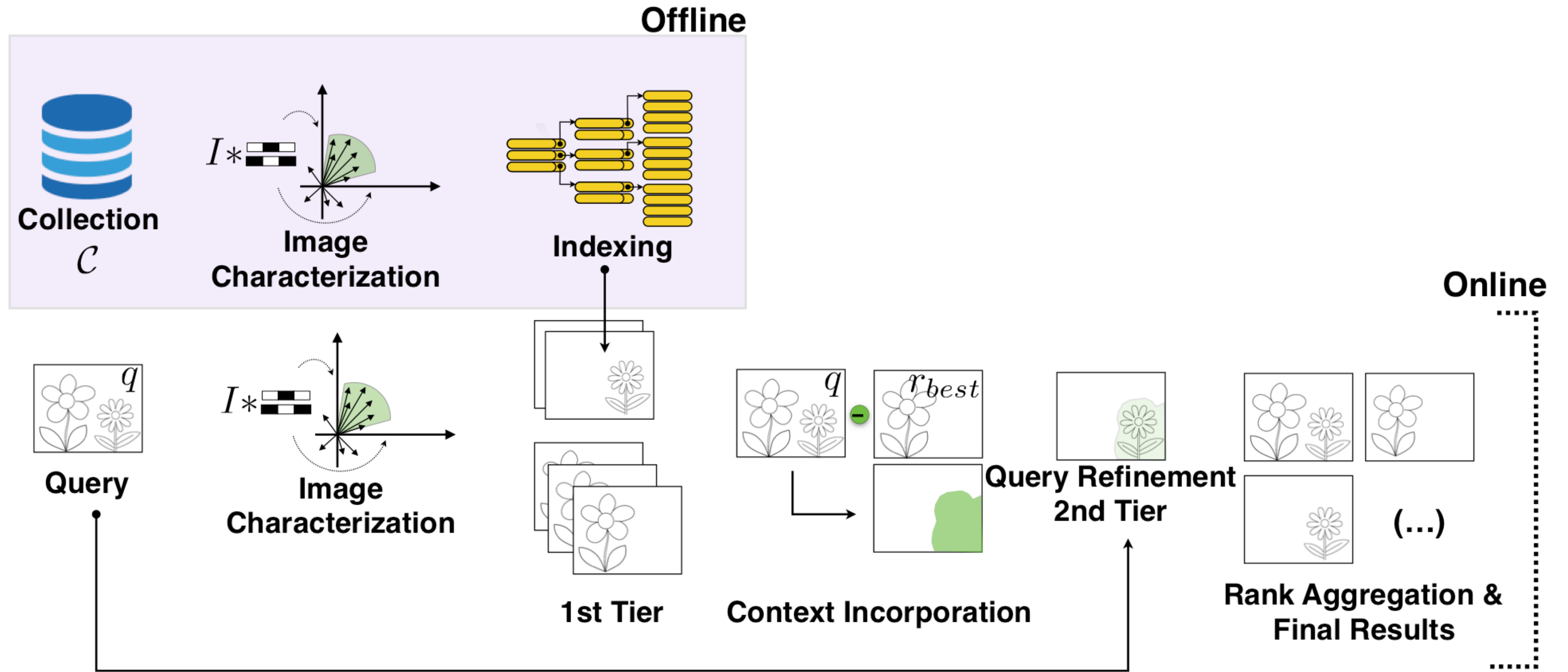


Multimedia Phylogeny

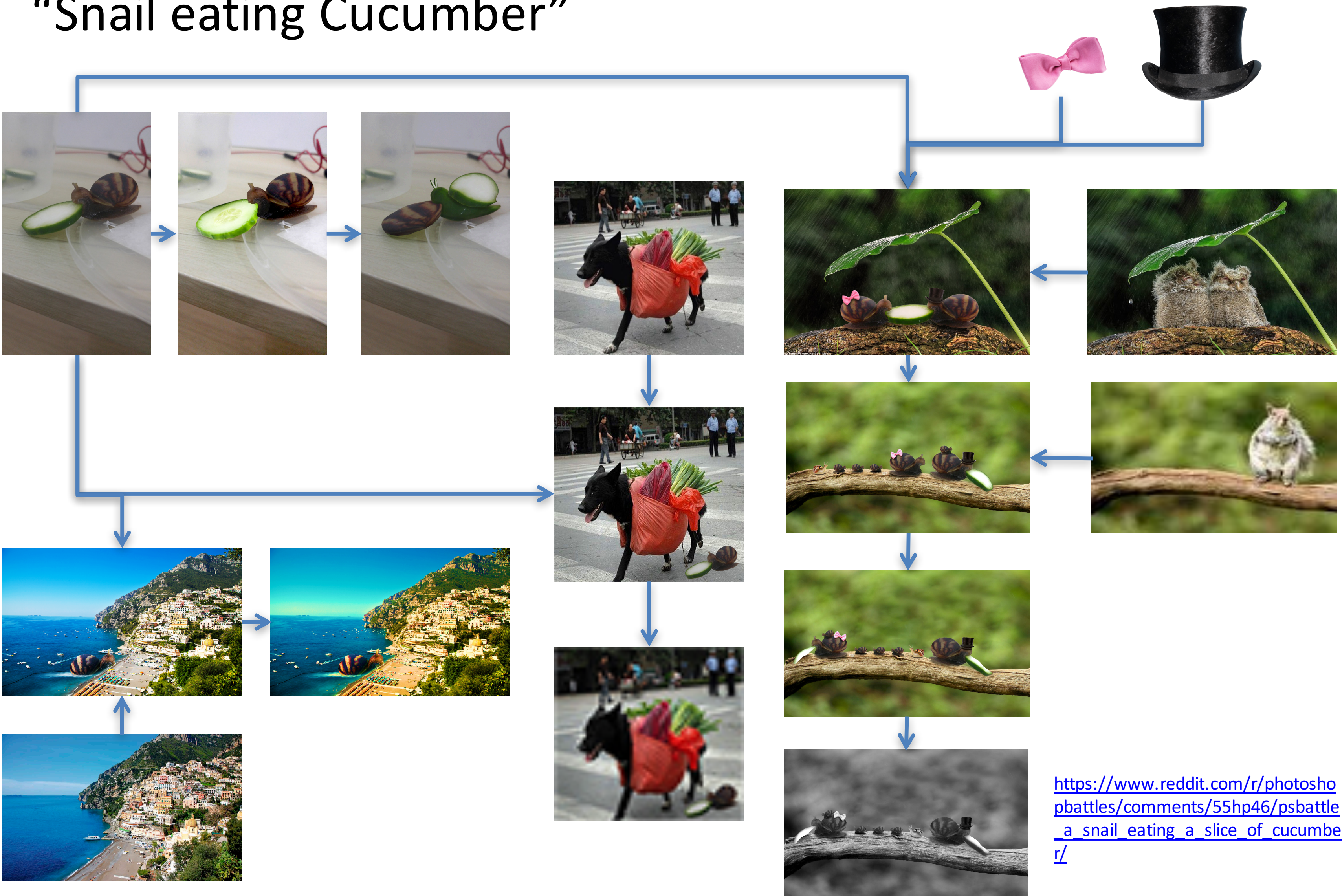


Provenance and Integrity Analytics

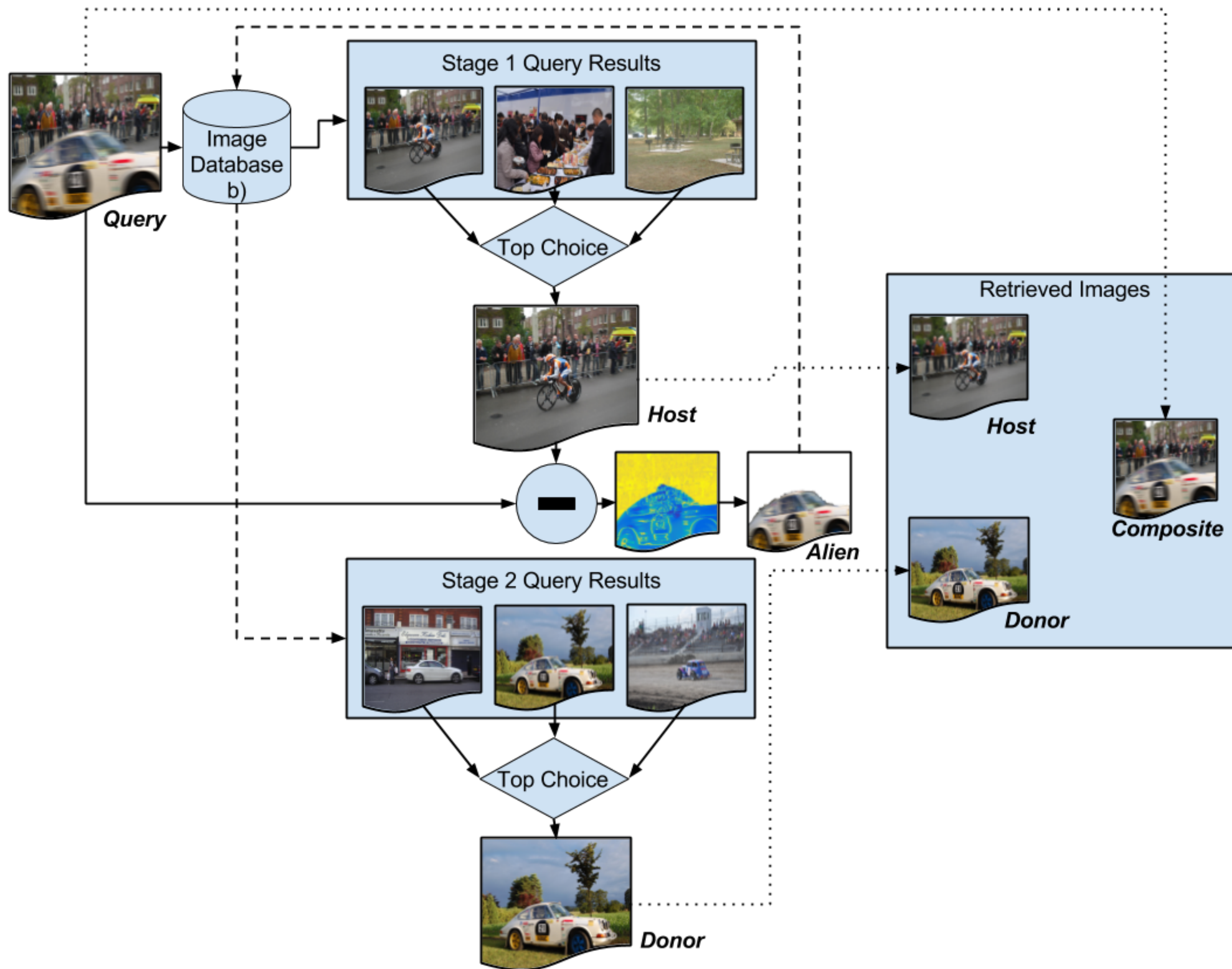
Provenance Analysis



“Snail eating Cucumber”



Provenance Analysis



1,000,000

Dataset	Type	Tier	Recall@10
NC2016 + World1M	Host	1st	99.65%
		2nd	100.00%
NC2016 + World1M	Donor	1st	63.00%
		2nd	67.71%

Method	KD-Tree	KD-Forest	PQ	HCAL
Runtime (11k)	0.69 s	0.72 s	13.96 s	0.85 s
Memory (11k)	1.48 GB	10.69 GB	0.02 GB	5.38 GB
Runtime (World1M)	8.8 s	7.61 s	*	*
Memory (World1M)	34.99 GB	66.42 GB	*	*

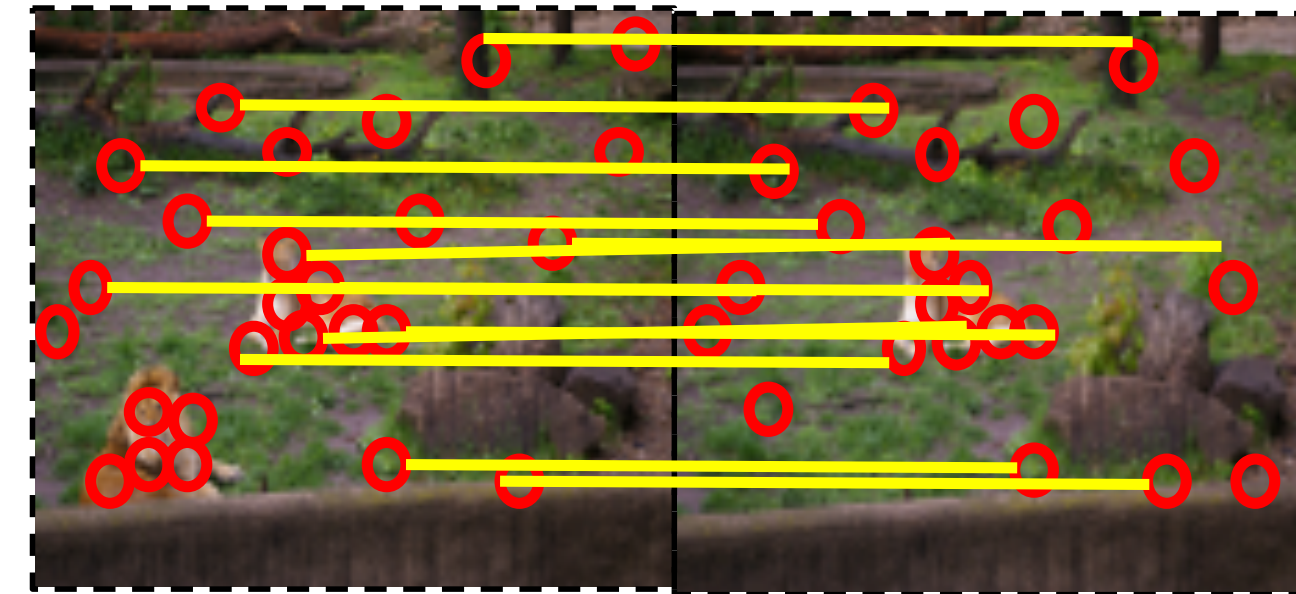
Provenance Analysis



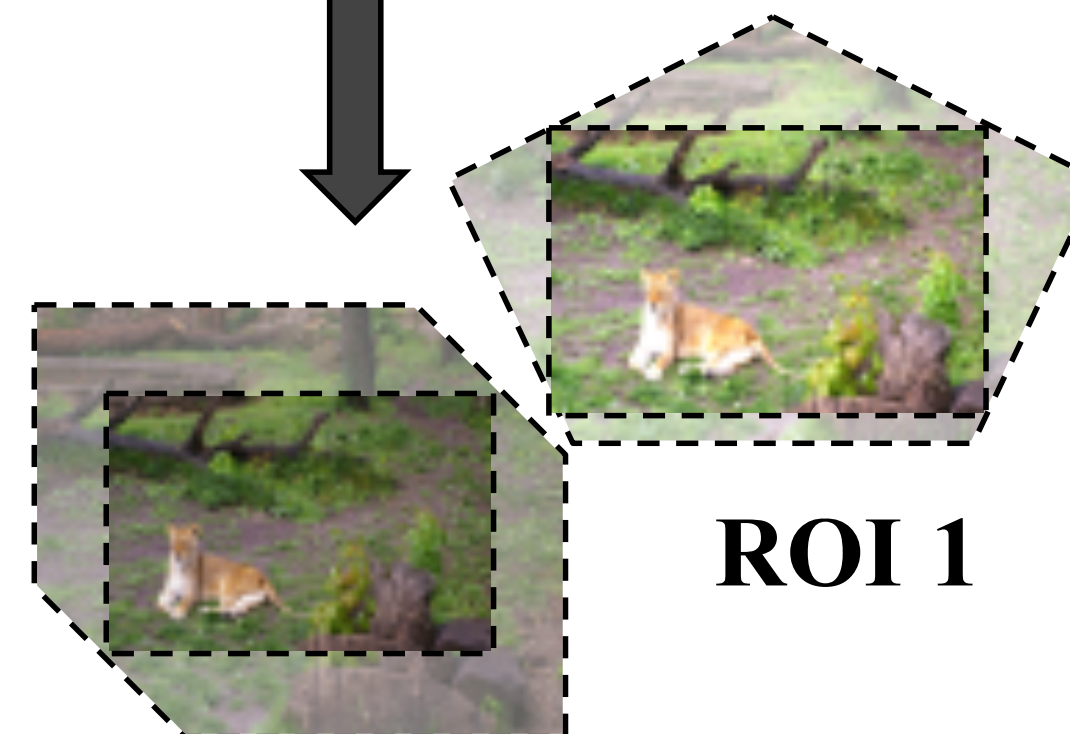
Provenance Analysis



$$\begin{bmatrix} M_{xx} & M_{xy} & M_{xz} & C_x \\ M_{yx} & M_{yy} & M_{yz} & C_y \\ M_{zx} & M_{zy} & M_{zz} & C_z \\ L_x & L_y & L_z & W \end{bmatrix}$$

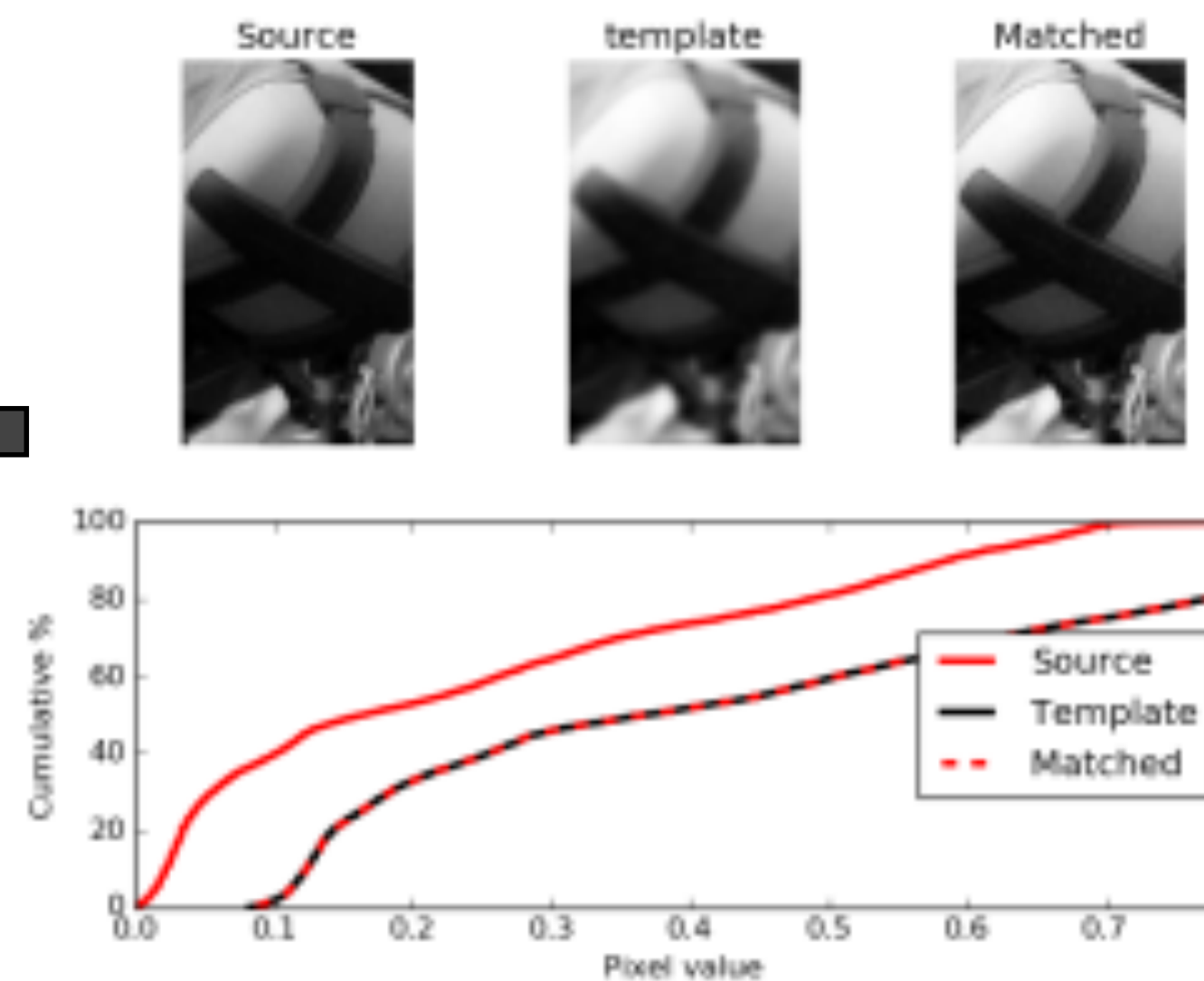


Convex-hull
based ROI
extraction

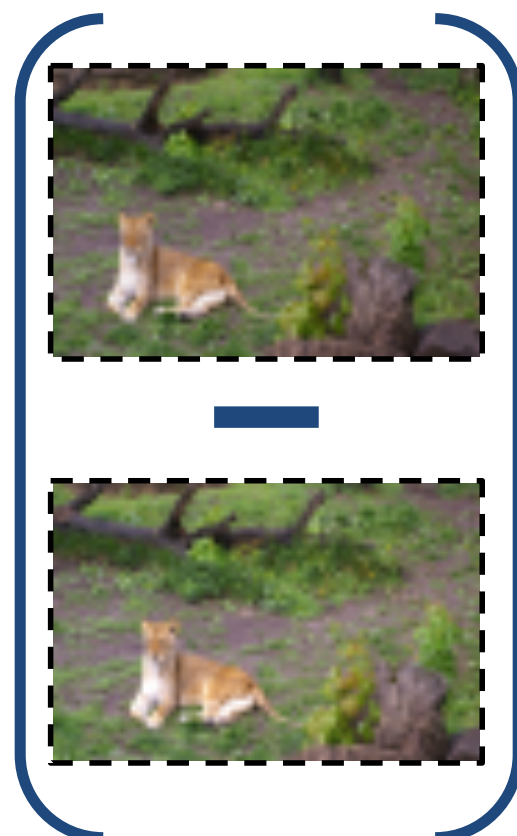


ROI
2

ROI 1



Color correction of ROIs

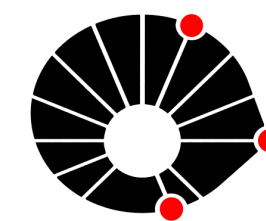


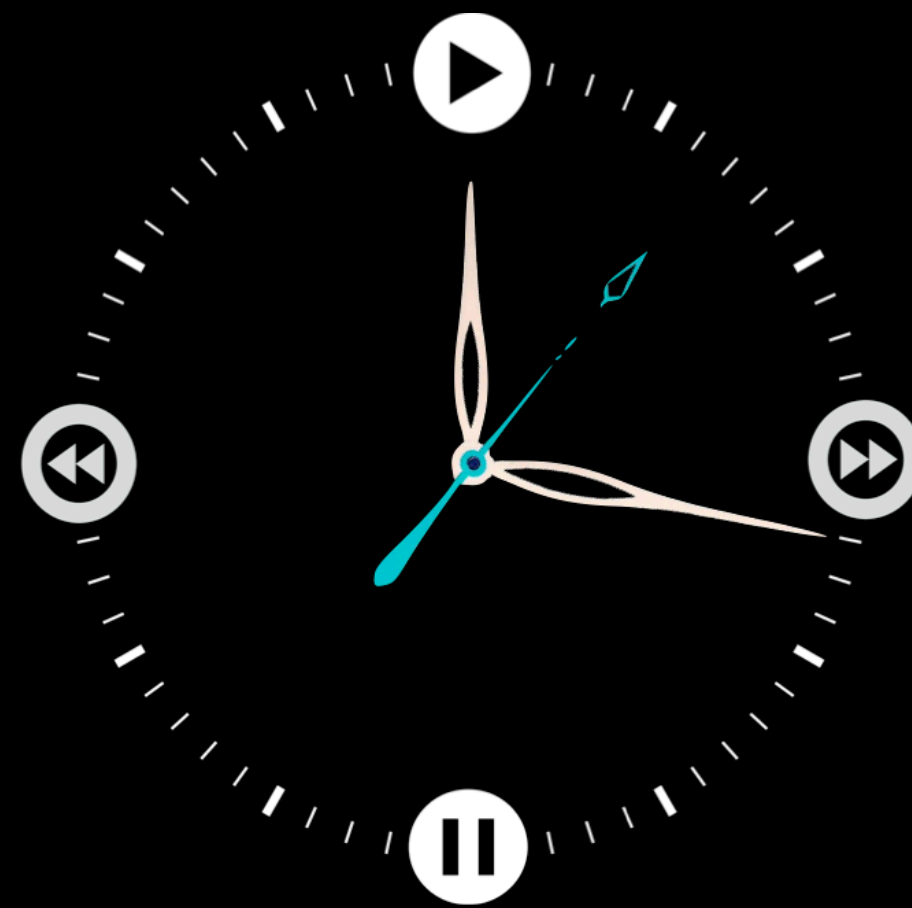


MediFor



Déjà Vu





Déjà Vu

Fact Sheet

Project Title: DéjàVu: Feature-Space-Time Coherence from Heterogeneous Data for Media Integrity Analytics and Interpretation of Events

Prof. Dr. Anderson Rocha, **Coordinator**

Prof. Dr. Hélio Pedrini, **Co-Investigator**

Prof. Dr. André Carlos Ponce de Leon Carvalho, **Co-Investigator**

(a) Data Collection & Cleaning



+



Keywords, Venue,
Time Period

Data Acquisition

(b) Data Organization & X-coherence

Time, Location, Side Information

Organization

Objects/Places of Interest

Pattern Discovery and
Event Highlights

X-coherence

(c) Content Understanding & Inference

Crowd-Generated
Data Analysis

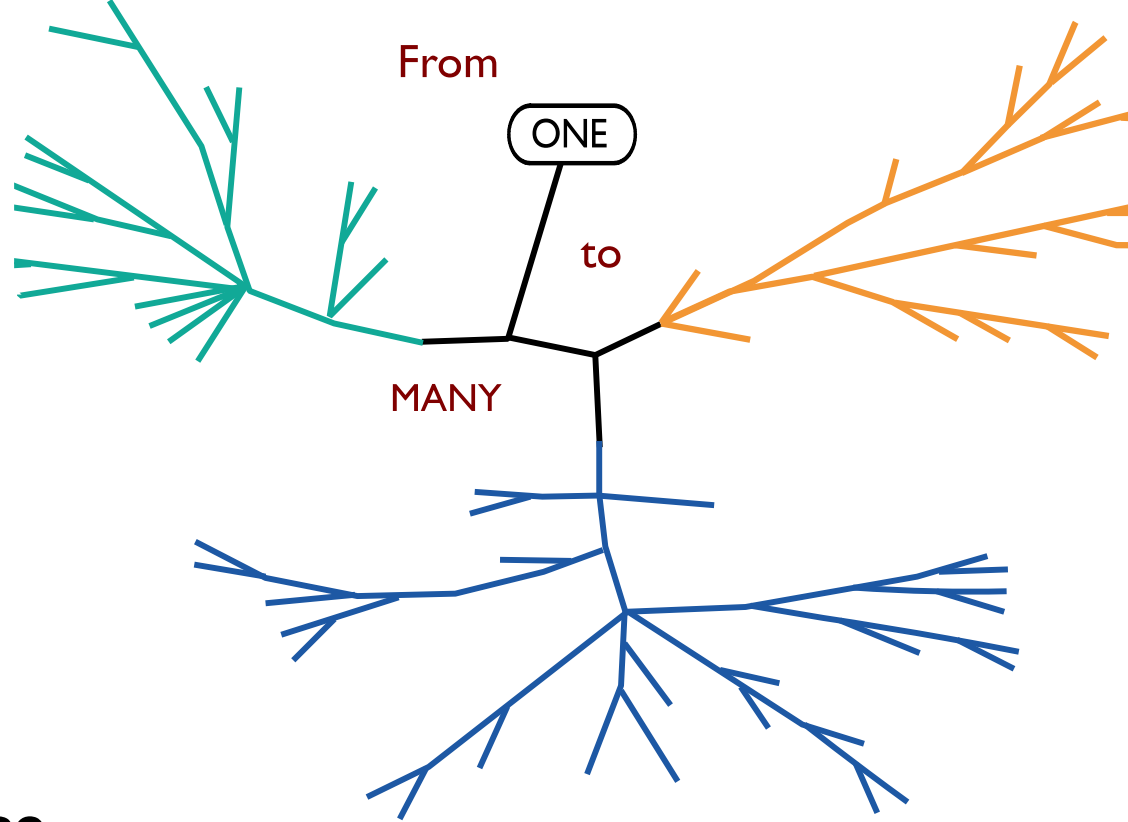
Mining Persons, Objects
or Places of Interest

Provenance Analysis
and Filtering

Sensitive Media
Analysis



OPEN-SET
MACHINE
LEARNING



Accountable ML





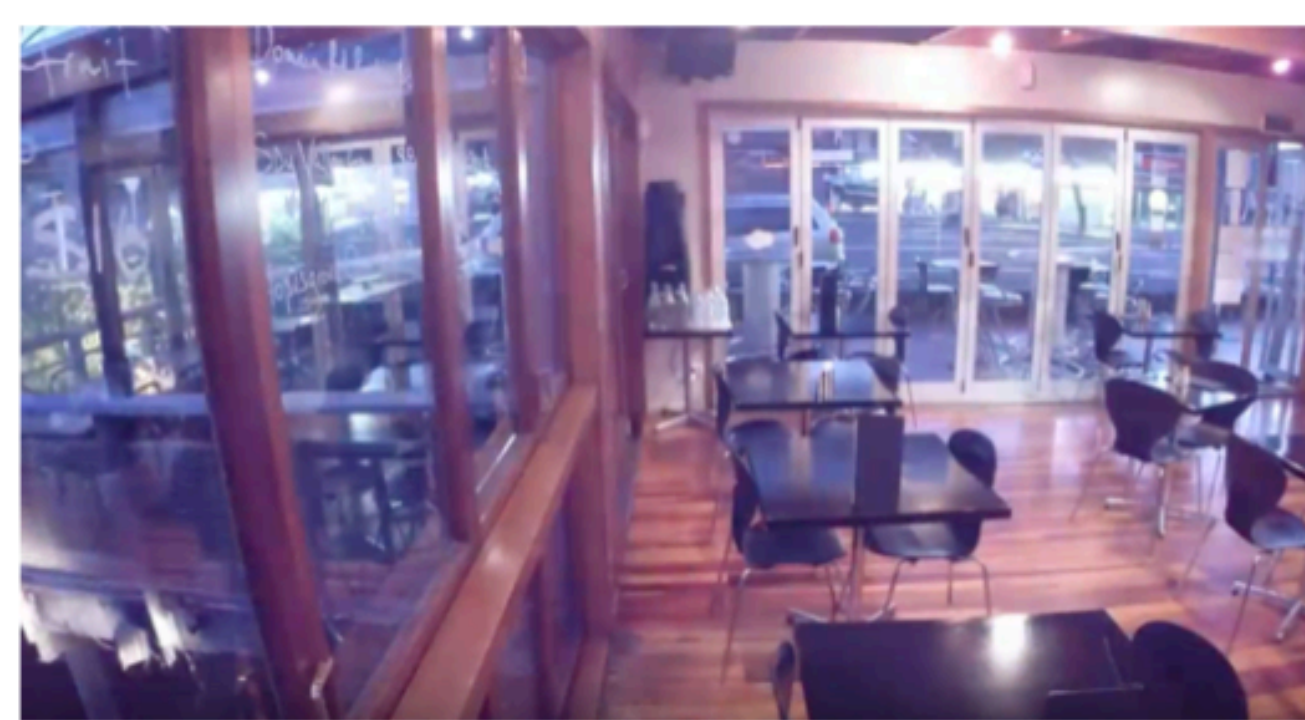
How to **synchronize** different sources of information (X-Coherence)

How to **efficiently search** for a specific object, place of interest, or moment in time

How to **extract and mine** information (pattern discovery) of an event

How to **filter media assets** with respect to a particular position in space or quantum in time

How to **rule out spurious data**



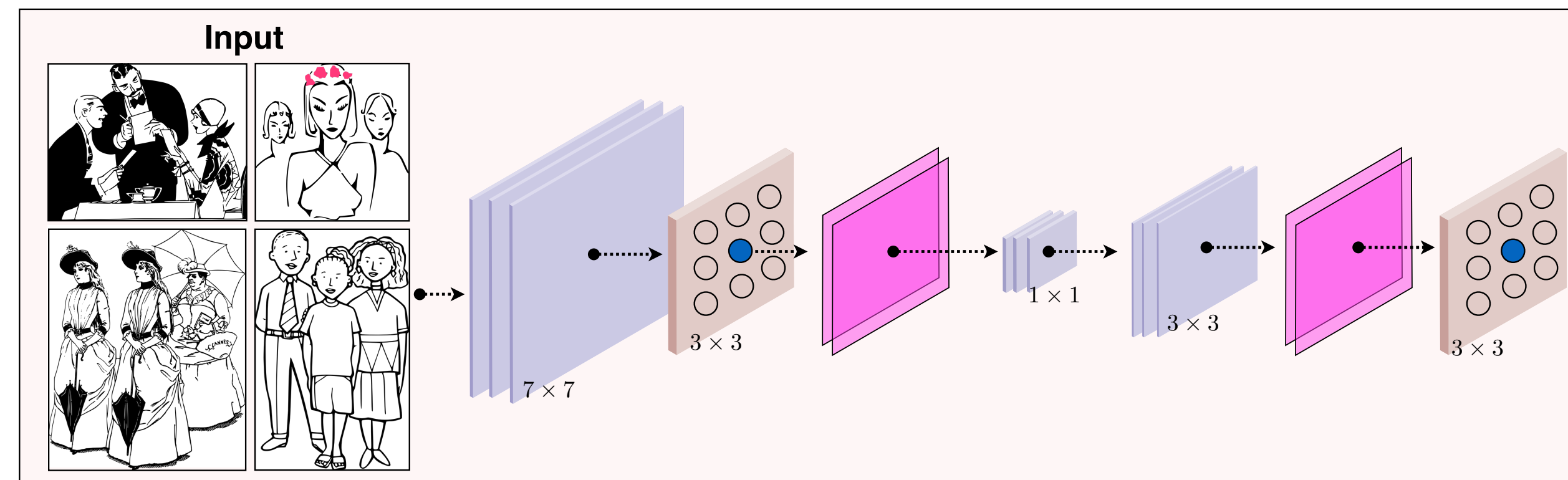
Finding the “**Arrow of Time**”



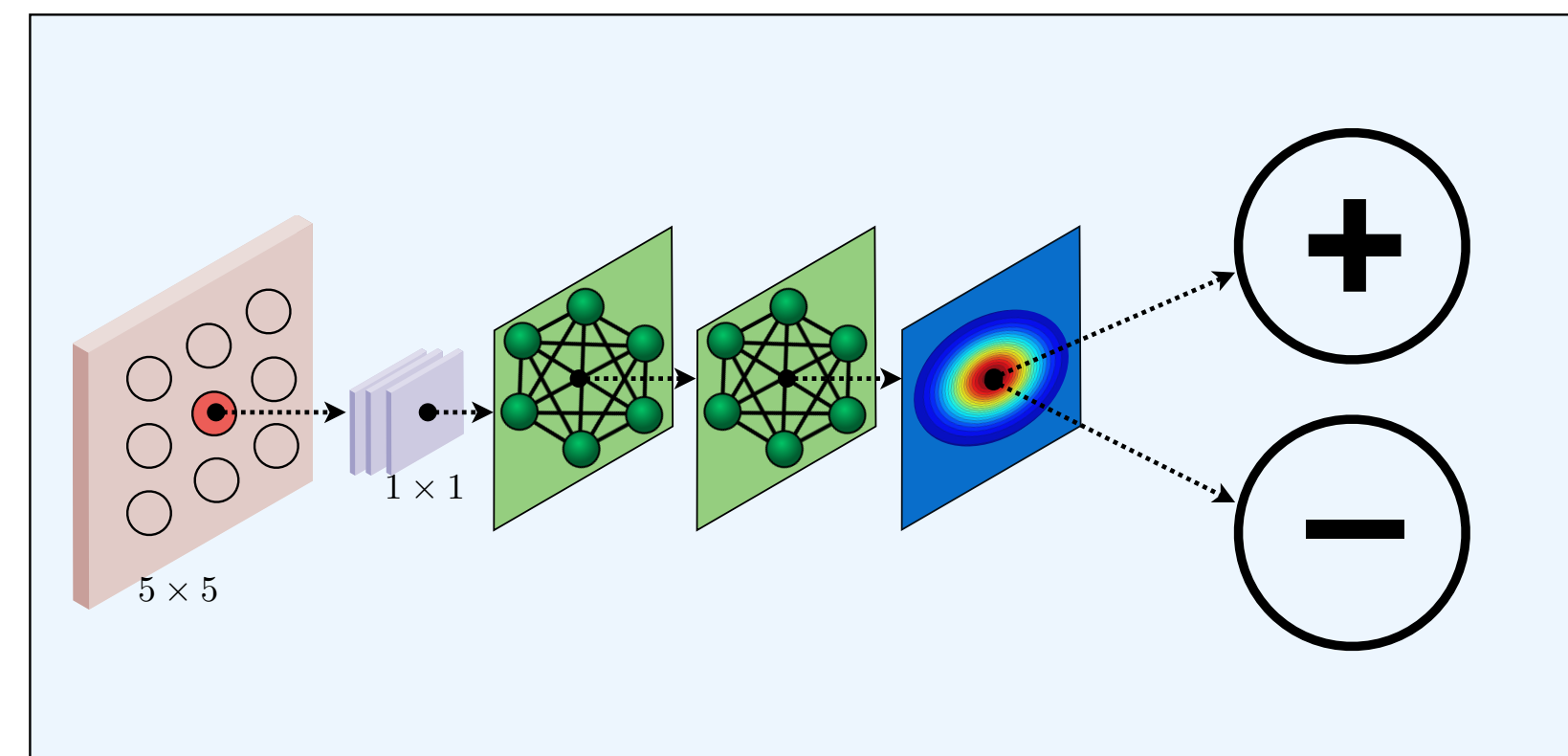
Sensitive Filtering



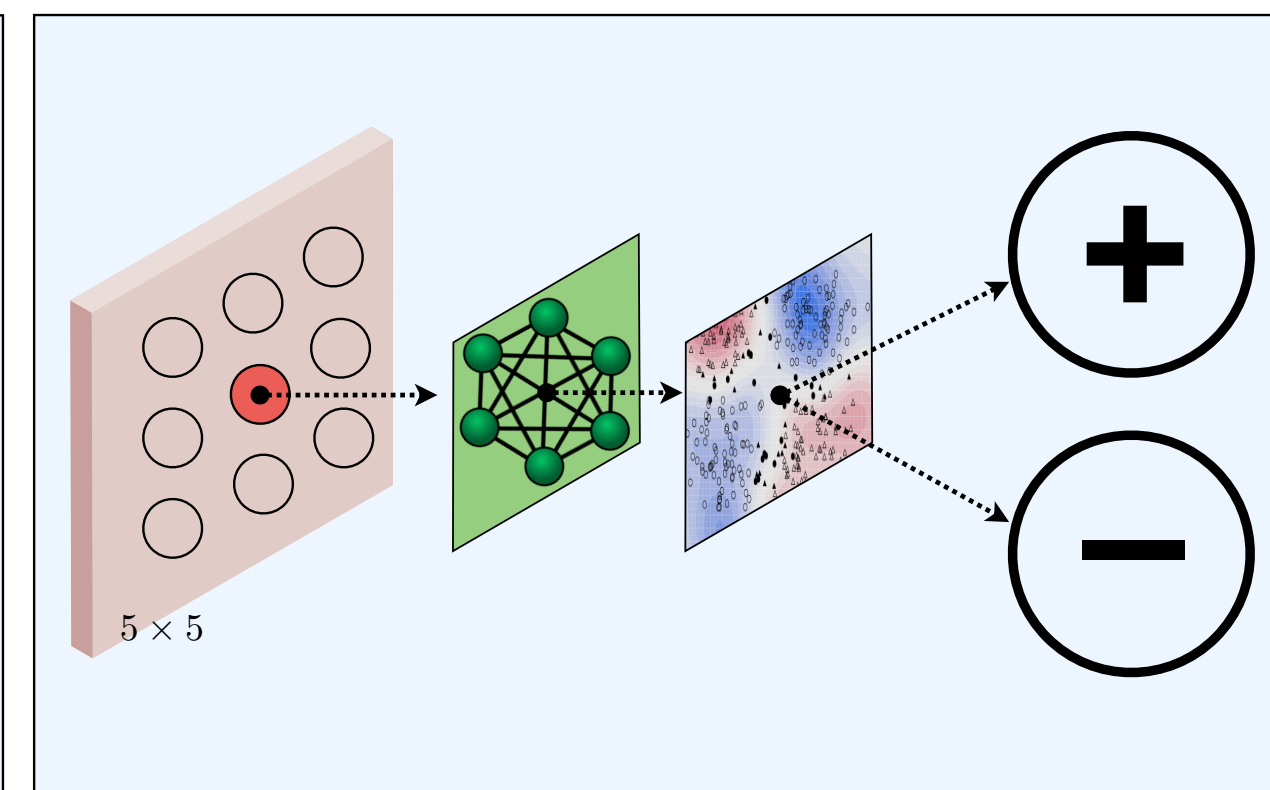
Initialization Module



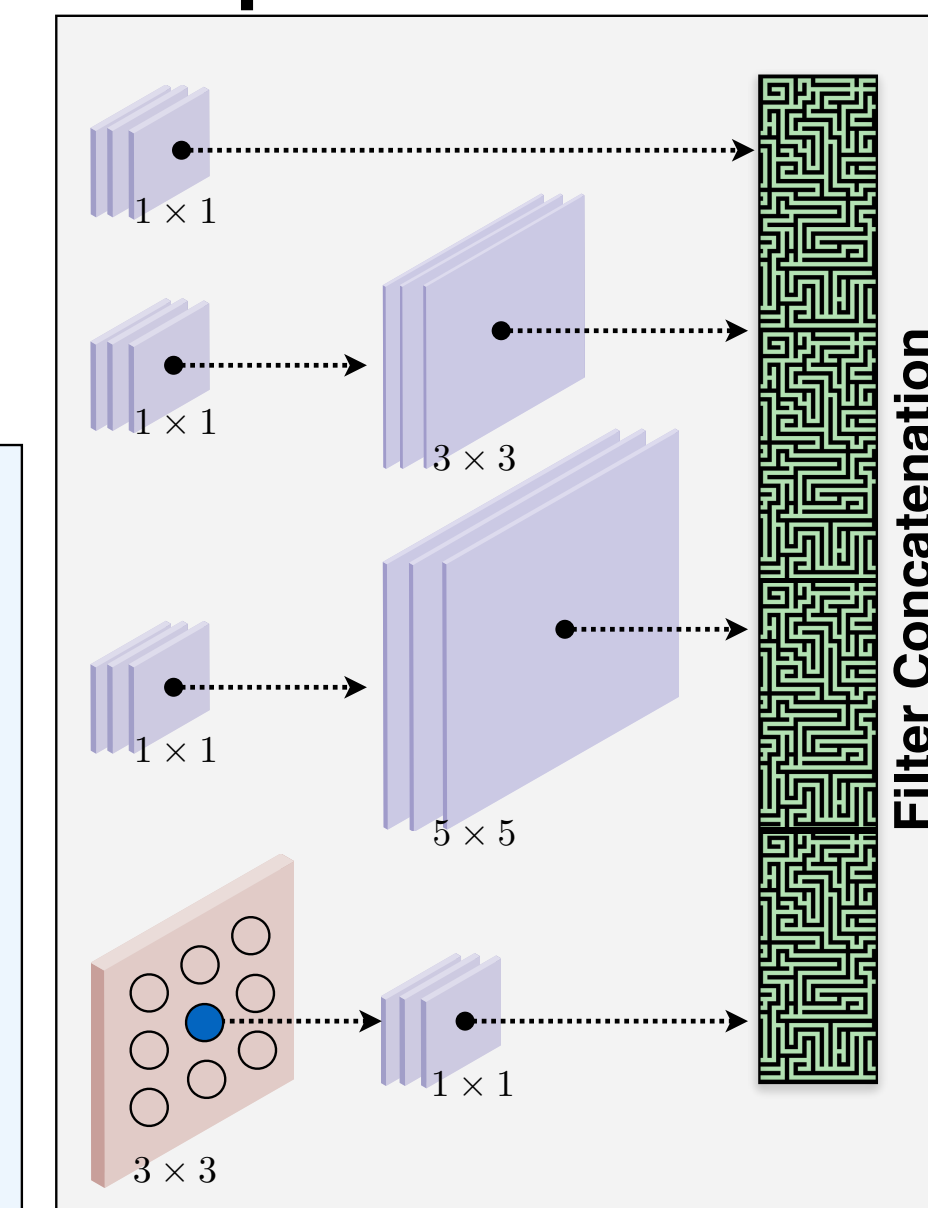
Auxiliary Classifier



Final Classifier



Inception Module



Motivating

Case-Studies

2013 Boston Marathon Bombing

WHO IS MY PARENT? RECONSTRUCTING VIDEO SEQUENCES FROM PARTIALLY MATCHING SHOTS

S. Lameri[#], P. Bestagini[#], A. Melloni[#], S. Milani[#], A. Rocha[♭], M. Tagliasacchi[#], S. Tubaro[#]

[#]Dipartimento di Elettronica, Informazione e Bioingegneria, Politecnico di Milano,
Piazza Leonardo da Vinci 32, 20133, Milano, Italy

[♭]Institute of Computing, University of Campinas (UNICAMP),
Av. Albert Einstein, 1251, Cidade Universitária, 13083-852, Campinas, SP - Brazil



Motivating

Case-Studies

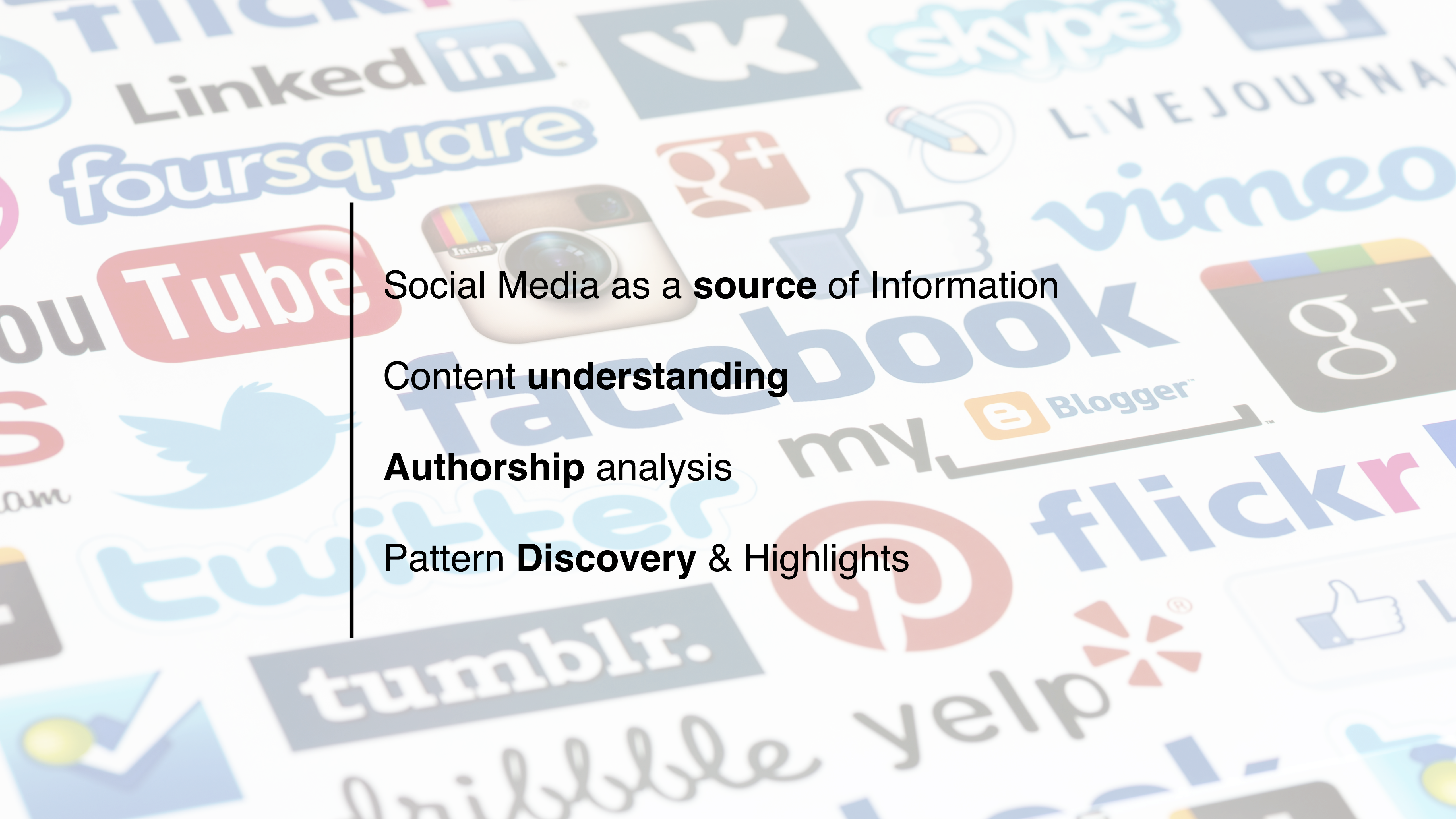
2017 Las Vegas Shooting



Motivating
Case-Studies

2014 Attack of Israel on Haifa (Black Friday)





Social Media as a **source** of Information

Content **understanding**

Authorship analysis

Pattern **Discovery** & Highlights

Opportunities

Opportunities

Postdocs

Ph.D. Students

Master Students

Scientific Initiation

Open positions

Contact

Prof. Anderson Rocha

Prof. Hélio Pedrini

Prof. André C. P. L. F. de Carvalho

Opportunities

Ph.D. Students

Double-Degree Diploma Options
Internships – U.S., E.U., Singapore

Opportunities

Prof. Anderson Rocha
anderson.rocha@ic.unicamp.br

<http://www.recod.ic.unicamp.br>



Interpretation of Events from Heterogenous Data

How to Connect Existing Pieces of Evidence in Space & Time

Anderson Rocha (Associate Professor)

Microsoft Research Faculty Fellow

Google Faculty Research Awardee

Tan Chin Tuan Fellow

IEEE Senior Member

anderson.rocha@ic.unicamp.br

Reasoning for Complex Data (RECOD) Lab.

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University of Campinas (Unicamp)

Av. Albert Einstein, 1251 – Cidade Universitária

CEP 13083-970 • Campinas/SP – Brasil

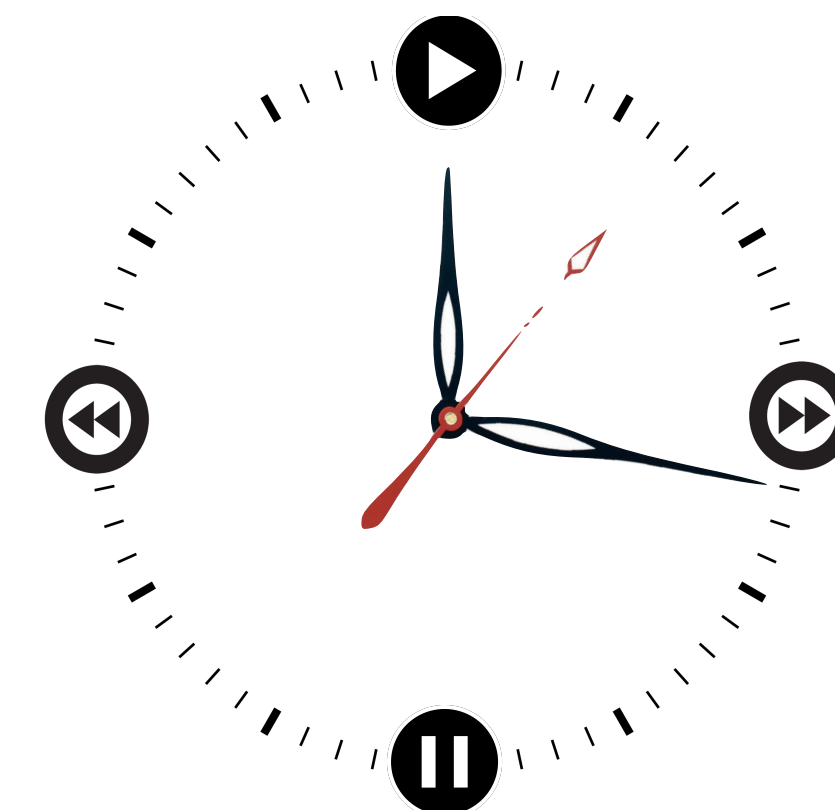


Image Credits (L to R): Peter Michael Hamel; ABC News; CNN; Child Rescue Coalition; thesun.co.uk

Background Music: Anthony Greninger - A Heavy Heart; Ludovico Einaudi - Primavera

