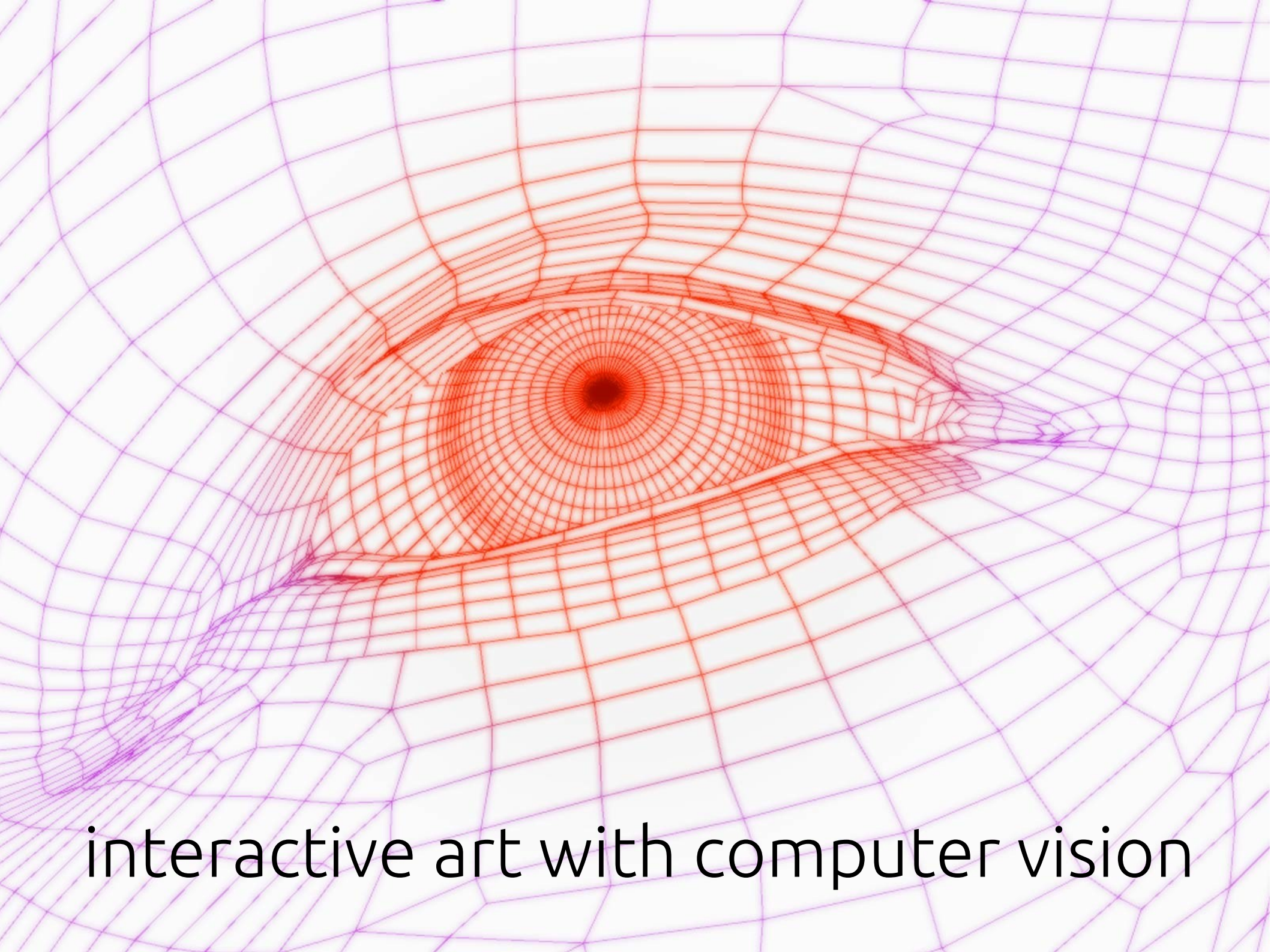
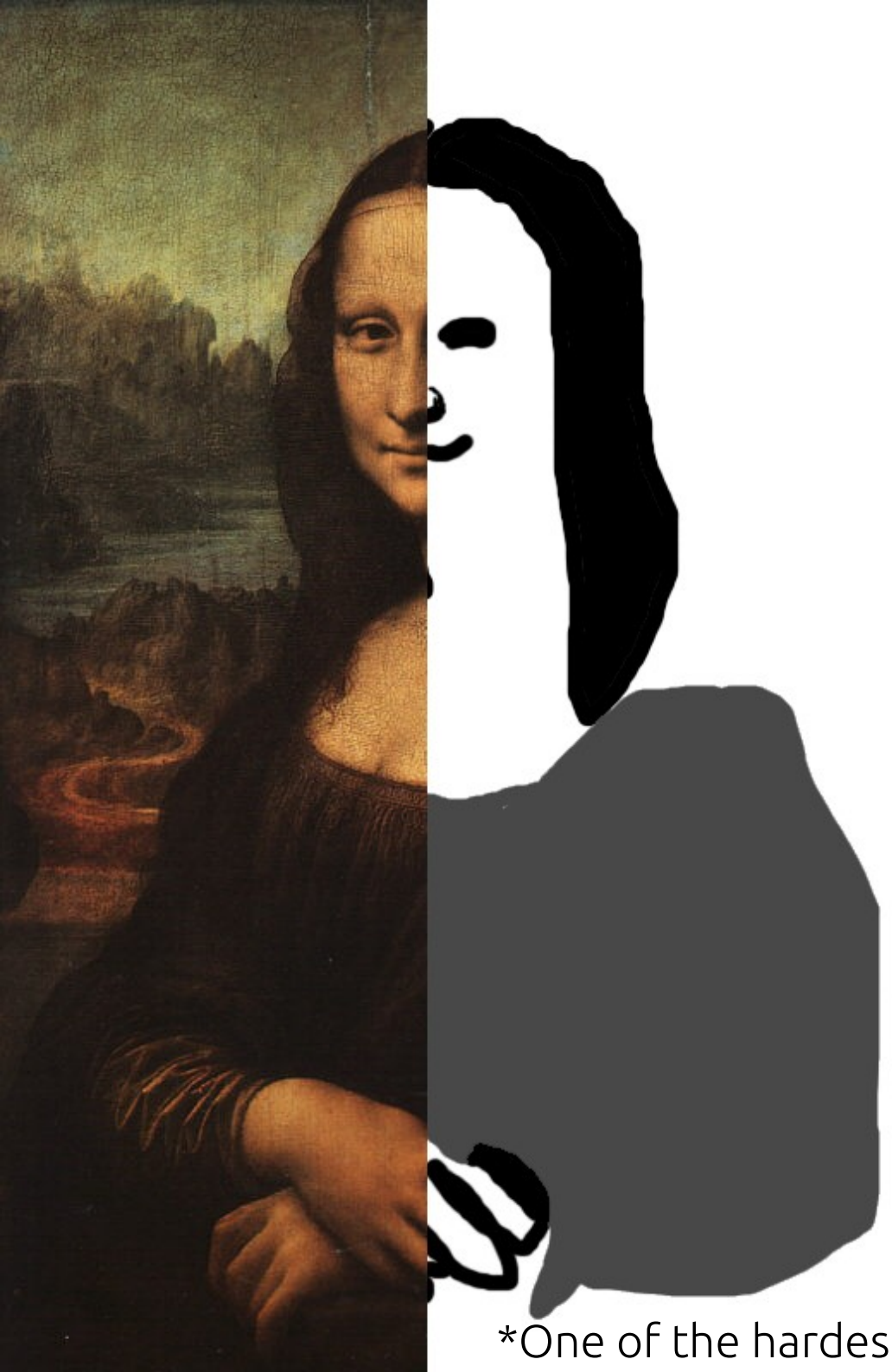
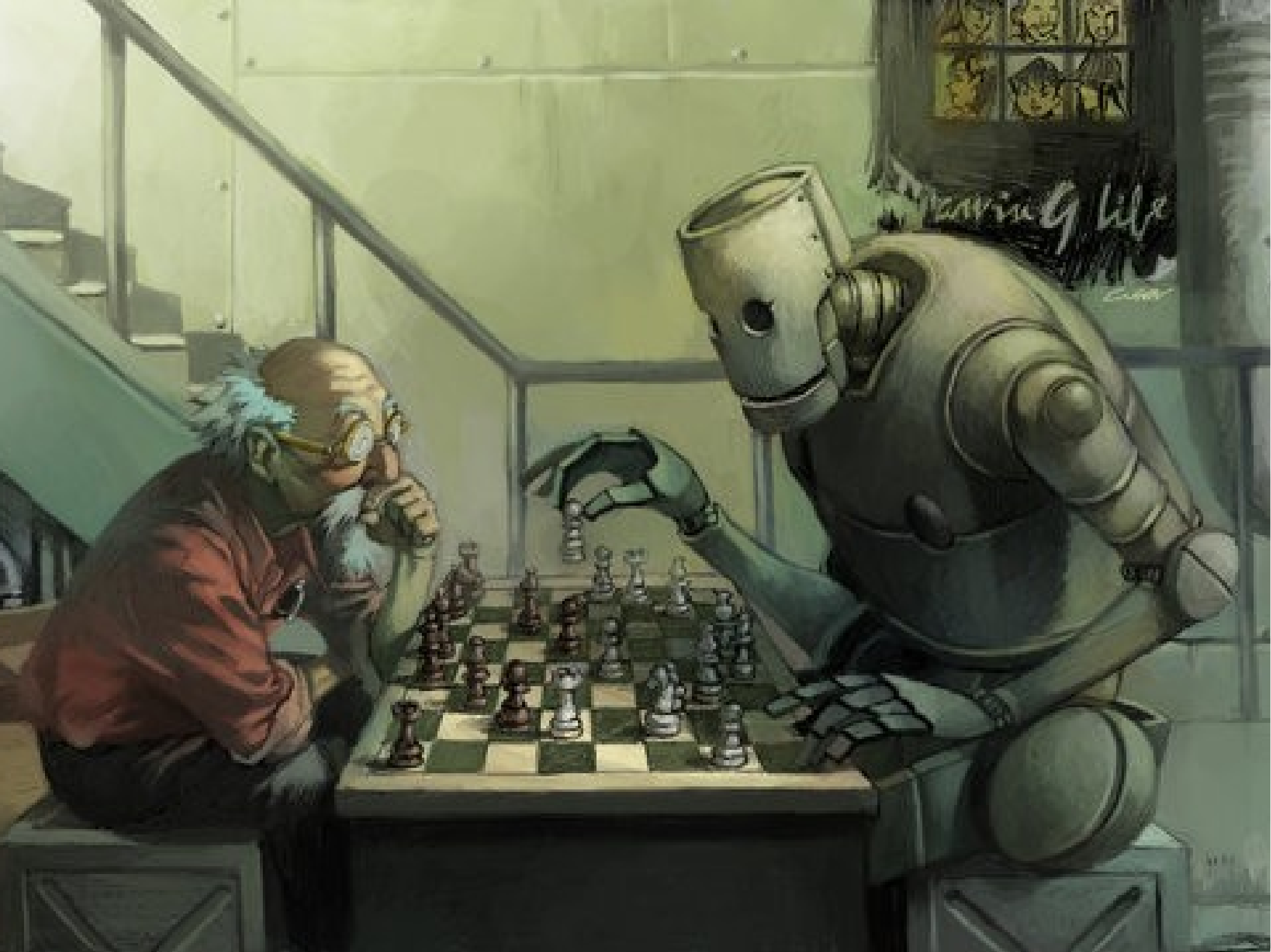

interactive art with computer vision



computer vision*:

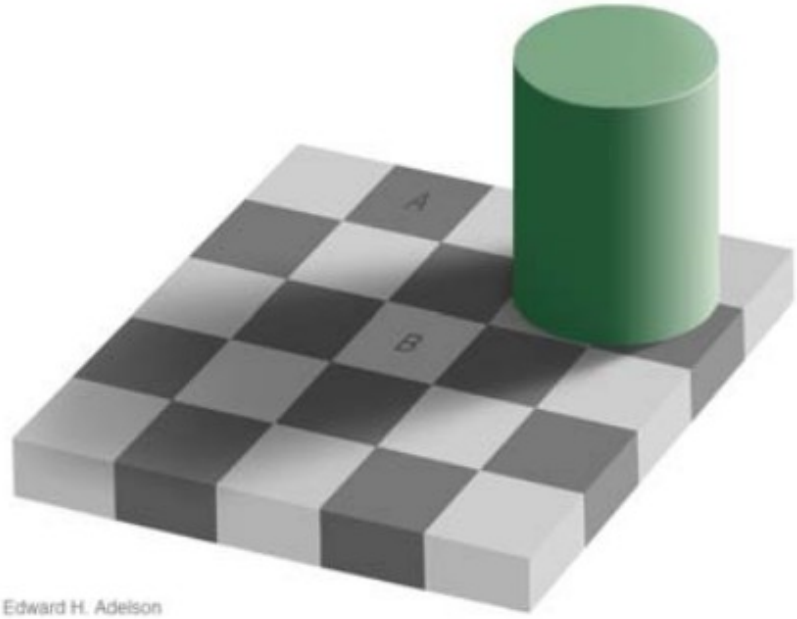
A set of algorithms that allow computers to understand images.

*One of the hardest problems in computer science



Vision by the brain

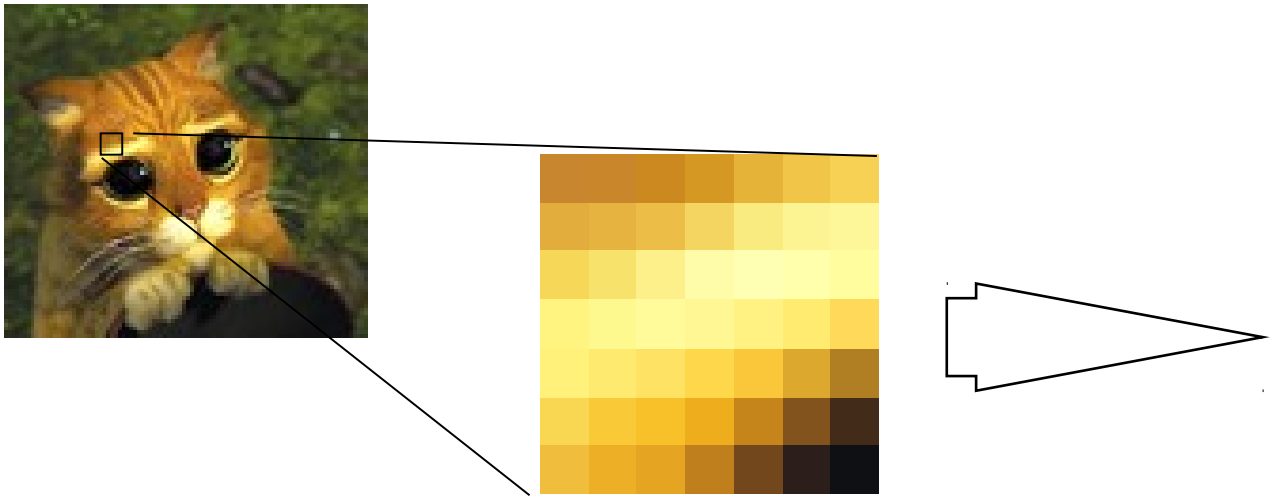
- **low quality** retina image
- **multi-channel analysis** of vision signal
- inputs from **other senses**
- years of **training**
- **feedback loops** that control the hardware sensors themselves
- **attention system** compliments vision



Edward H. Adelson

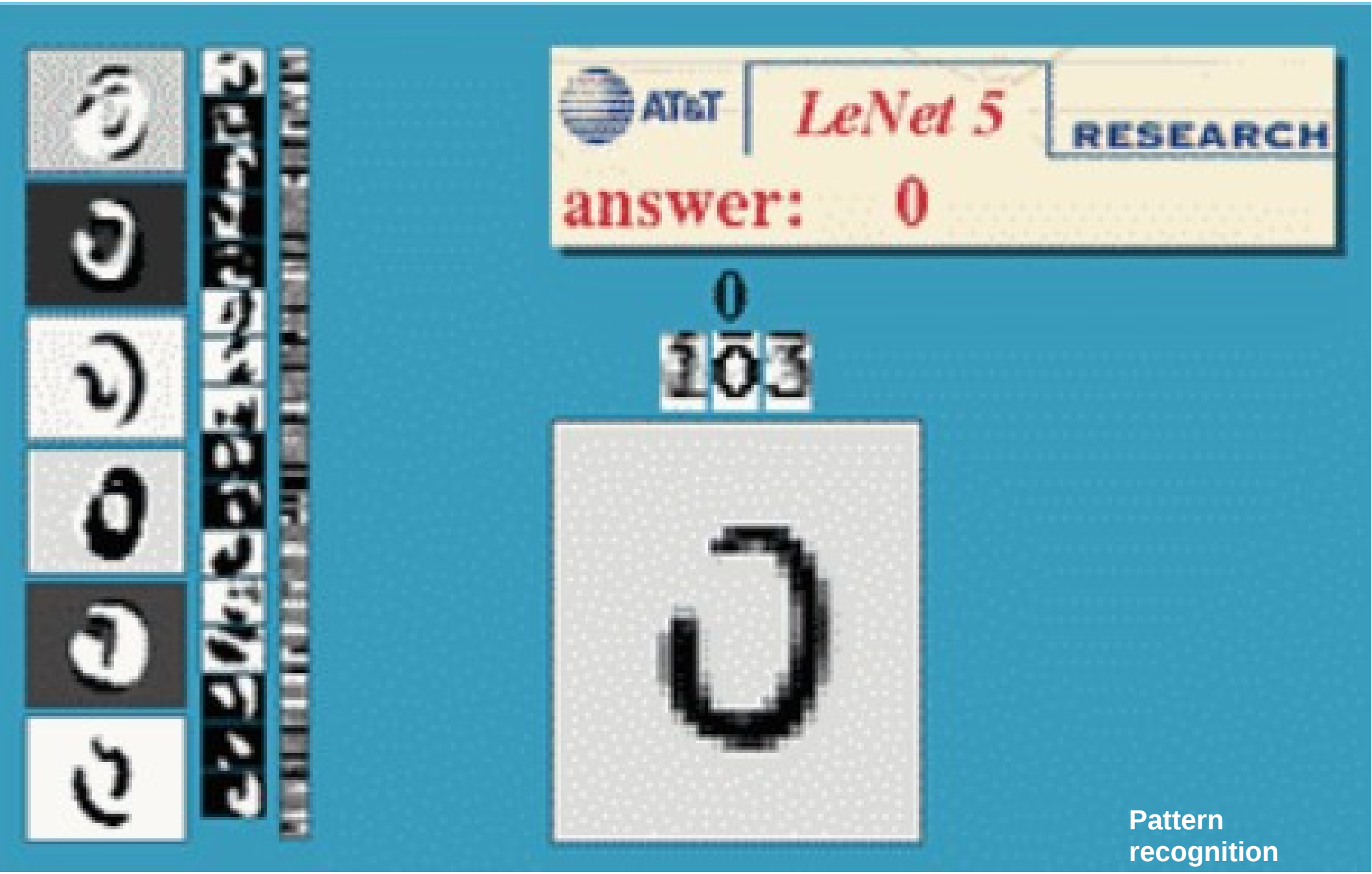
The computer vision problem

- An image has no semantic information. It's just an array of small squares (pixels)
- A machine, without special programming, is incapable of making any assertion about an image
- The field of computer vision was born to cover the need for that programming.



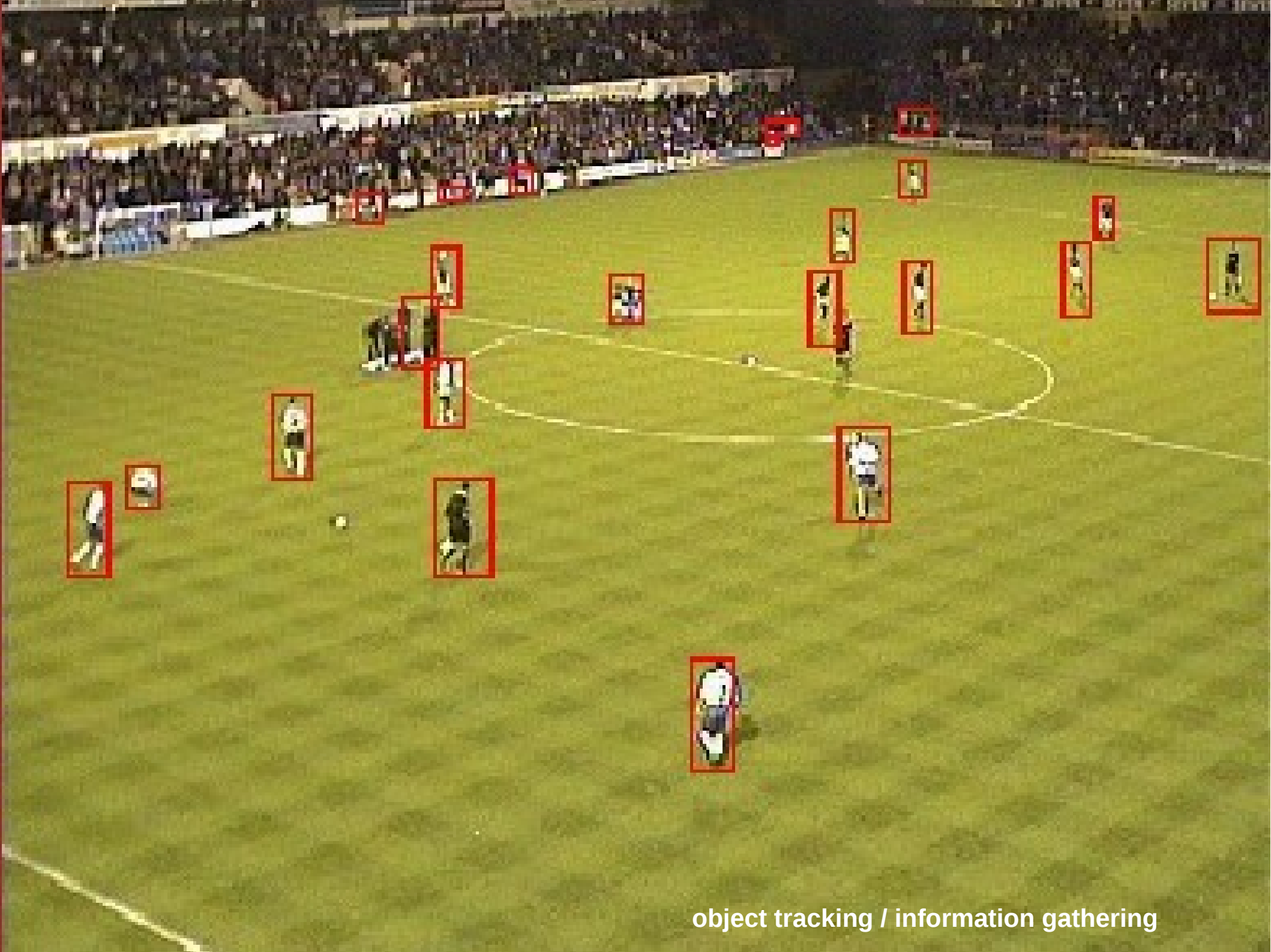
50	44	23	31	38	52	75	52
29	09	15	08	38	98	53	52
08	07	12	15	24	30	51	52
10	31	14	38	32	36	53	67
14	33	38	45	53	70	69	40
36	44	58	63	47	53	35	26
68	76	74	76	55	47	38	35
69	68	63	74	50	42	35	32

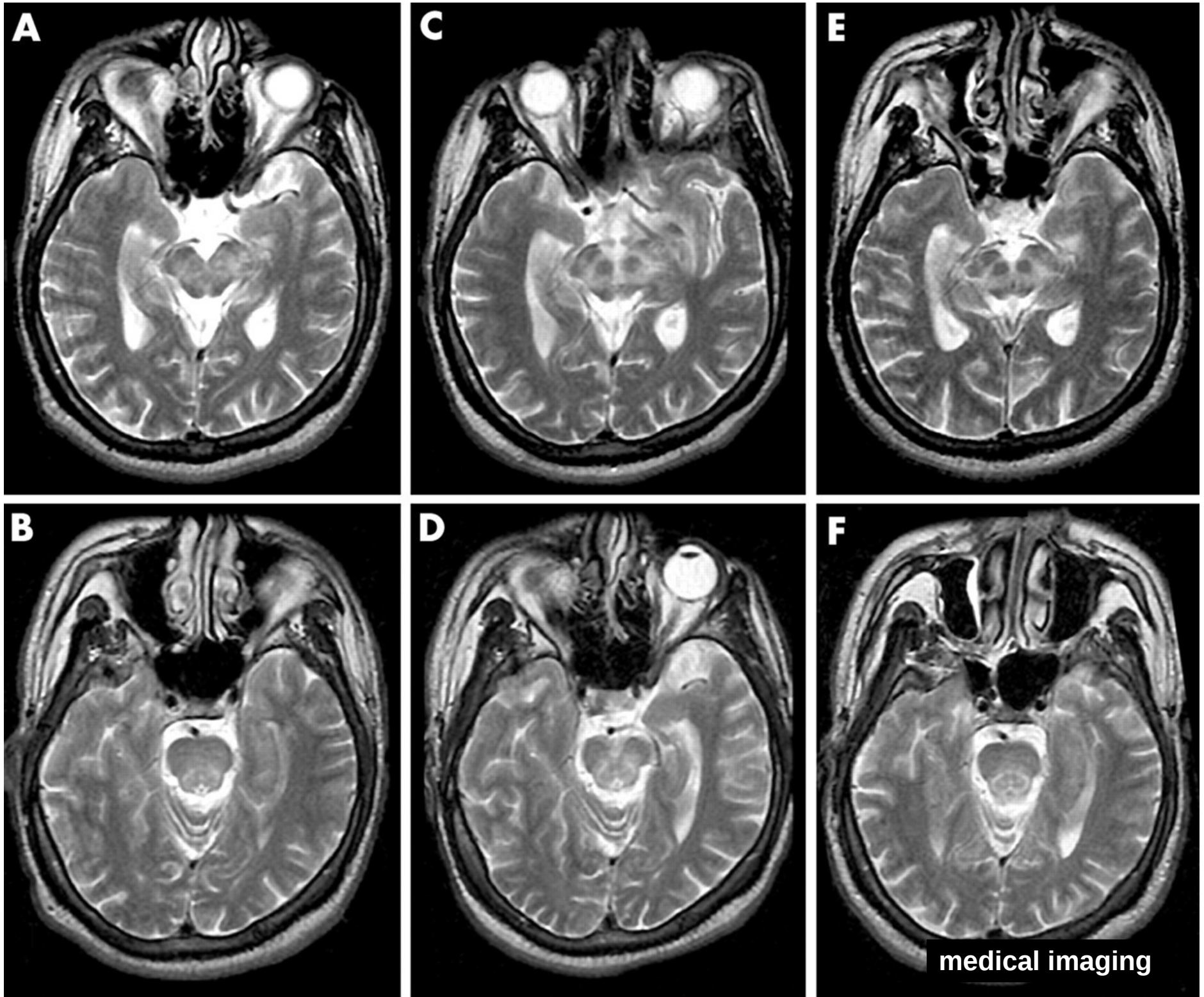

138
military

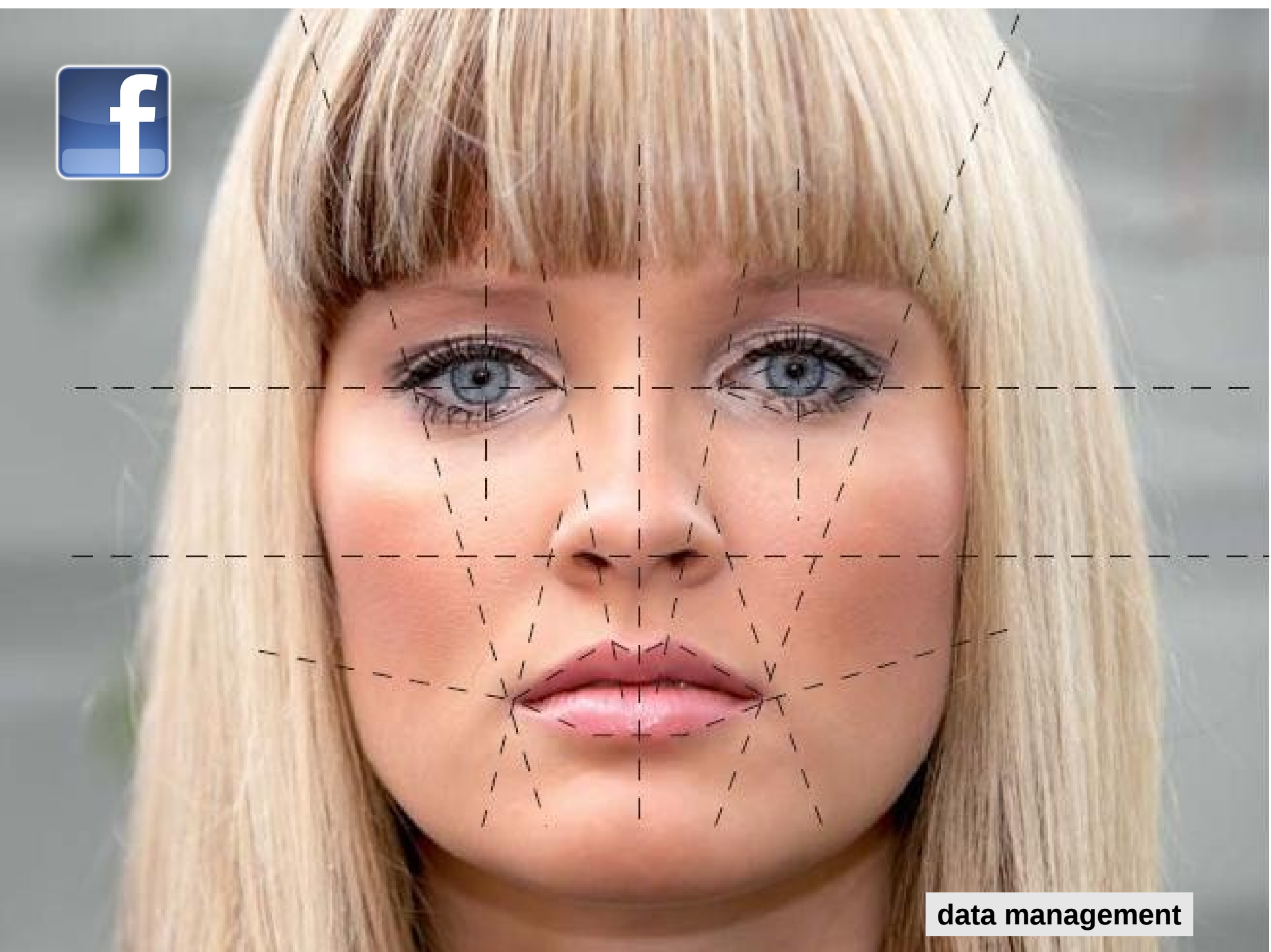


Pattern recognition


guidance / robotics


object tracking / information gathering

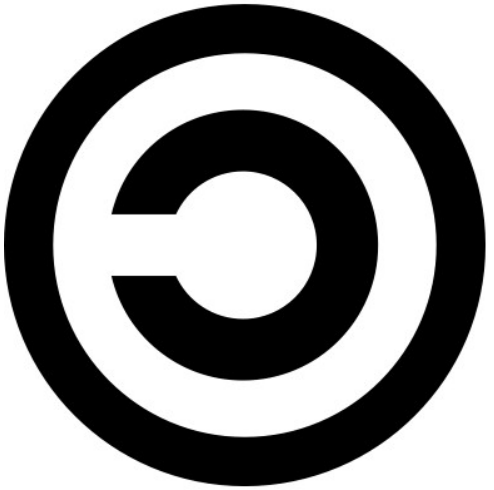

A
C
E
B
D
F
medical imaging


data management

State of the Art

- After a slow start it's now a rapidly growing field
- Already in use in some home appliances and games
- Vast array of tools for artists and amateur programmer
- but: professionals use the simple, tried and tested techniques

- A result of:
  - Maturing of vision algorithms
  - Free software movement
  - Affordable processing power
  - Cheaper/better cameras



The beginning

- “Videoplace" (1972-1990s) of Myron Krueger
  - The first interactive artwork using visual information
  - Participants stand in front of back-lit surfaces
  - Silhouette is digitized and analysed

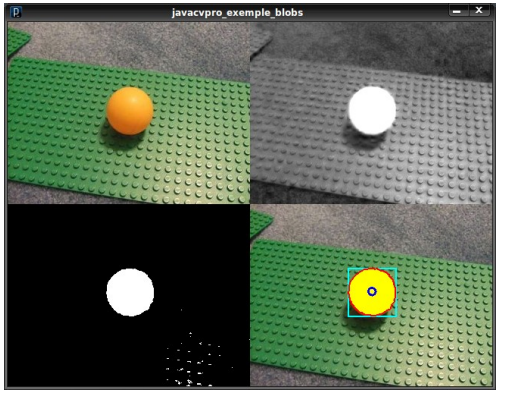
Simple techniques of machine vision *

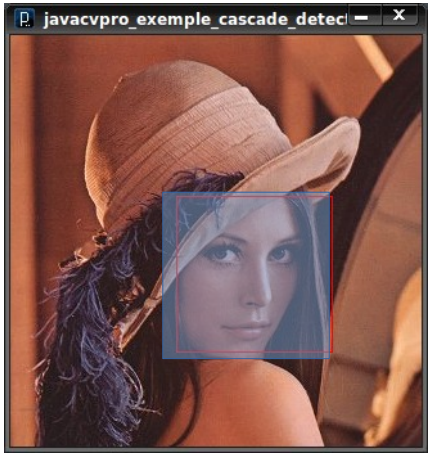
- E-motion – brightness tracking
- Catch of the day – color tracking
- The Cage – IR brightness tracking
- Flatlander – background subtraction
- Webcam piano – frame differencing
- Mesa di Voce – blob detection with physics

* and their shortcomings

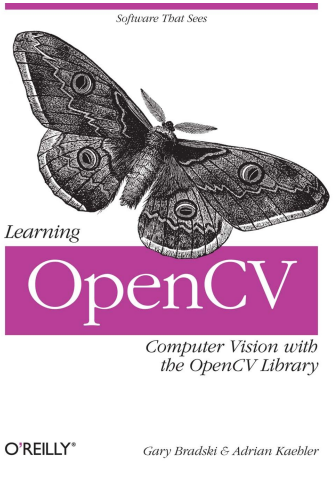
Ways to improve simple techniques

- Techniques that increase the contrast and reduce noise in images
- Advanced algorithms that look for more complex patterns
  - why use it? For simplicity + speed!



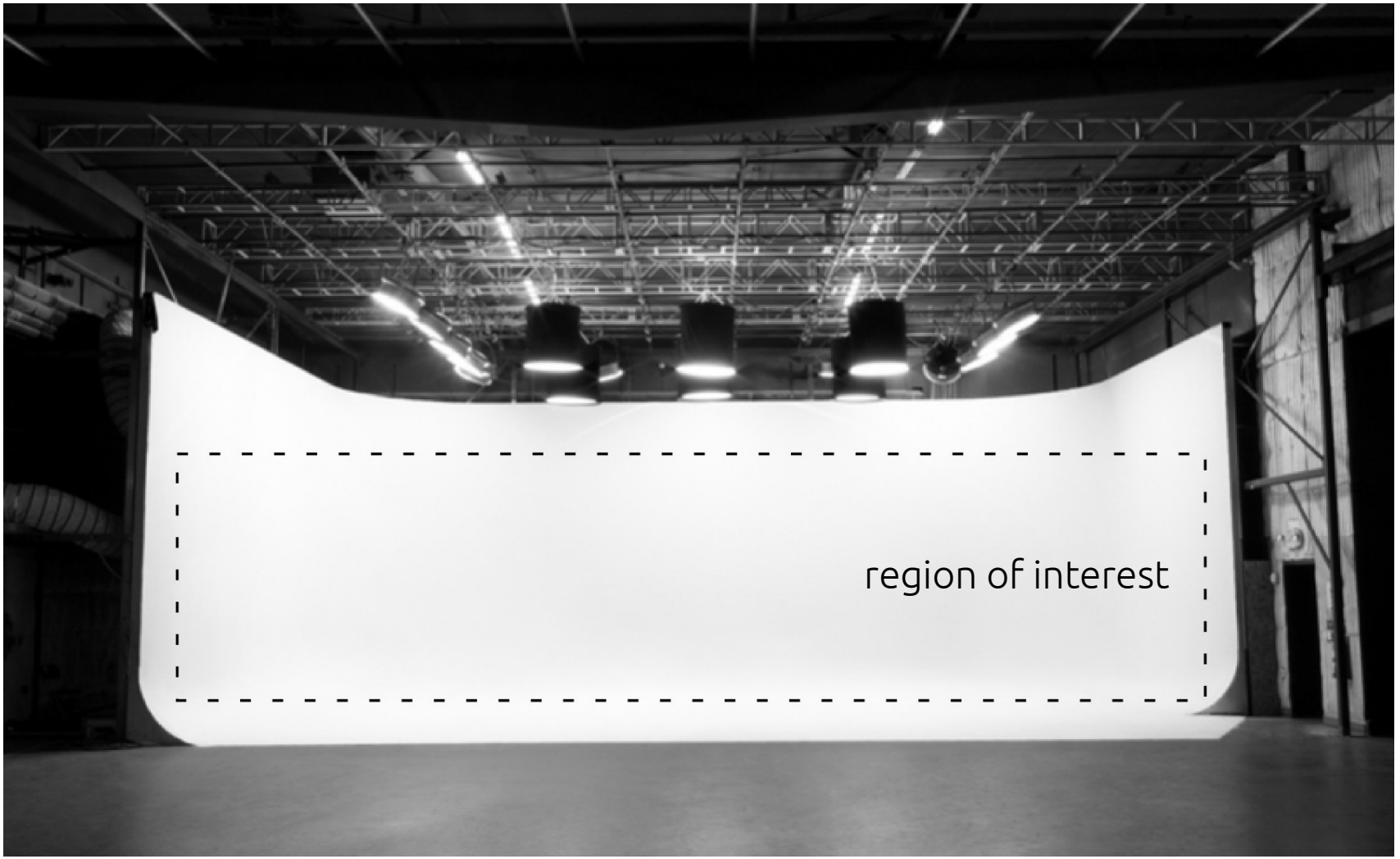


OpenCV



simple techniques explained

background subtraction



background subtraction

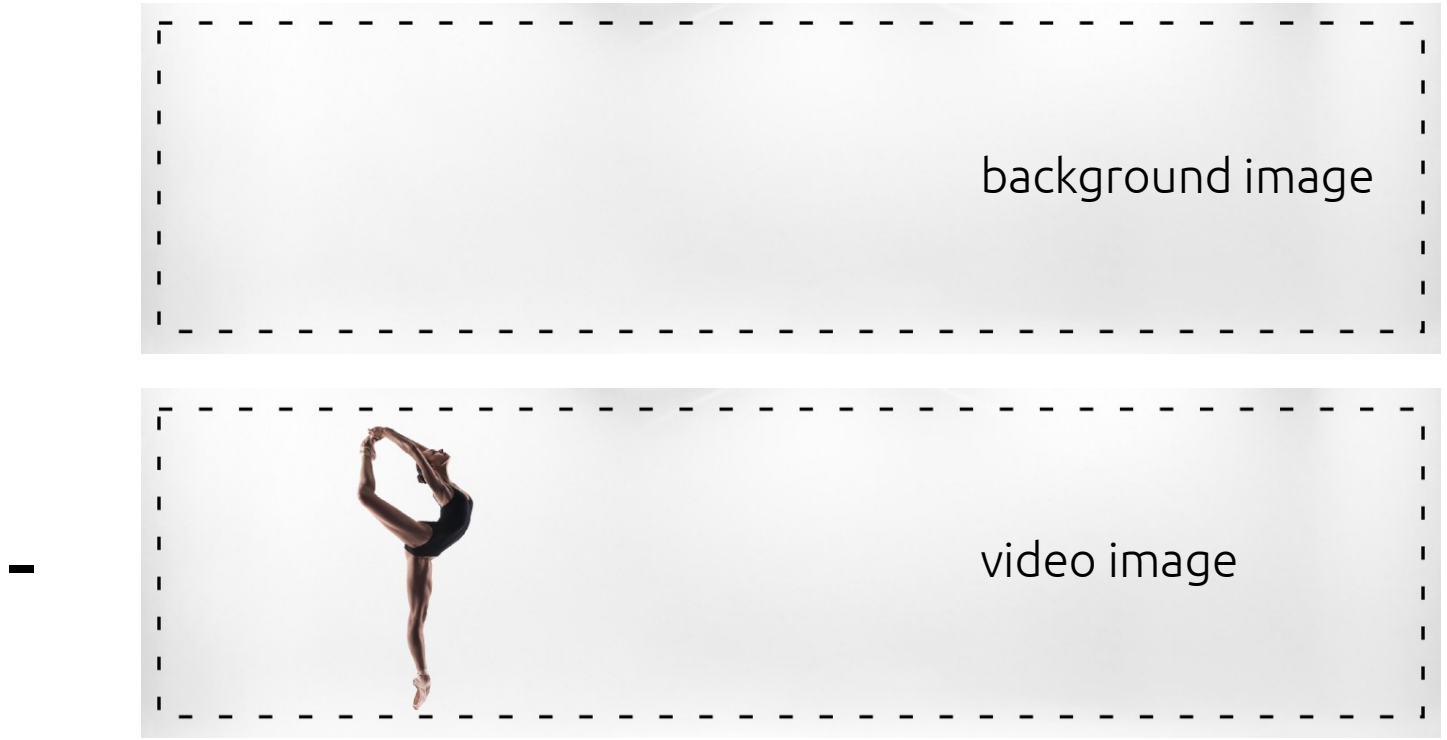


image subtraction explained

background image

255	255	255	255	255
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255

−

video image

255	255	255	255	255
255	255	255	255	255
255	255	0	0	255
255	255	0	0	255
255	255	0	0	255

=

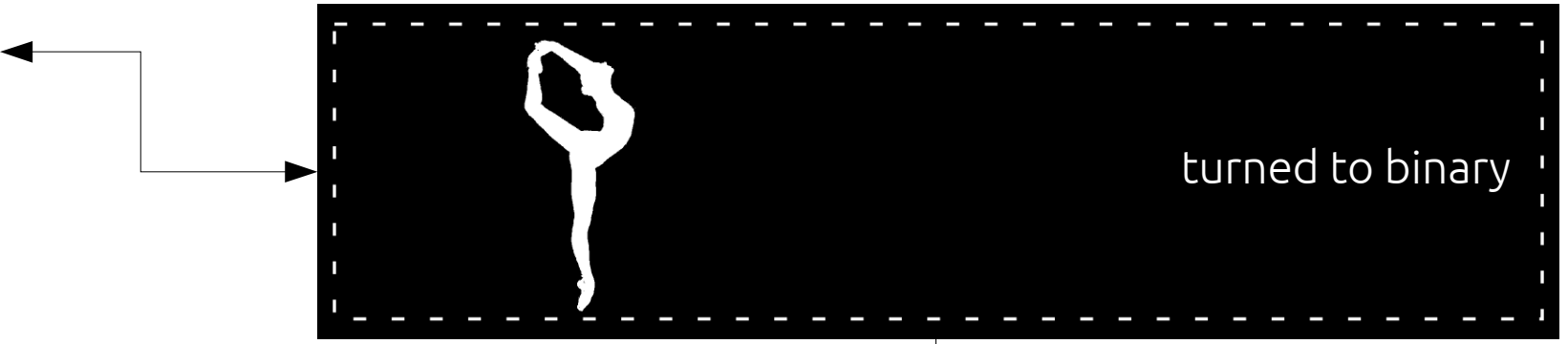
difference image

0	0	0	0	0
0	0	0	0	0
0	0	255	255	0
0	0	255	255	0
0	0	255	255	0

background subtraction

-

=

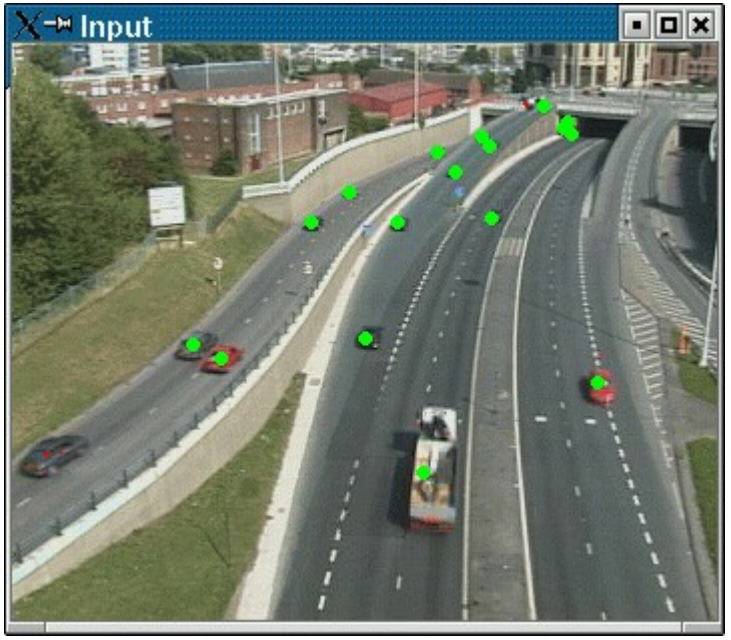

turned to binary

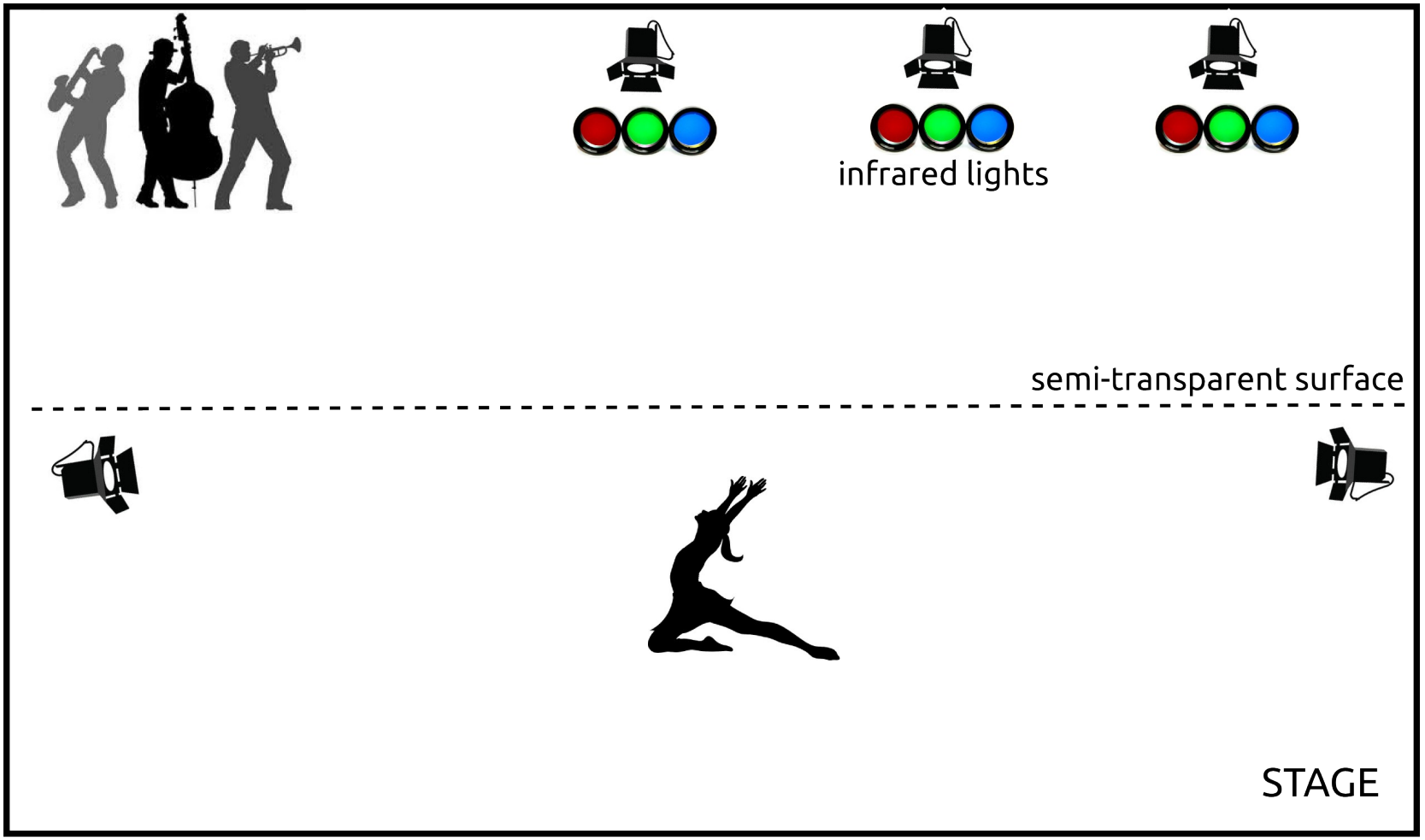

high-res outline extraction
using contour finder

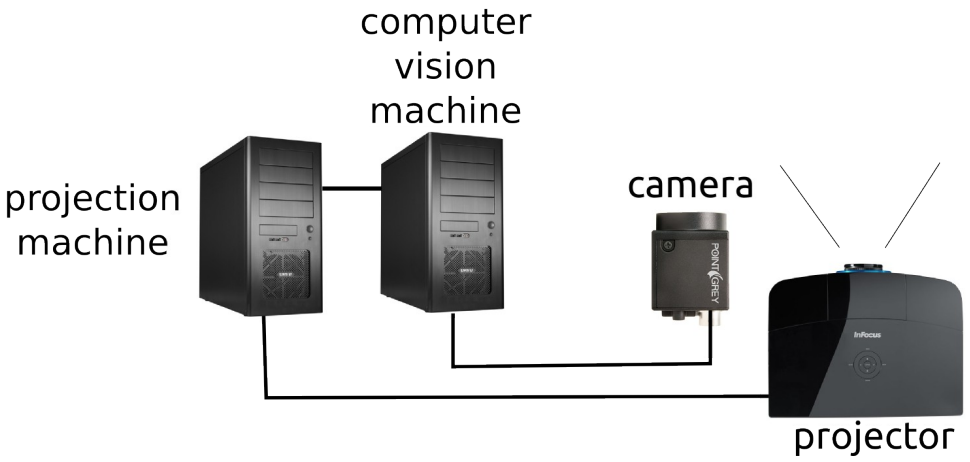
blob tracking + background differencing

issues to consider

- changing background
- changing light conditions
- tracking of blob
  - need to implement some sort of tracker




infrared lights
semi-transparent surface
STAGE


computer
vision
machine
projection
machine
camera
projector

Orthographies

frame differencing

+ **drawbacks:** variable lighting cond. / result depending on color of obj.
+ **solution:** use background diff / optical flow / depth camera

I previous frame				
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255
255	255	255	255	255

−

video image				
255	255	255	255	255
255	255	255	255	255
255	255	0	0	255
255	255	0	0	255
255	255	0	0	255

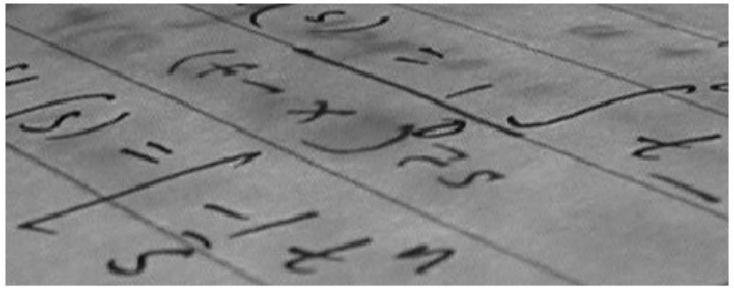
=

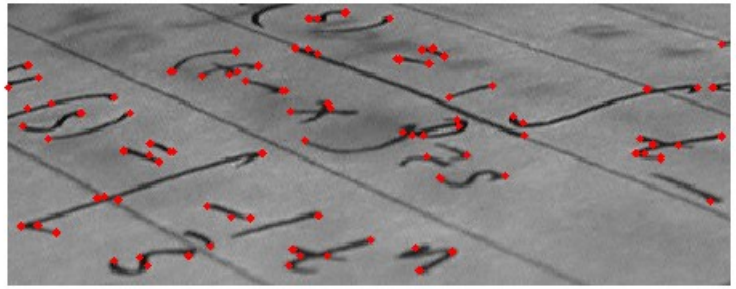
difference image				
0	0	0	0	0
0	0	0	0	0
0	0	255	255	0
0	0	255	255	0
0	0	255	255	0

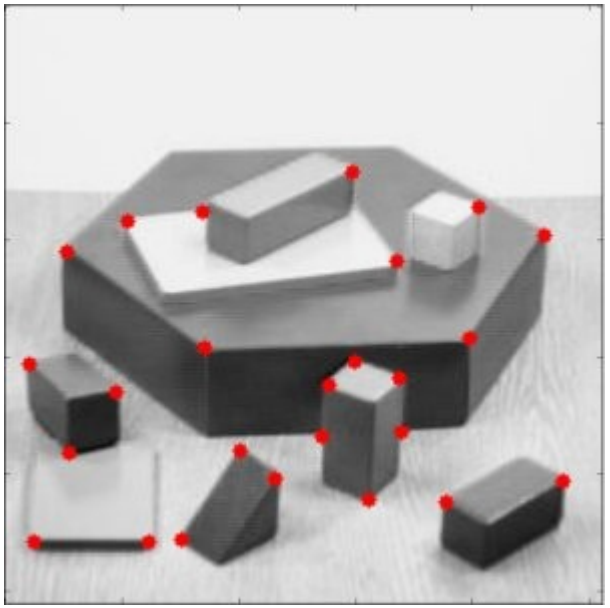
frameDifferencing

Good features to track

- Shi-Tomasi technique
- detects corners in image
- is not implemented by ofxOpenCV (the wrapper)
- is implemented by openCV (the native one)







Dance + computer vision

- 1st stage: traditional video projections
- 2nd stage: video projections to hide/reveal dancers
- 3rd stage: dynamic projections
- 4th stage: semi-independence of light + dynamic sound

Gideon Obarzanek

Frieder Weiss