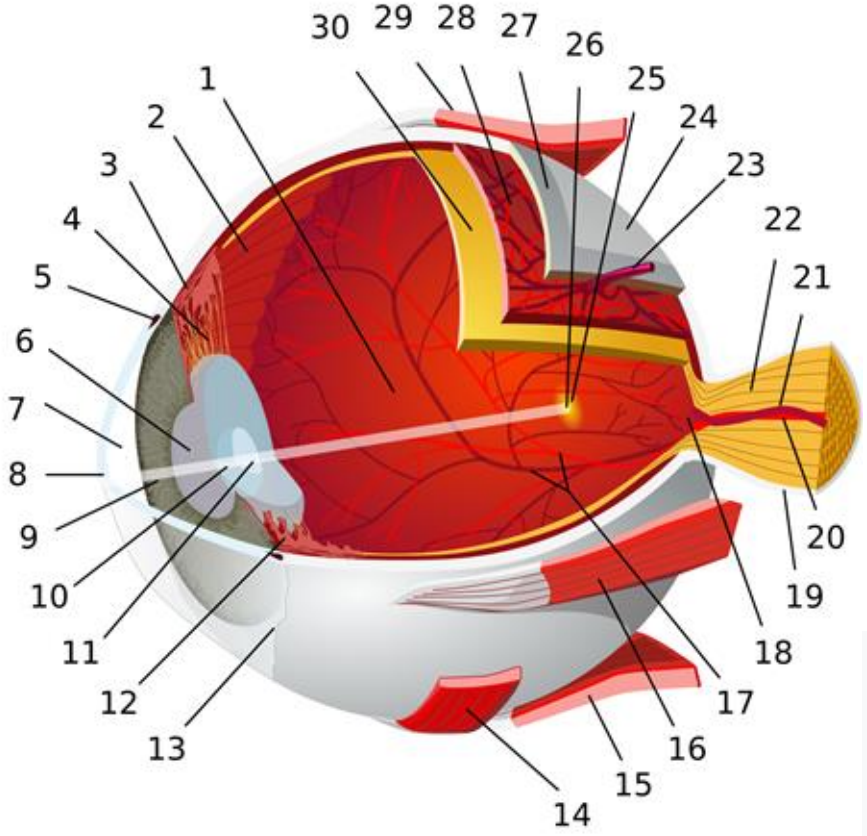
Insper

Computer Vision

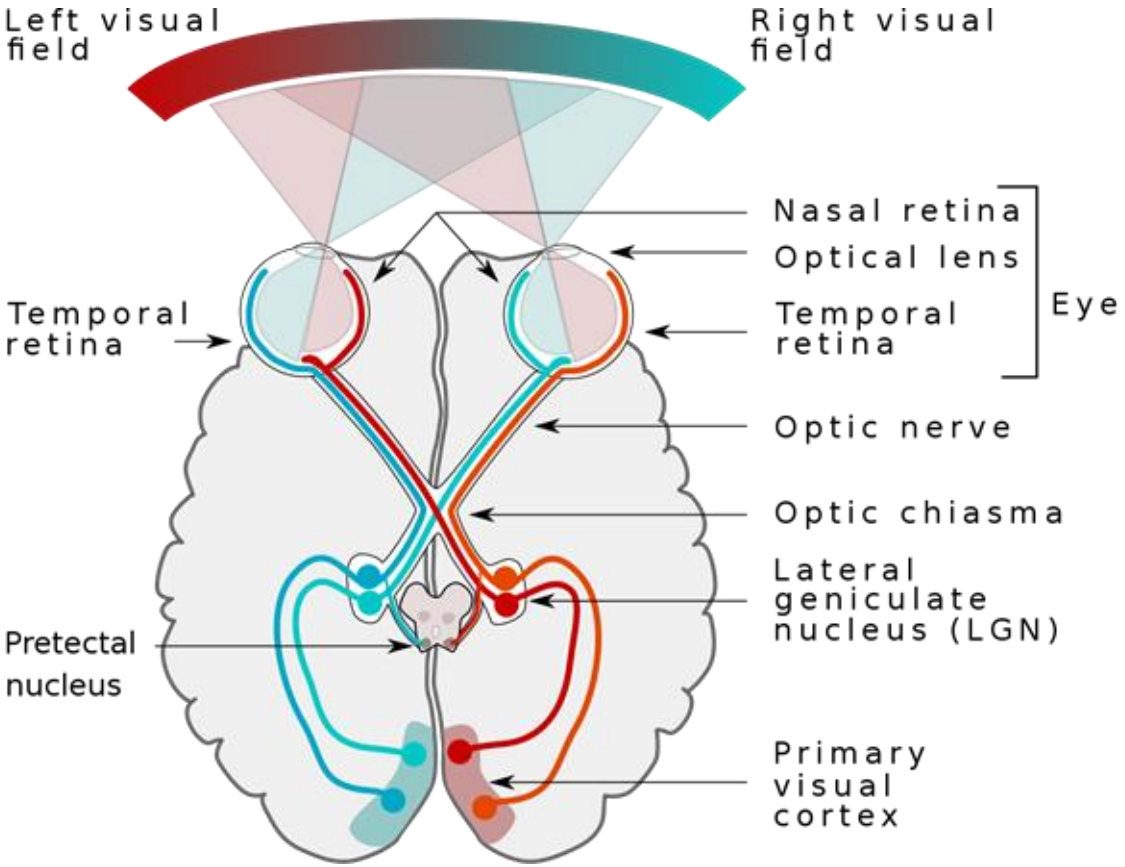
Class 1: Introduction

What is computer vision?

*First: what is **vision**?*



1. vitreous body 2. ora serrata 3. ciliary muscle 4. ciliary zonules 5. Schlemm's canal 6. pupil 7. anterior chamber 8. cornea 9. iris 10. lens cortex 11. lens nucleus 12. ciliary process 13. conjunctiva 14. inferior oblique muscle 15. inferior rectus muscle 16. medial rectus muscle 17. retinal arteries and veins 18. optic disc 19. dura mater 20. central retinal artery 21. central retinal vein 22. optic nerve 23. vorticose vein 24. bulbar sheath 25. macula 26. fovea 27. sclera 28. choroid 29. superior rectus muscle 30. retina


Left visual field
Right visual field
Nasal retina
Optical lens
Temporal retina
Eye
Temporal retina
Optic nerve
Optic chiasma
Lateral geniculate nucleus (LGN)
Pretectal nucleus
Primary visual cortex

*Better: how do we **use** vision?*

Human vision:

eyes capture image and brain extracts information

This is a panoramic view of the two Insper buildings under daylight. You can also see other buildings, nearby streets, and surrounding trees. The sky is slightly clouded. Some of the windows are lit, but others are not...

Computer vision:
camera captures image and algorithms extract information

This is a panoramic view of the two Insper buildings under daylight. You can also see other buildings, nearby streets, and surrounding trees. The sky is slightly clouded. Some of the windows are lit, but others are not...

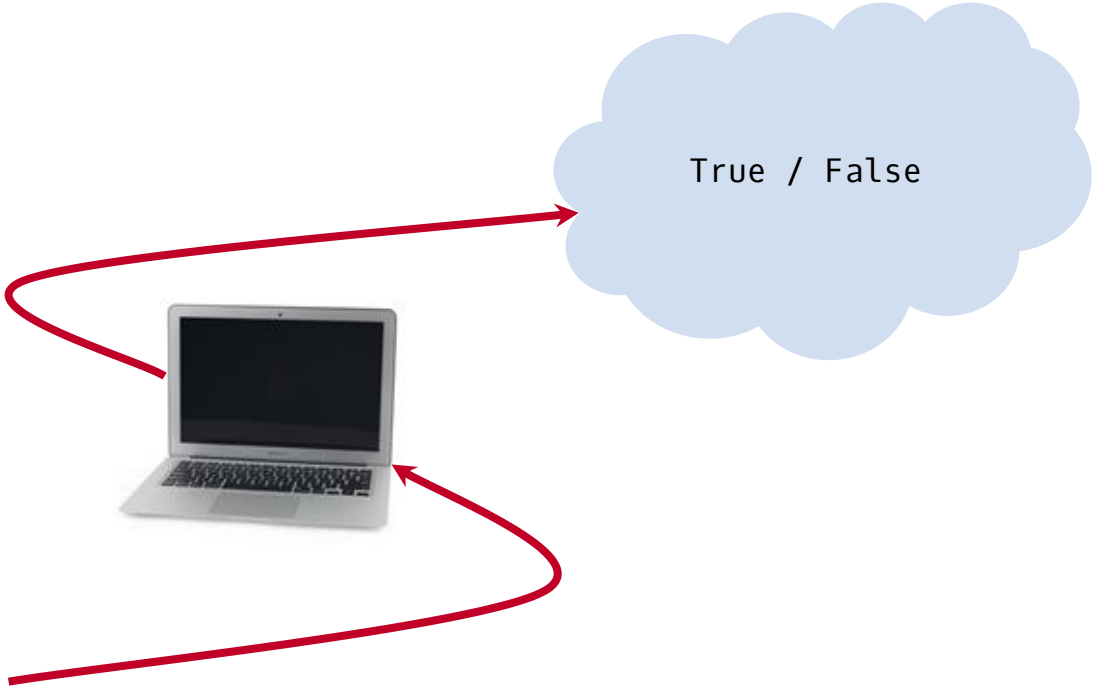
Computer vision: algorithms to extract high-level information from one or more digital images.

Computer vision: algorithms to extract ***high-level information**** *from one or more digital images.*

**this is why it is useful*

Boolean model

"Is it a face?"



Discrete model

"Where are the faces?"

```
( 71,54,15,19),
( 92,79,15,19),
(117,71,16,18),
...
```

Continuous model

"What is the similarity?"

99.37%

Continuous model

"What is the similarity?"

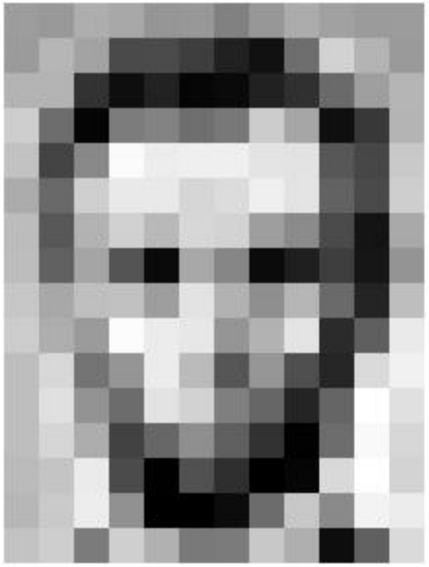
99.37%

Think this example is unrealistic? This man was actually arrested because of the sketch. Last slide has a link.

Computer vision: algorithms to extract high-level information from one or more ***digital images****.

**this is why it is difficult*

Raster image:
array of integers



157	153	174	168	150	152	129	151	172	161	155	156
155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	84	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

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155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
194	68	137	251	237	239	239	228	227	87	71	201
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199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
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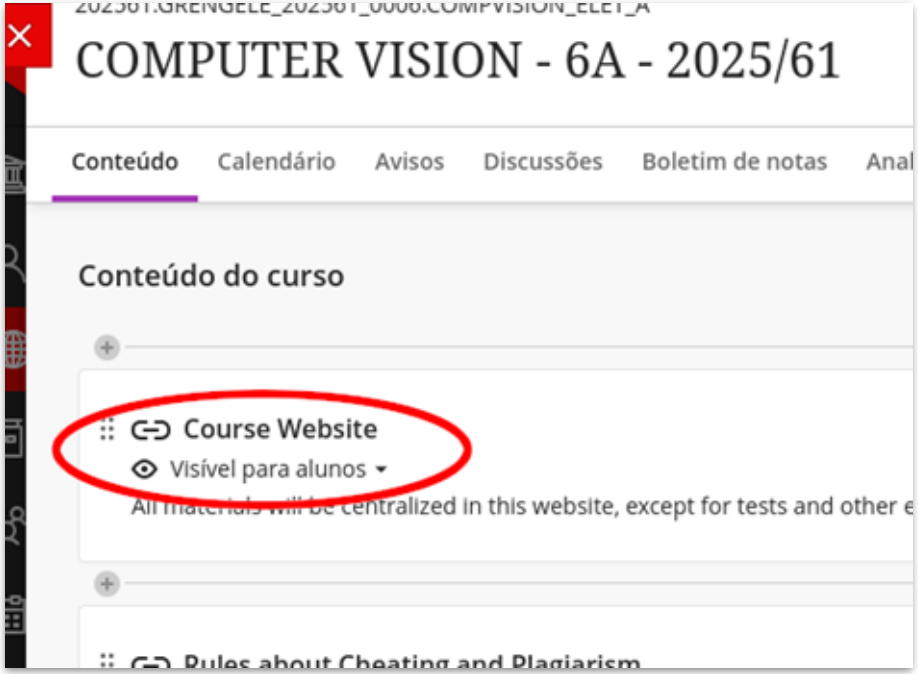
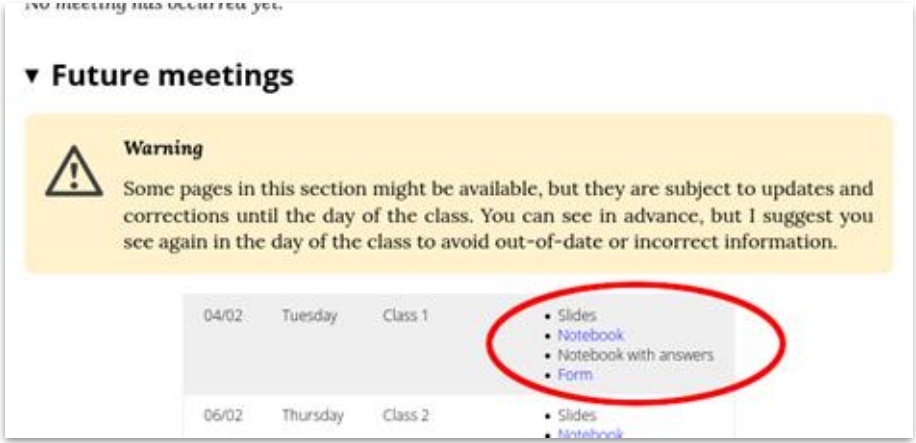
183	202	237	145	0	0	12	108	200	138	243	236
195	206	123	207	177	121	123	200	175	13	96	218

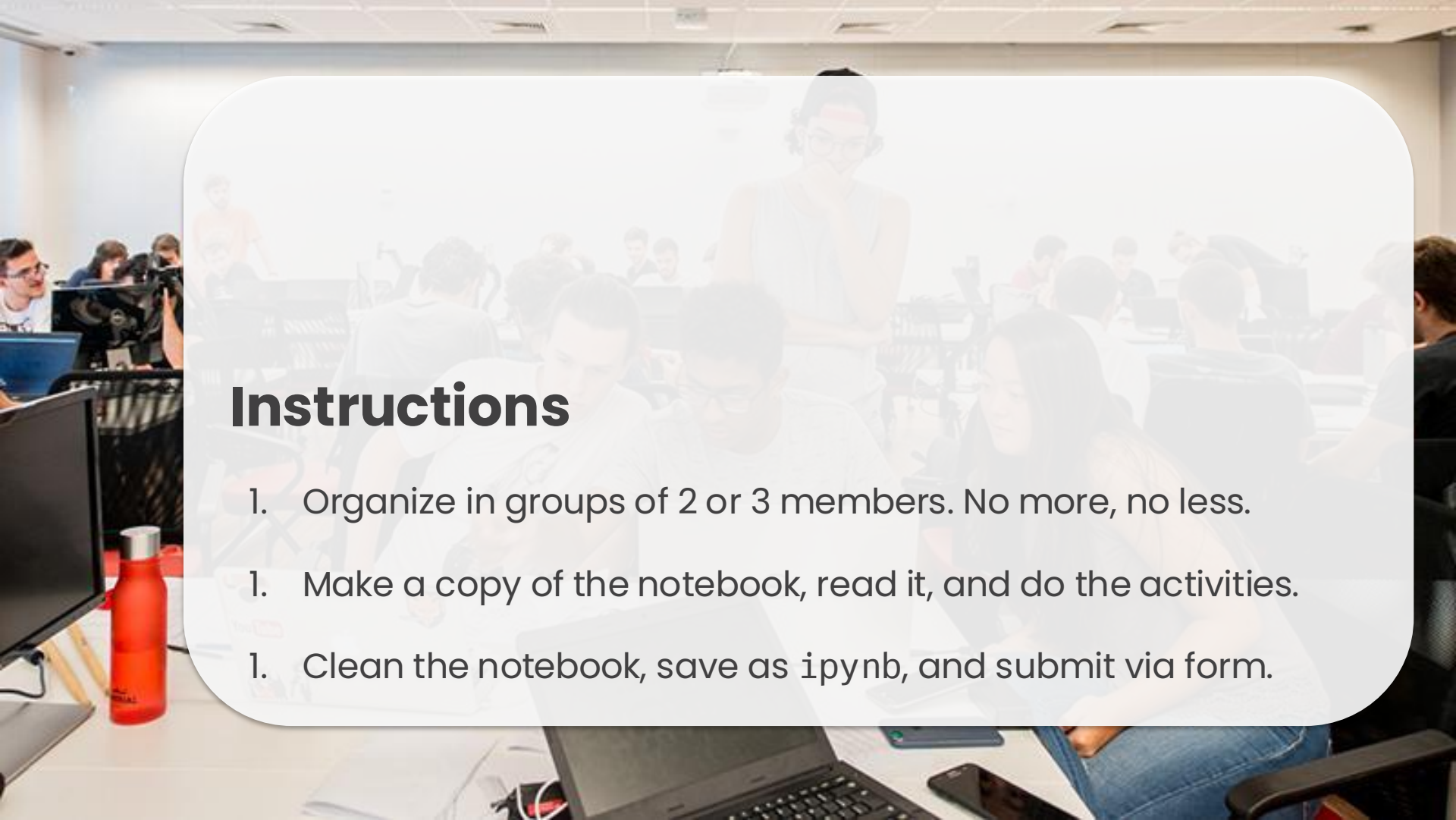
handout


COMPUTER VISION - 6A - 2025/61
Conteúdo
Calendário
Avisos
Discussões
Boletim de notas
Conteúdo do curso
Course Website
Visível para alunos


No meeting has occurred yet.
▼ Future meetings
Warning
Some pages in this section might be available, but they are subject to updates and corrections until the day of the class. You can see in advance, but I suggest you see again in the day of the class to avoid out-of-date or incorrect information.
04/02 Tuesday Class 1
Slides
Notebook
Notebook with answers
Form
06/02 Thursday Class 2
Slides

Toolkit

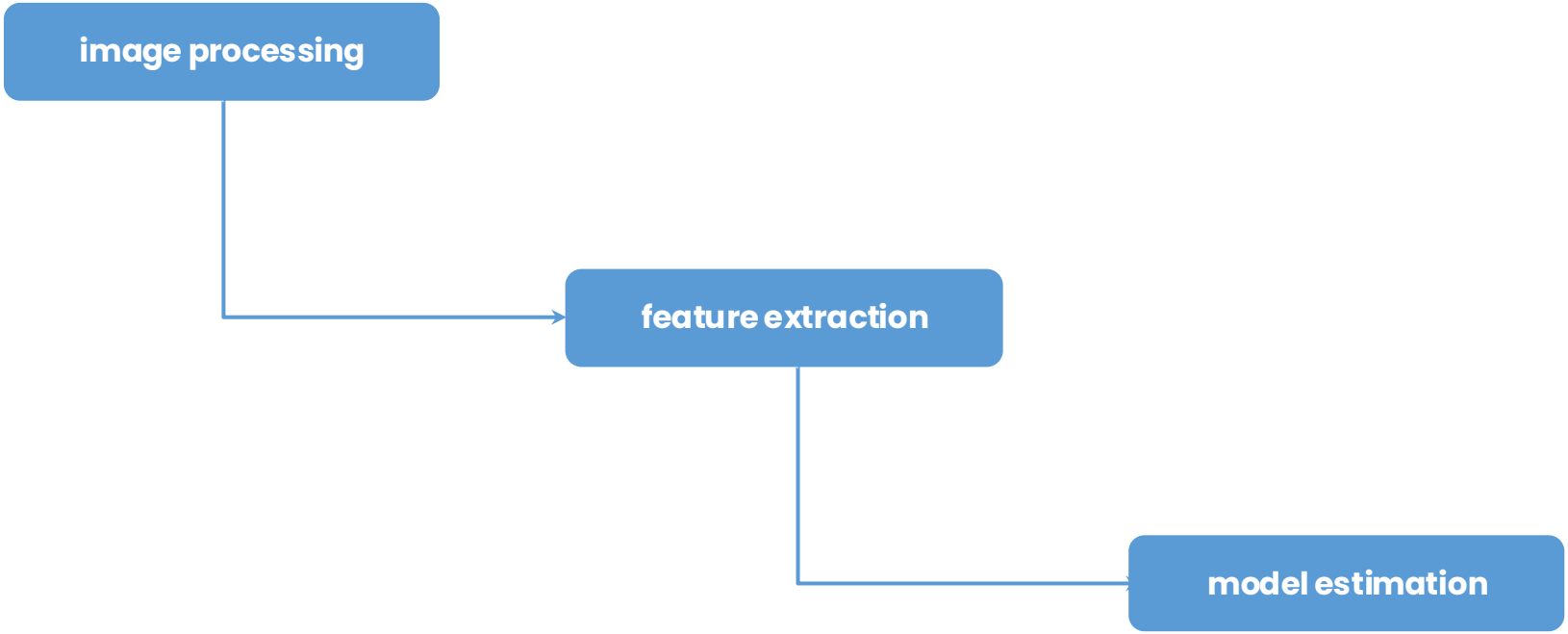
- **Language:** Python
- **Library:** OpenCV
- **Platform:** Google Colab



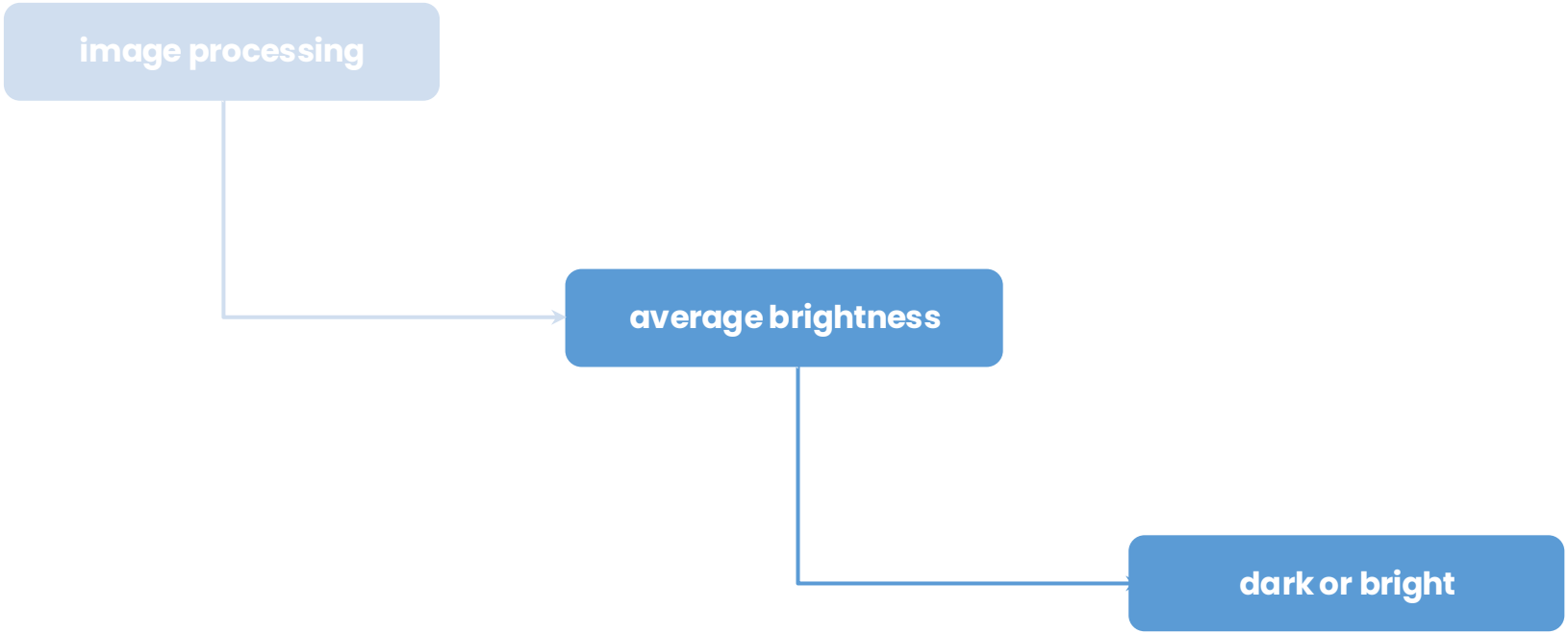
Instructions

1. Organize in groups of 2 or 3 members. No more, no less.
1. Make a copy of the notebook, read it, and do the activities.
1. Clean the notebook, save as `ipynb`, and submit via form.

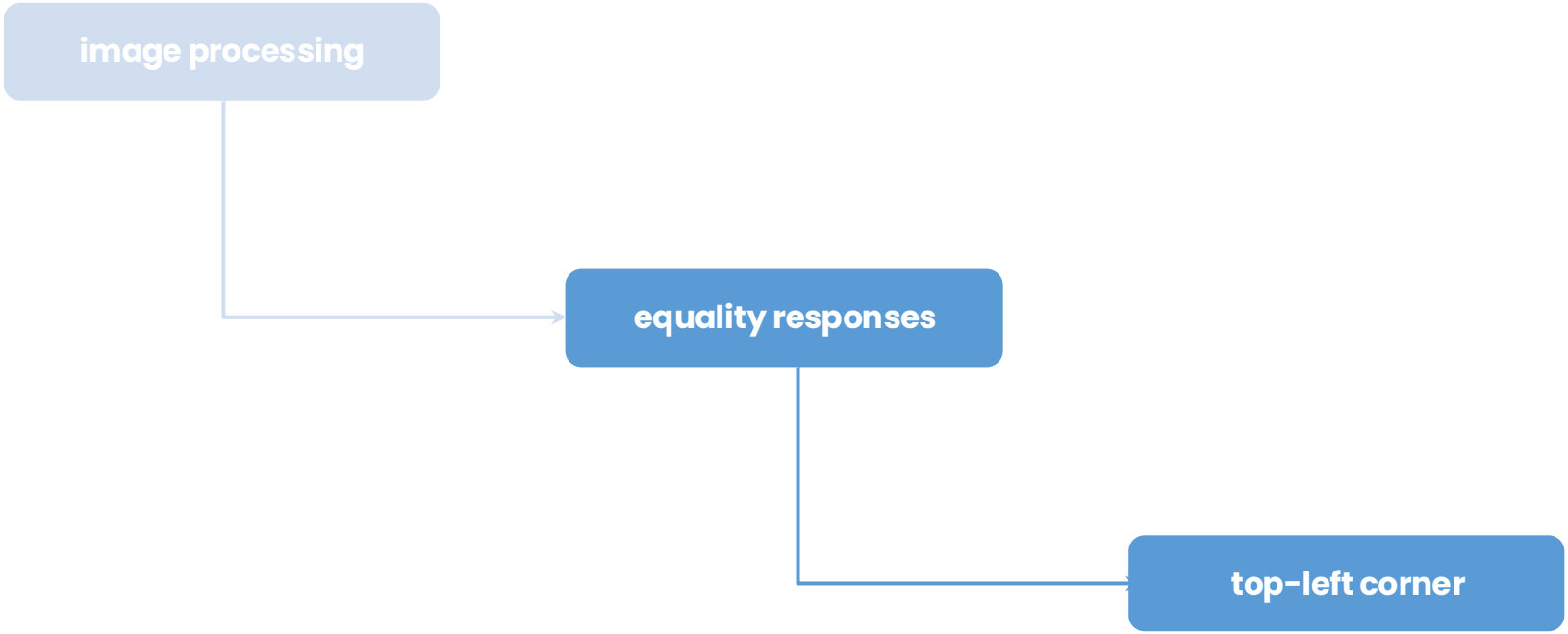
The basic computer vision pipeline



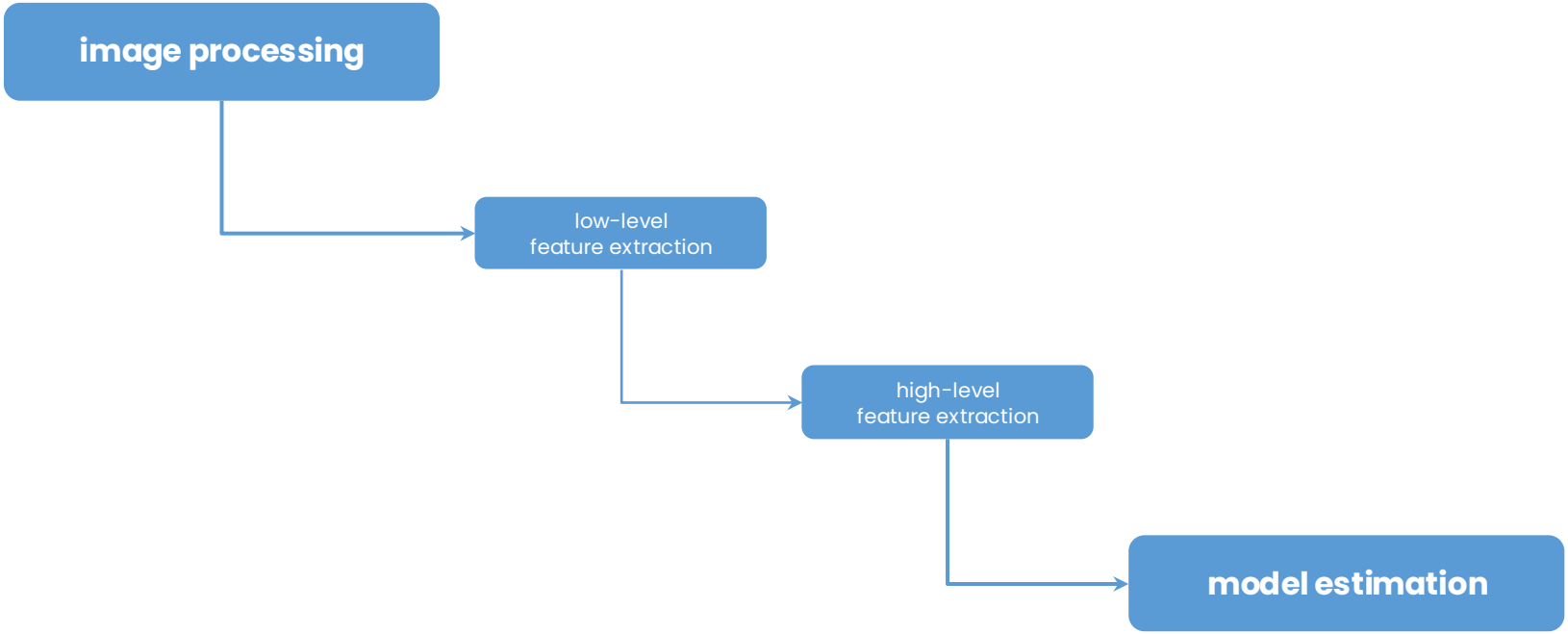
The basic computer vision pipeline *(Activity 1)*



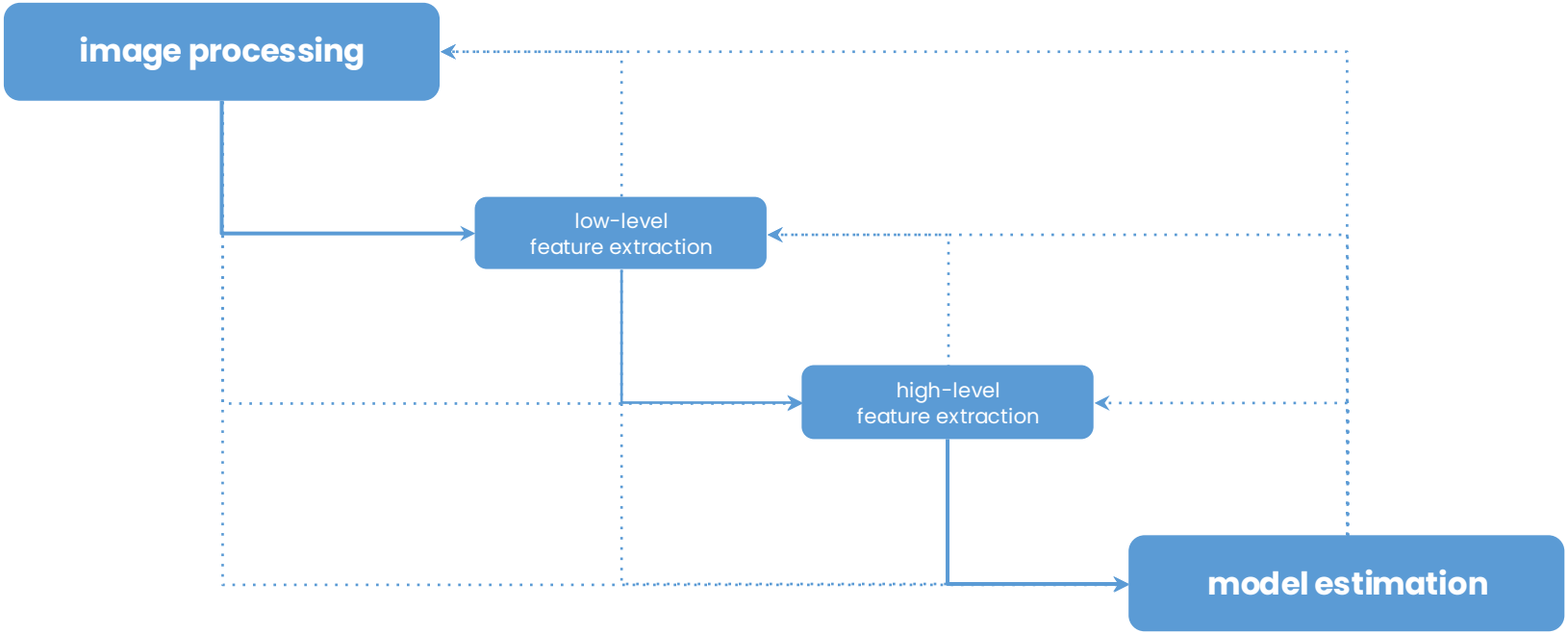
The basic computer vision pipeline *(Activity 2)*



The advanced computer vision pipeline

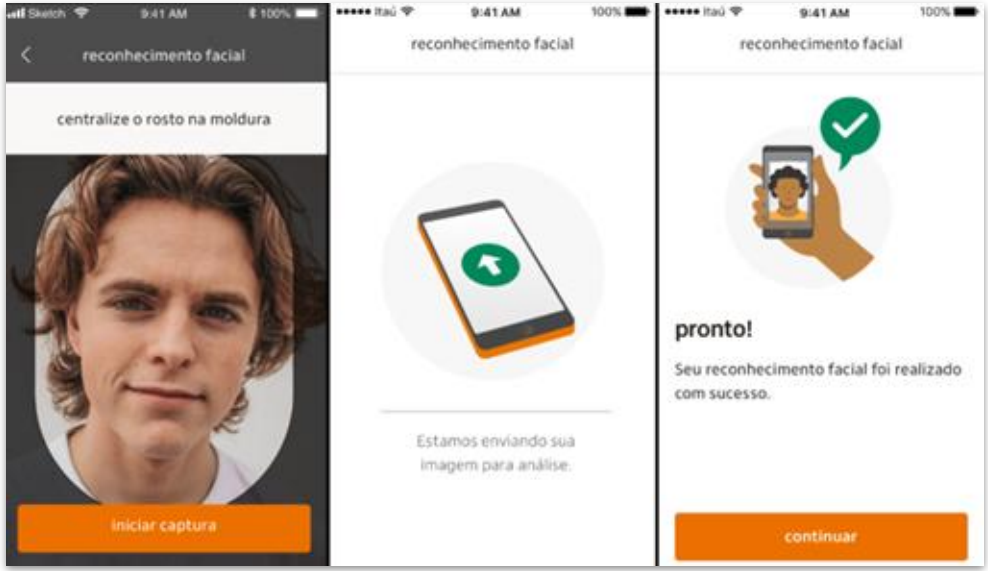


The advanced computer vision pipeline



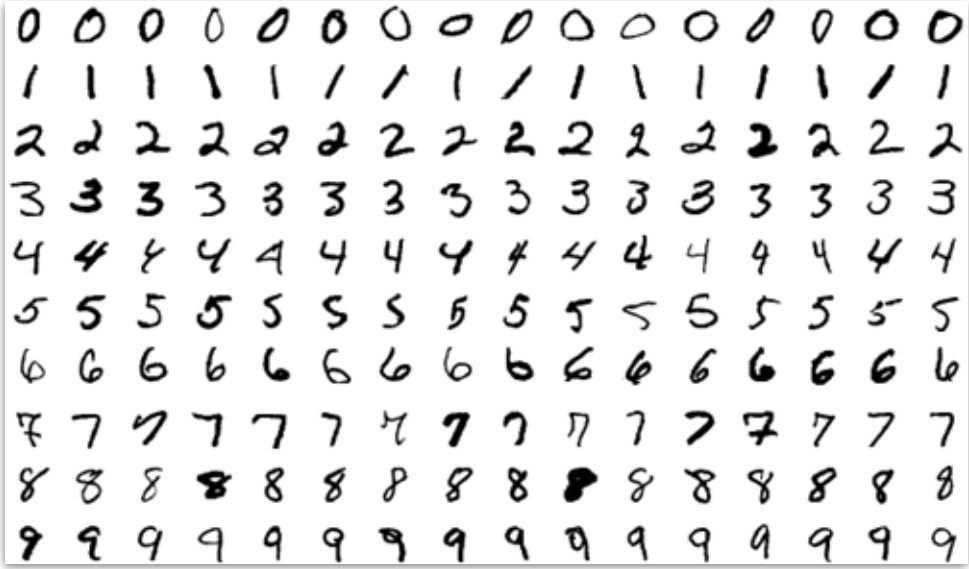
The recognition problem:

likelihood of belonging to a specific category

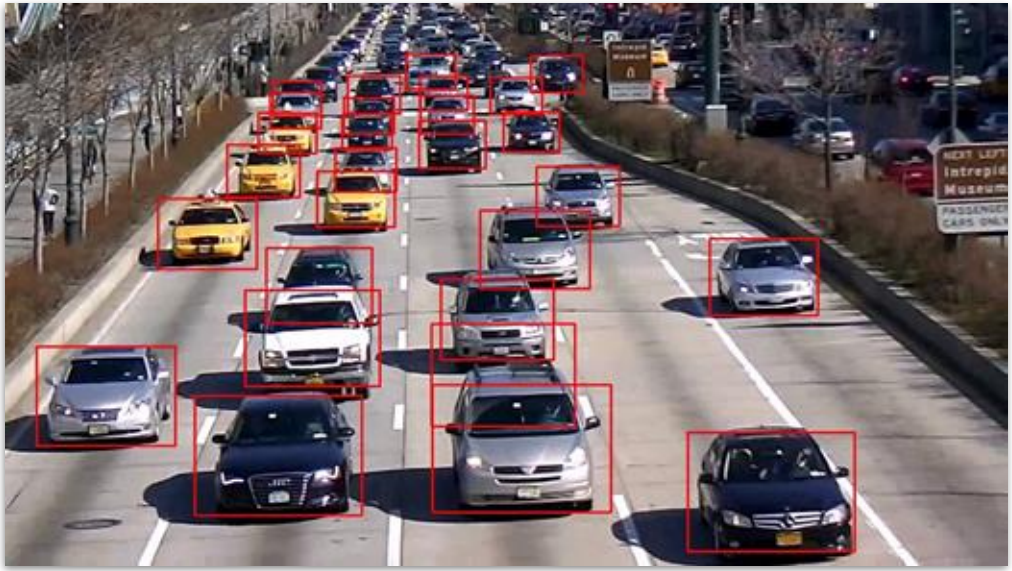


The classification problem:

likelihood of belonging to each of multiple categories

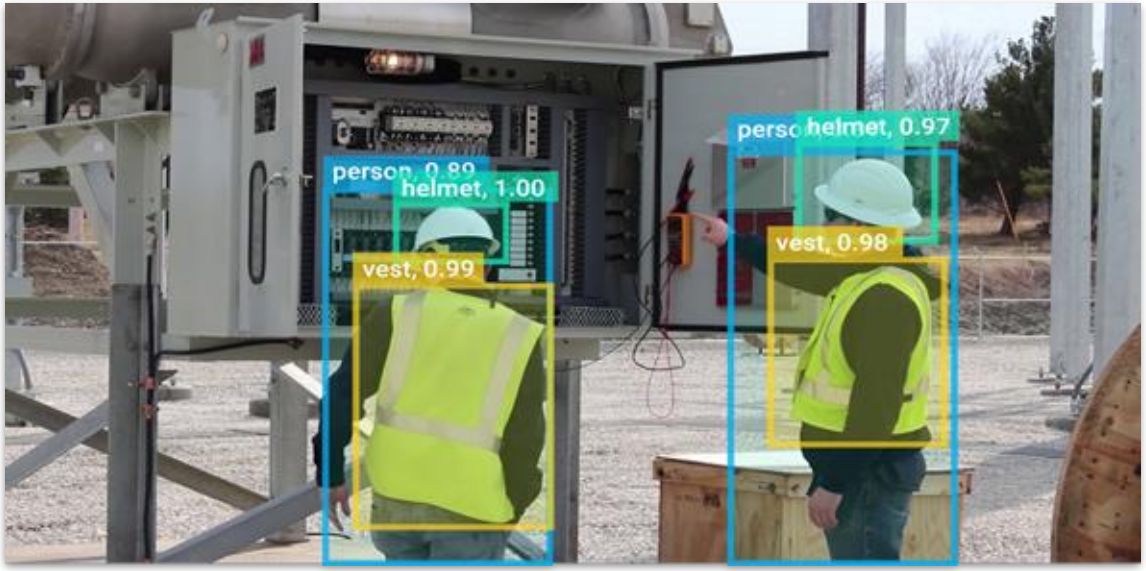


The detection problem:
approximate position of something



The segmentation problem:
exact boundaries of something

Hybrid problem:
classification + detection



Hybrid problem:
recognition + segmentation

Hybrid problem:

recognition + classification + detection + segmentation

Possible obstacles:

- gray level reduction;
- brightness changes;
- contrast changes;
- noise;
- occlusion;
- translation;
- rotation;
- scale;
- perspective distortion;
- deformation.

organization

Objectives

- Analysis of problems involving image processing and computer vision.

- Design and implementation of technical solutions for image processing and computer vision problems using classical techniques and the OpenCV library.

- Performance evaluation of image processing and computer vision implementations.

Assessment

- **Complementary (25%):** class handouts and project sprints.
- **Essential (75%):** final submission of the project.

Class handouts

- Non-trivial submissions are mandatory for attendance.
- Adequate submissions receive one point.
- Above-average submissions receive two points.
- Complementary grade will be based on the received-total ratio.
- The criteria for “adequate” and “above-average” is specific to each handout and will consider the general performance.

Project sprints

- Non-trivial progress is mandatory for attendance.
- Adequate progress receive one point.
- Above-average progress receive two points.
- Complementary grade will be based on the received-total ratio.
- The criteria for “adequate” and “above-average” is specific to each project and will consider the general performance.

Project tracks:

1. researcher;
1. contributor;
1. developer;
1. entrepreneur.

Researcher track

- Study and implementation of a vision paper from 2020-2025.
- Study must result in a Medium article and an YouTube video. Both should make the main ideas accessible for a general audience. Level of depth and degree of formality are negotiable.
- Implementation can use any available libraries, including the ones created for the paper itself, and does not necessarily need a refined interface. However, it must be straightforward to run with arbitrary input and parameters.

Contributor track

- Implementation and documentation of a new public library for usage of vision in a specific domain.

- Implementation can use any available libraries, but must wrap them in an API specifically designed for the domain and focus on novelty and developer experience. Ideally, should include tests with good coverage.

- Documentation must include the full API specification and a complete manual, with high-level explanations and examples.

Developer track

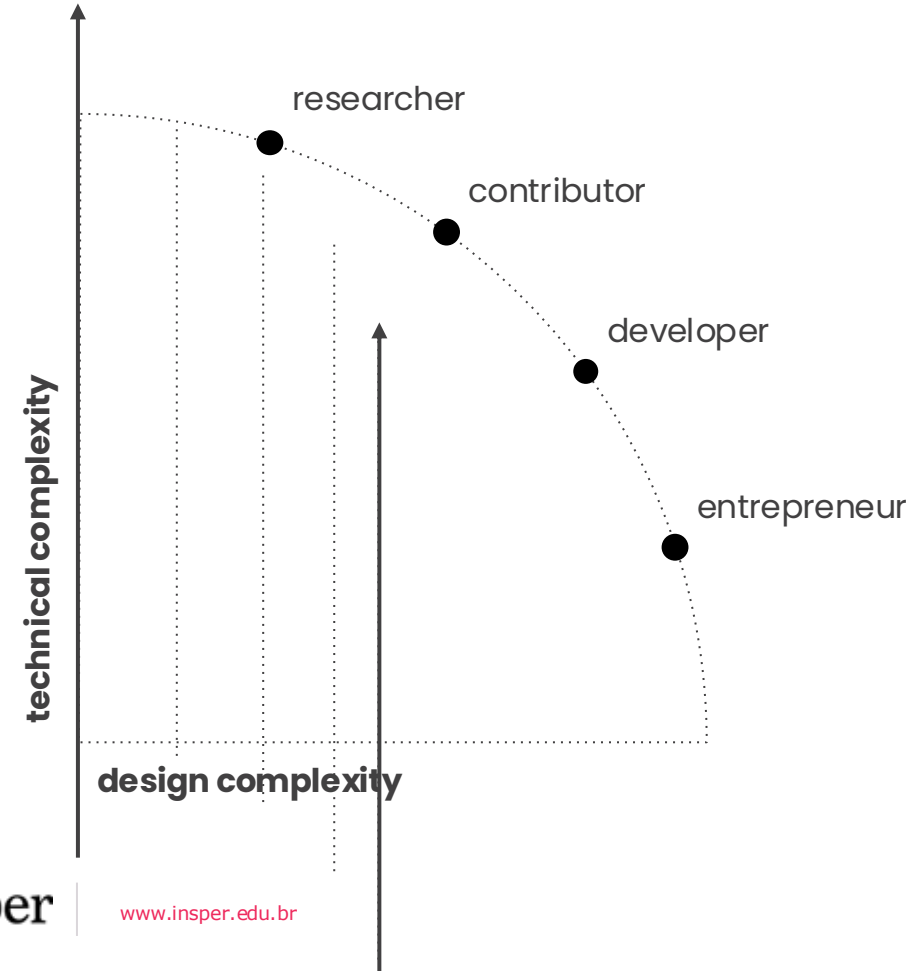
- Implementation and deployment of a web application primarily based on vision.

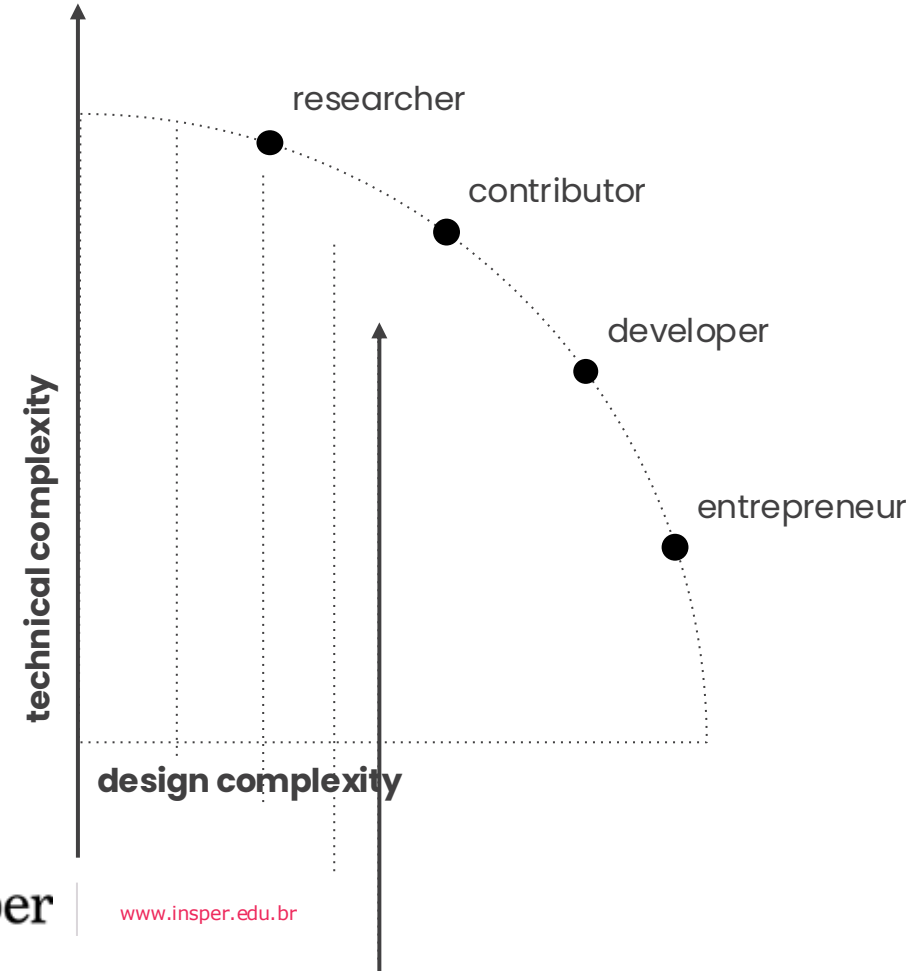
- Implementation must be useful, novel, and fully-functional, but not necessarily monetizable. Accuracy, performance, and resource usage, all considering real data, must show potential.

- Deployment must be public, with professional-level presentation, responsiveness, and usability. Ideally, should be continuous and use a testing environment based on containers.

Entrepreneur track

- Proposal of a startup primarily based on vision.
- Desirability and viability must be shown via interviews, personas, benchmarks, a complete canvas, and a video pitch. Ideally, should have feedback from investors.
- Feasibility must be shown via a functional proof of concept. Implementation can use any available libraries and does not necessarily need a refined interface. Accuracy, performance, and resource usage, all considering real data, must show potential.


researcher
contributor
developer
entrepreneur
technical complexity
design complexity



The perceived difficulty is irrelevant. All tracks can be made easier or harder as needed.

Next class:

- modern computer vision.

Credits

This material was based on the work of other professors, listed below.

- Fabio Miranda (fabiomiranda@insper.edu.br)
- Raul Ikeda (RaulIGS@insper.edu.br)
- Fabio Ayres (FabioJA@insper.edu.br)
- Igor Montagner (IgorSM1@insper.edu.br)
- Andrew Kurauchi (AndrewTNK@insper.edu.br)
- Luciano Silva (LucianoS4@insper.edu.br)
- Tiago Sanches (tiagoss4@insper.edu.br)

Well, except for the errors. Any errors you might find are probably my fault.

Images

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