



# TRACKING OLYMPIAD

Summer term 2024

# Tracking Olympiad Agenda

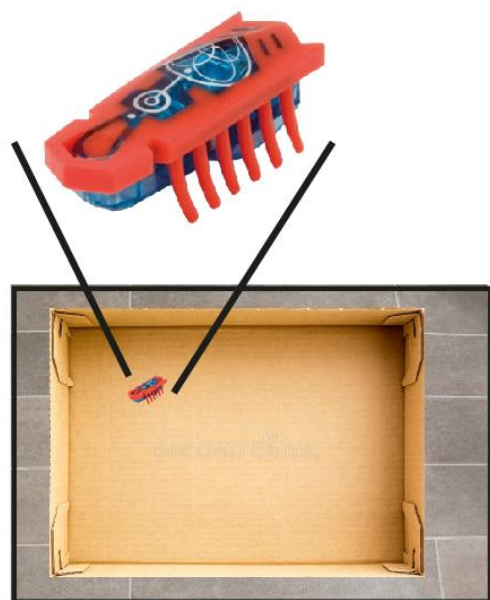
- Aim of the seminar
- How to achieve this aim
- How to monitor progress
- How to present papers about tracking
- How the seminar is graded
- When you need to be where
- Open questions

# Your aim

Build an artificial intelligence to track hexbugs!



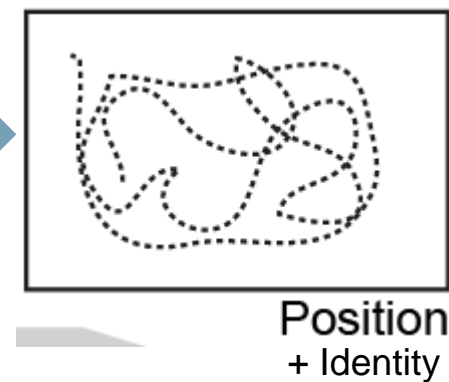
# In detail...



Video



YOUR FANCY AI ALGORITHM



# Your aim

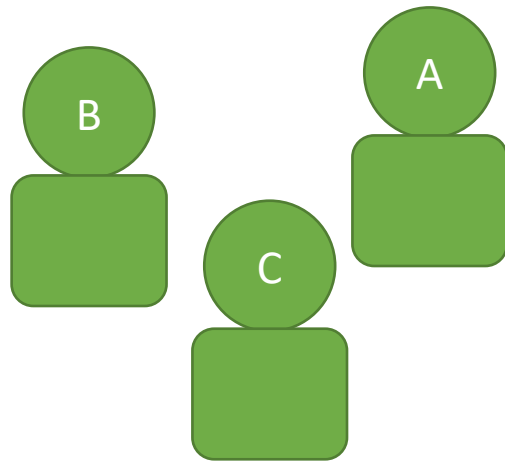
- You receive 100 videos from us **labelled**, and 5 videos from us **not labelled**.  
These 5 videos are used to create an intermediate leaderboard.
- You will get a **crappy baseline** to get started
- You can use ANY ALGORITHM to come up with (x,y) coordinates for the hexbugs and their identity – i.e. track.

You are allowed to:

- Work in your team with team mates
- Acquire new data (and you should – see competitions)
- Annotate new data

# Teams

- You are part of a team of 3.  
(We will decide on teams in a moment)
- You need a fancy team name.



## 1 Solution

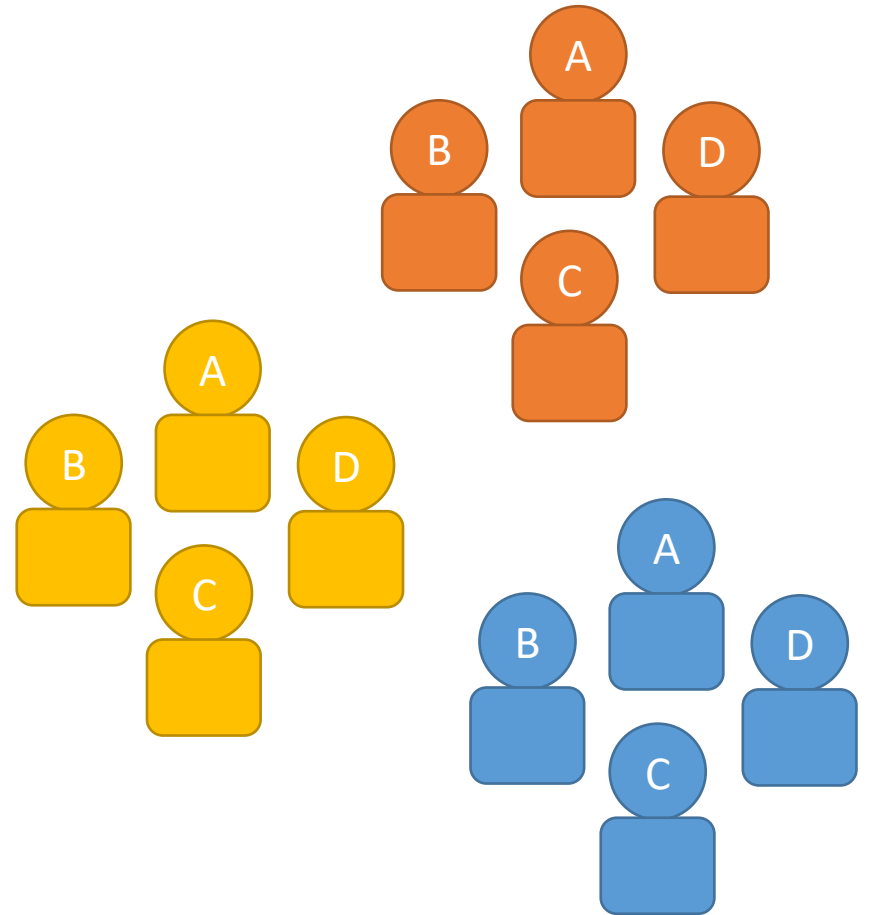
Ensemble solution:

- Voting?
- Averaging?
- Another network/classifier?
- Hand-written rules?!

# Competitions

vs. The seminar team  
(Leaderboard!)

vs. The other teams!



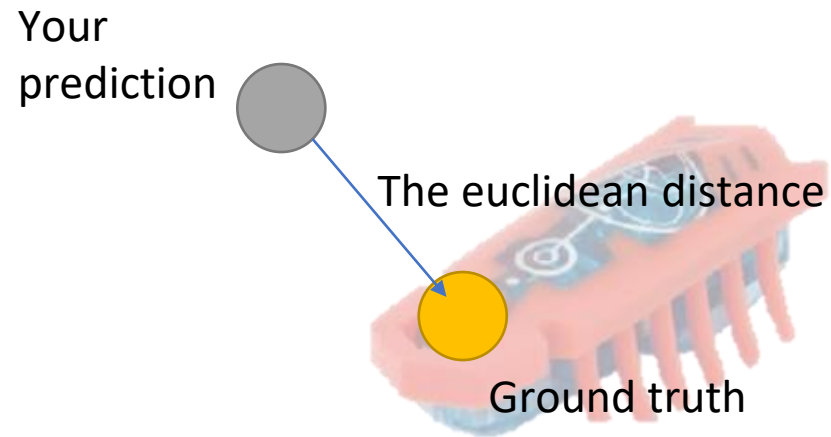
# Team competition (Bonus challenge)

- **Record and annotate 3 videos** (i.e. one per team member) to for the inference week.
- Everyone runs all team videos
- The one with the lowest overall score wins!

➔ Just for fun

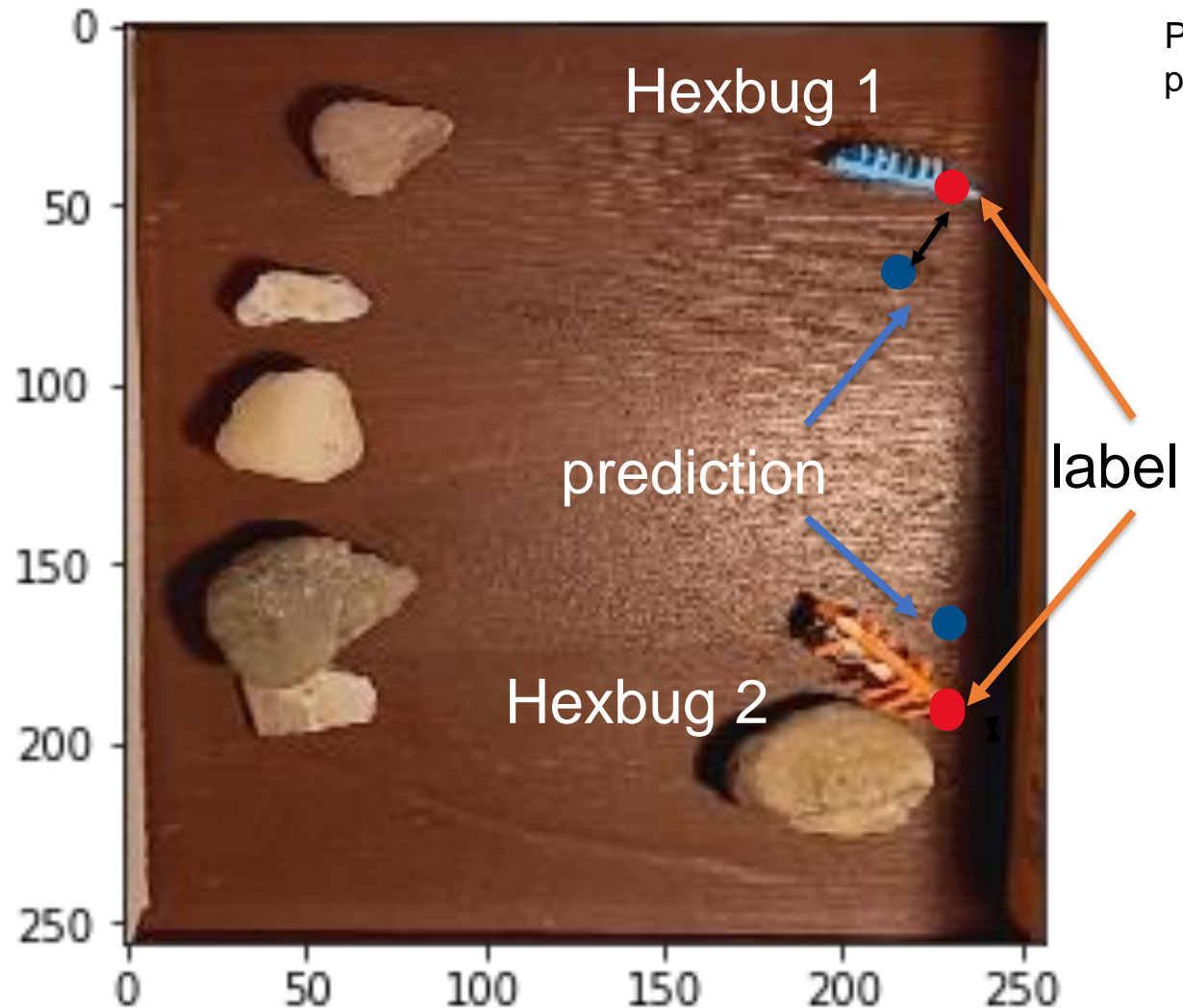


# The score...?

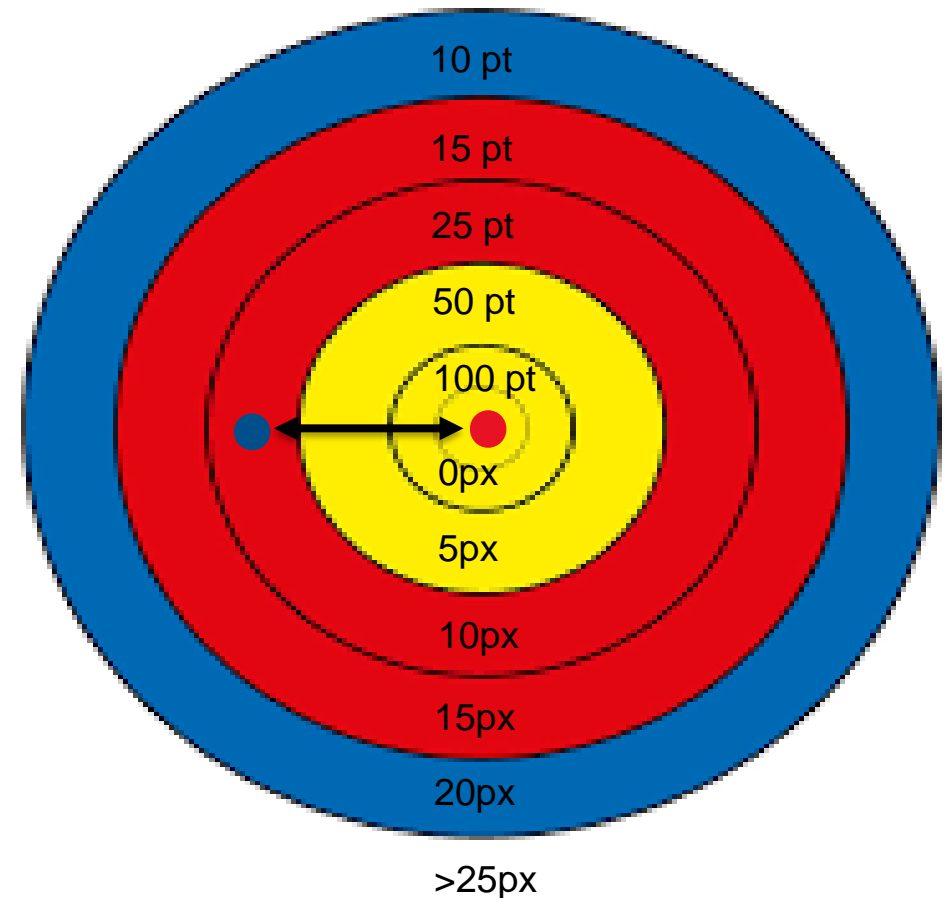


$$E = \sqrt{(x_1 - x_0)^2 + (y_1 - y_0)^2}$$

# How are the Points gathered



Points (pt) depending on the distance in pixel to the label  
1pt



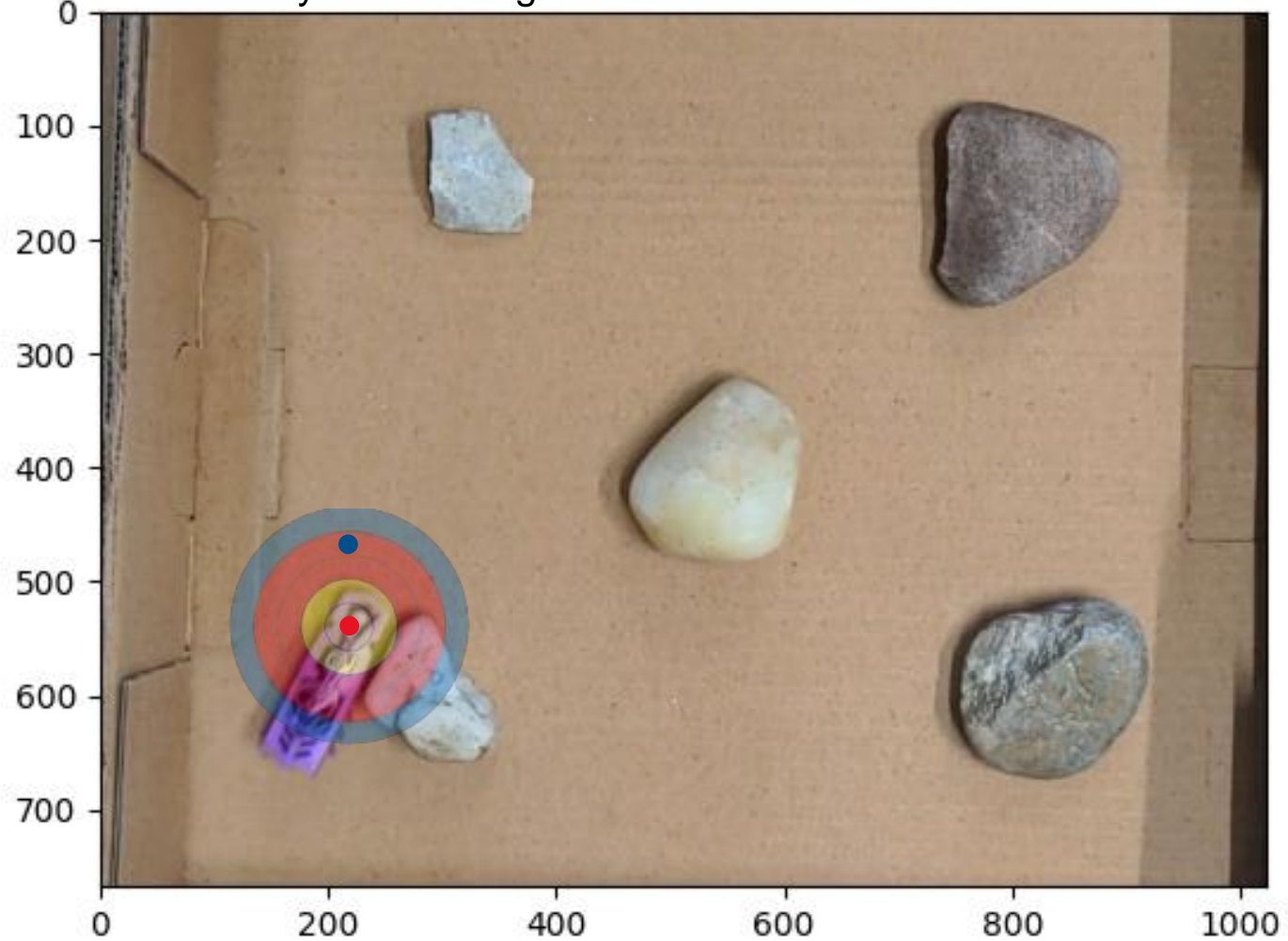
# Streaks

If you track the same hexbug over multiple frames and give it the same id then you are on streak.

Number of frames correctly tracked	Points of the hexbug get ...
0-19	x1
20-39	x2
40-59	x3
60-100	x4

Assumption: The Streak begins with 4 tracked correct in a row

There is only one hexbug which has the id: 0



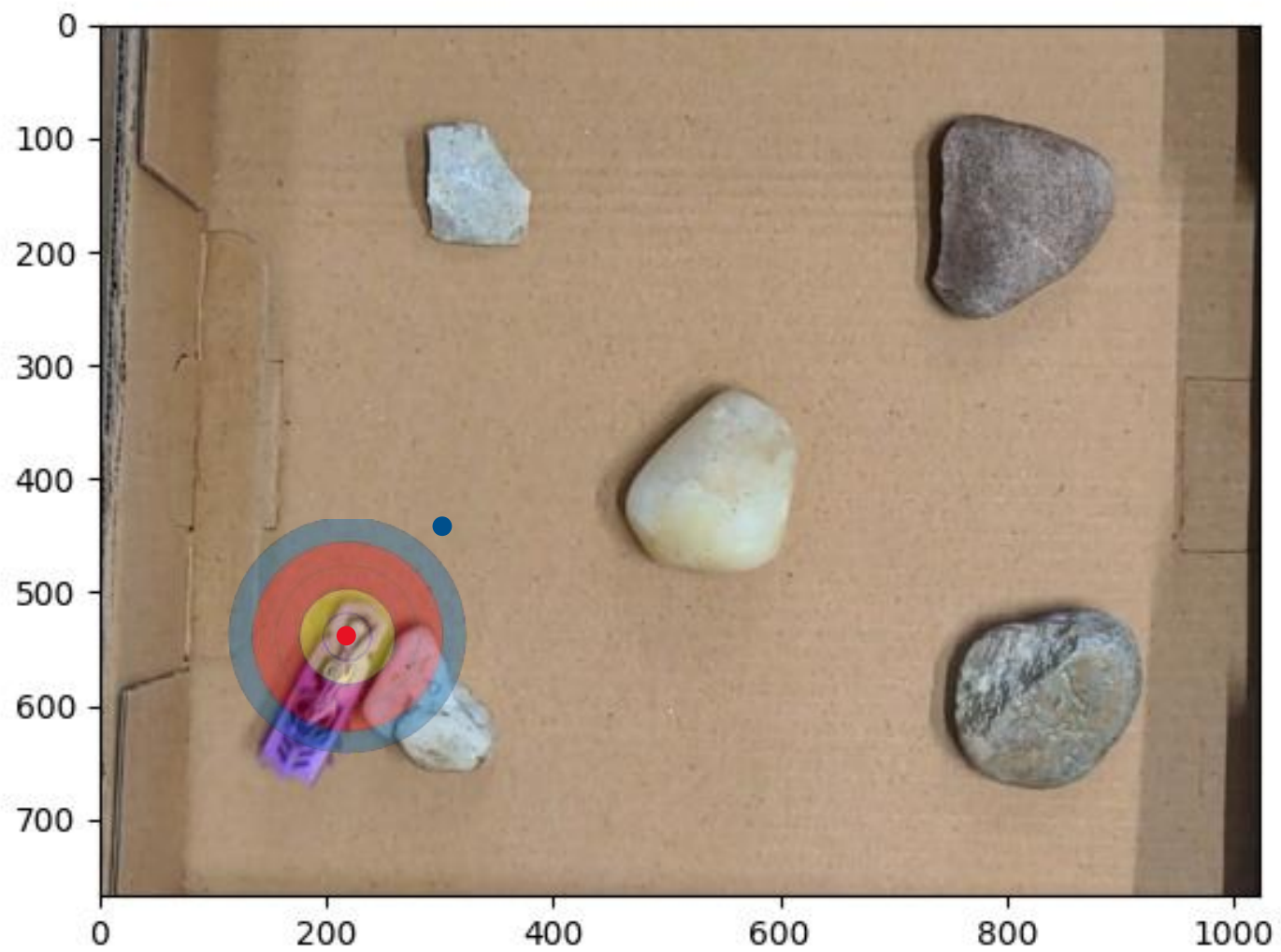
ID: 0

Points: 15

Streak: 0

Because this is the first frame  
the id: 0 from the label is  
connected to the id:0 from  
the prediction

Final Score: 15



ID: 0  
Points: 1  
Streak: 1

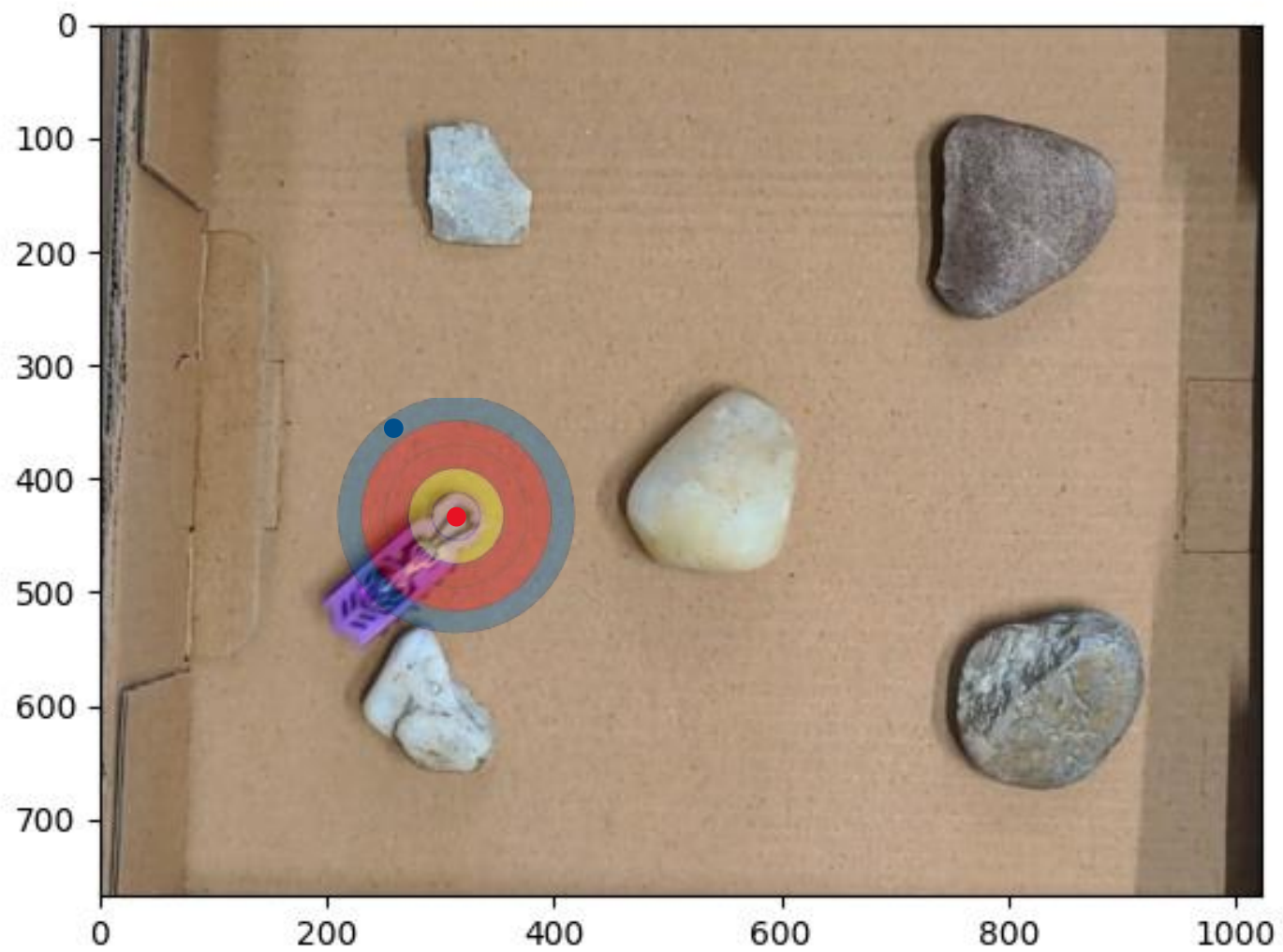
Final Score: 16



ID: 0  
Points: 50  
Streak: 2

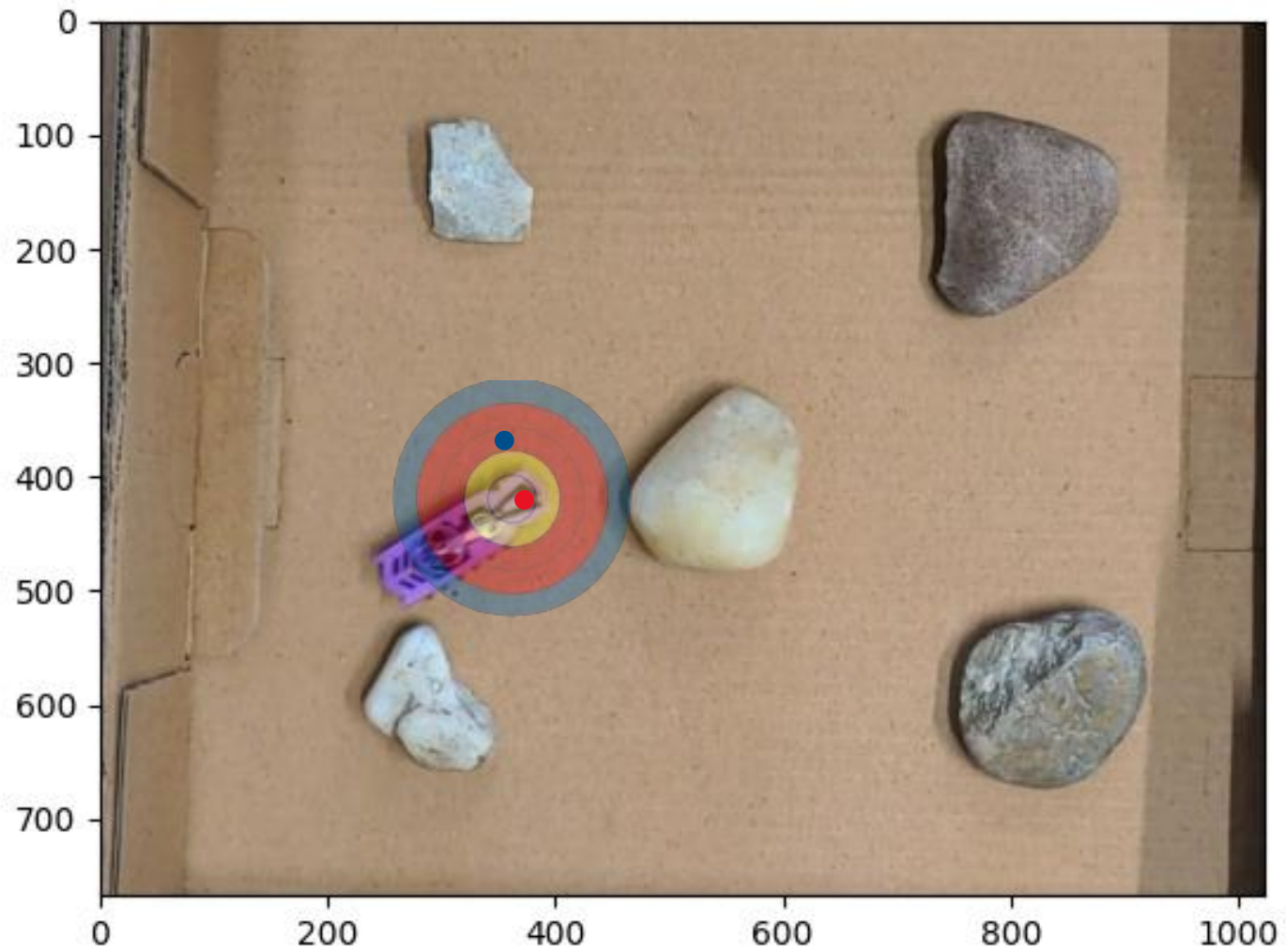
Final Score: 66





ID: 0  
Points: 10  
Streak: 3

Final Score: 76

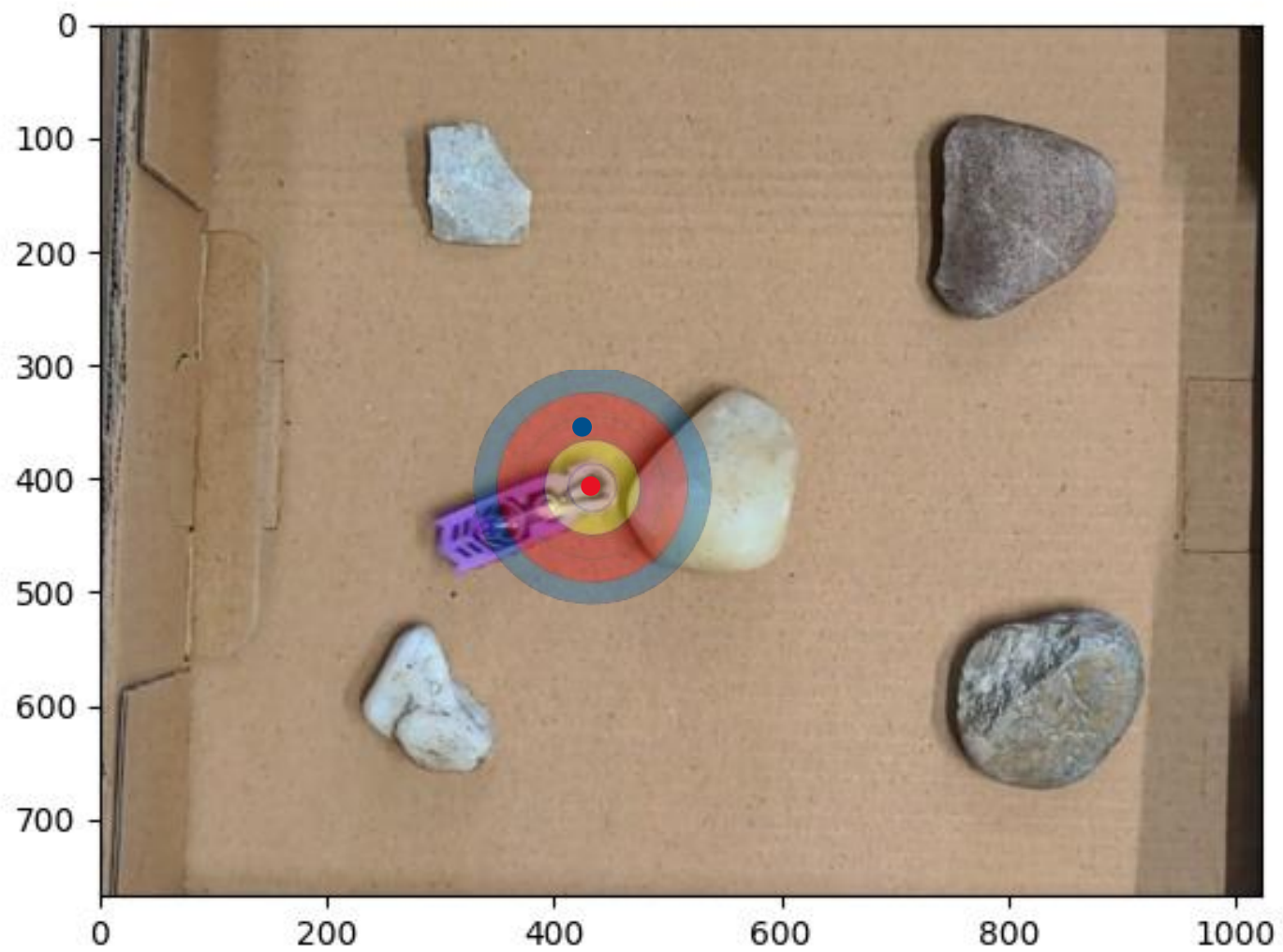


ID: 0  
Points: 25  
Streak: 4

-> x2

Final Score: 126

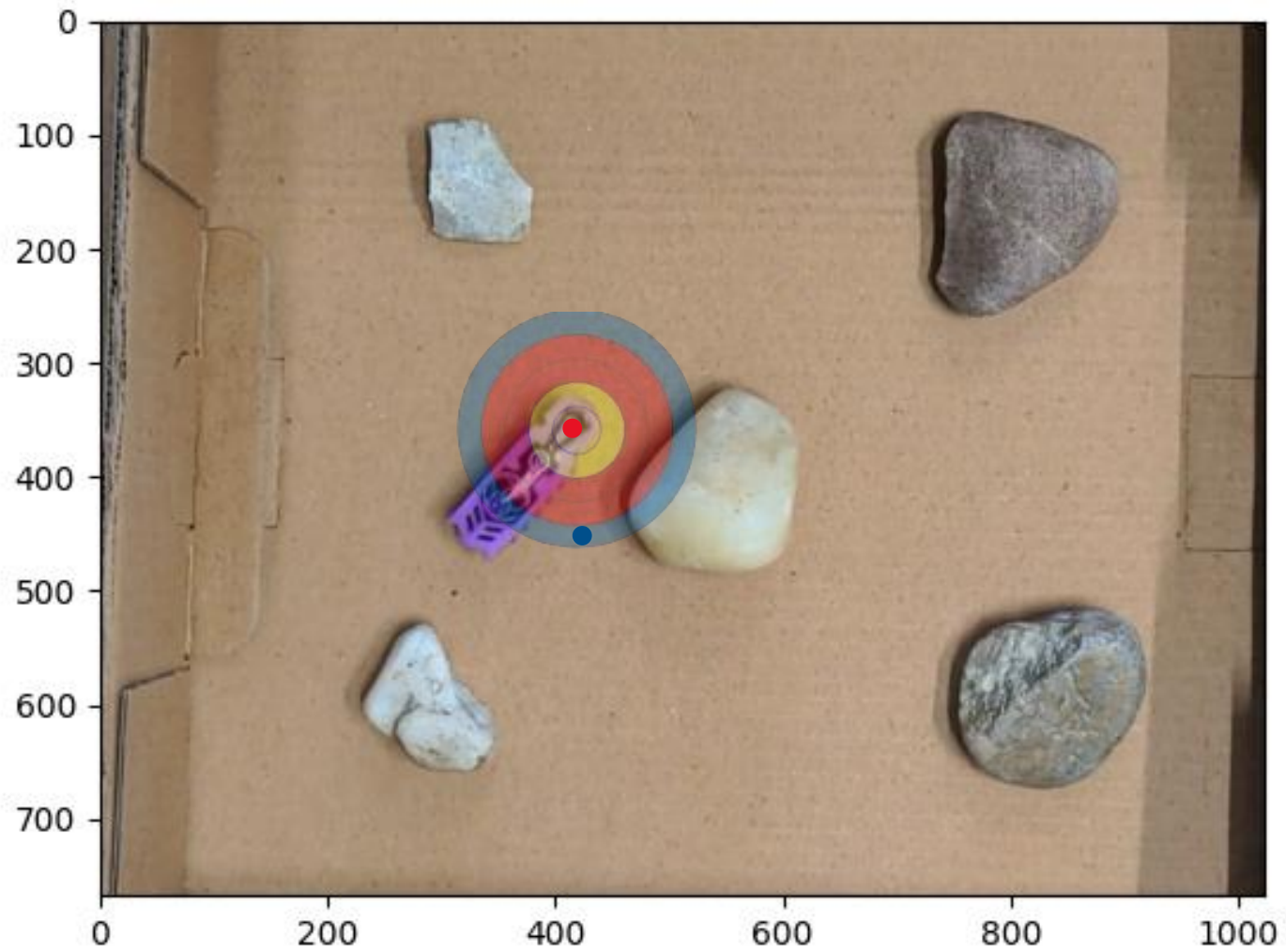




ID: 0  
Points: 25  
Streak: 5

-> x2

Final Score: 176



ID: 0  
Points: 10  
Streak: 6

-> x2

Final Score: 196



ID: 1

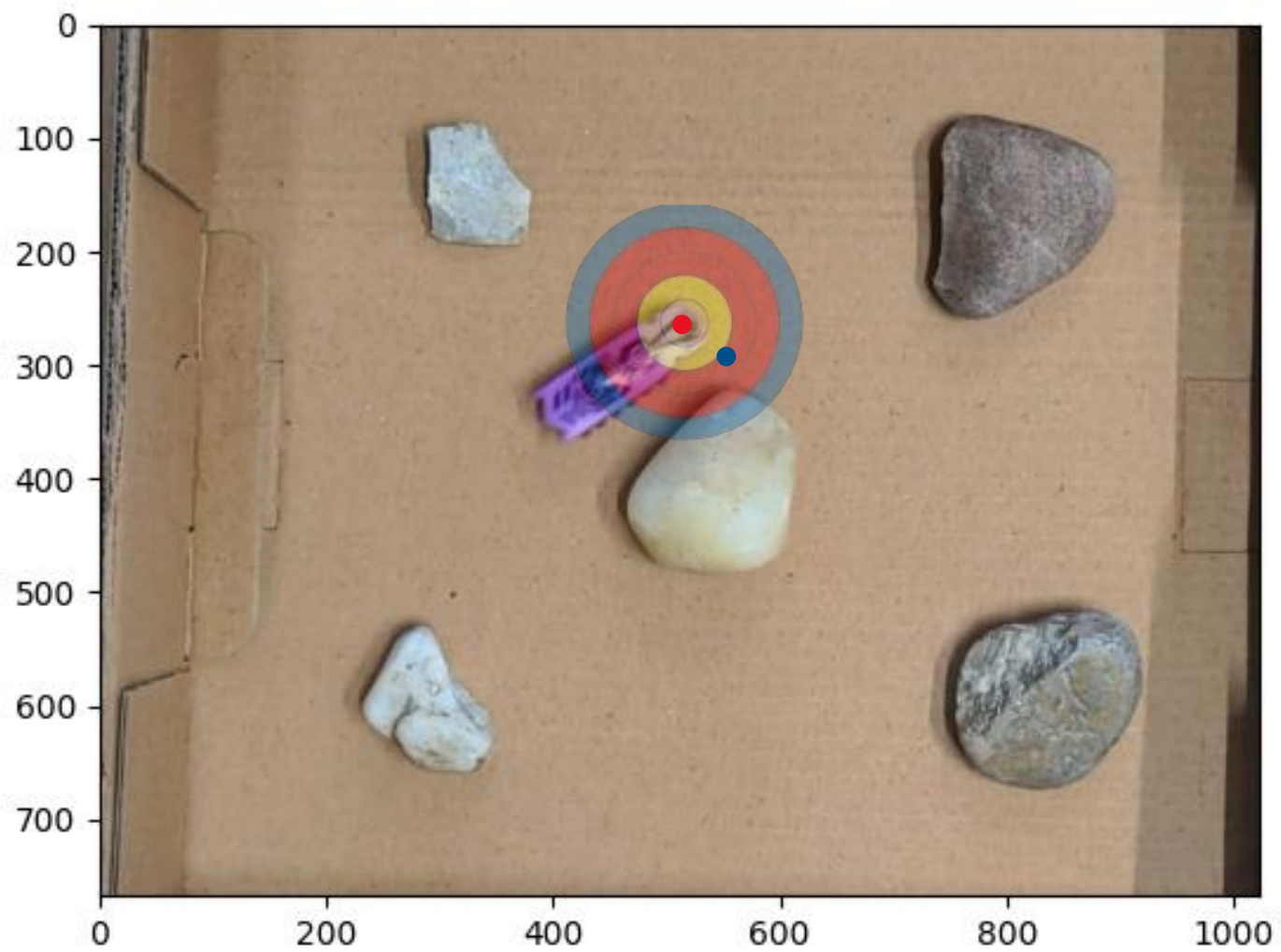
Points: 10

Streak: 0

-> -100 penalty

Final Score: 106

The id: 0 from the label is now  
connected to the id:1 from the  
prediction



ID: 1  
Points: 25  
Streak: 1

Final Score: 131



ID: 1  
Points: 15  
Streak: 2

Final Score: 145

# Submission of Files

- Has to be a csv in this format:

	t	hexbug	x	y
0	0	0	181	1414
1	0	1	139	1396
2	1	0	161	1389
3	1	1	34	1416
4	2	0	122	1422
5	2	1	35	1419
.	.	.	.	.
.	.	.	.	.

t: frame number

hexbug: ID of the  
hexbug

x,y: coordinates



# Example script

```
import csv

# Open a CSV file in write mode
with open('predicted_data.csv', mode='w', newline='') as csv_file:
    # Define the fieldnames for the CSV file
    fieldnames = ['', 't', 'hexbug', 'x', 'y']

    # Create a CSV writer object
    writer = csv.writer(csv_file)

    # Write the header row
    writer.writerow(fieldnames)
    idx = 0
    # Write data from the list to the CSV file
    for t, frame in enumerate(list_max_value_ordered):
        for hexbug, pos in enumerate(frame):
            x, y = pos
            writer.writerow([idx, t, hexbug, x, y])
            idx += 1

print("CSV file has been created successfully!")
```

# Have fun hunting your hexbug





# More information and Leaderboard

**anki**

[Home](#)

[Information](#)

[Teams](#)

[Sponsors](#)

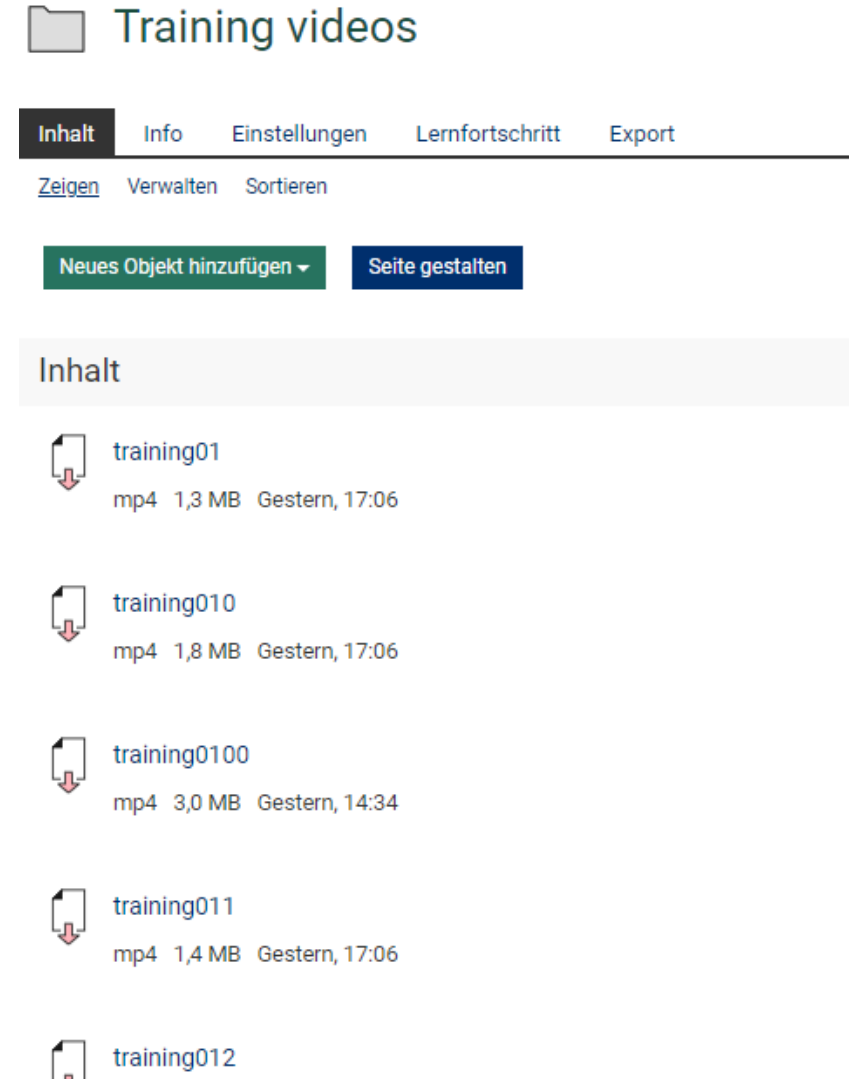
[Contact](#)

Tracking Olympiad (TRACO)



# The data

- Is on StudON in the data folder
- You receive mp4 files with traco/csv files



The screenshot shows the StudON interface for a folder named 'Training videos'. At the top, there is a folder icon and the title 'Training videos'. Below this is a navigation bar with tabs: 'Inhalt' (selected), 'Info', 'Einstellungen', 'Lernfortschritt', and 'Export'. Under the 'Inhalt' tab, there are links for 'Zeigen', 'Verwalten', and 'Sortieren'. Below these links are two buttons: 'Neues Objekt hinzufügen' (with a dropdown arrow) and 'Seite gestalten'. The main content area is titled 'Inhalt' and lists five files:

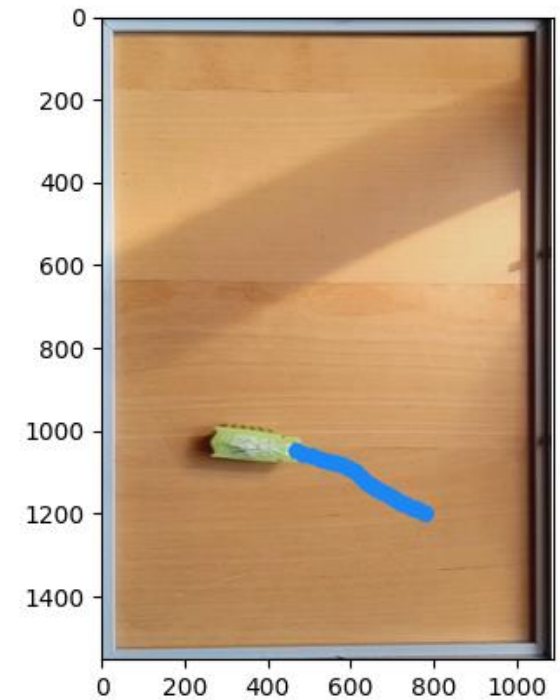
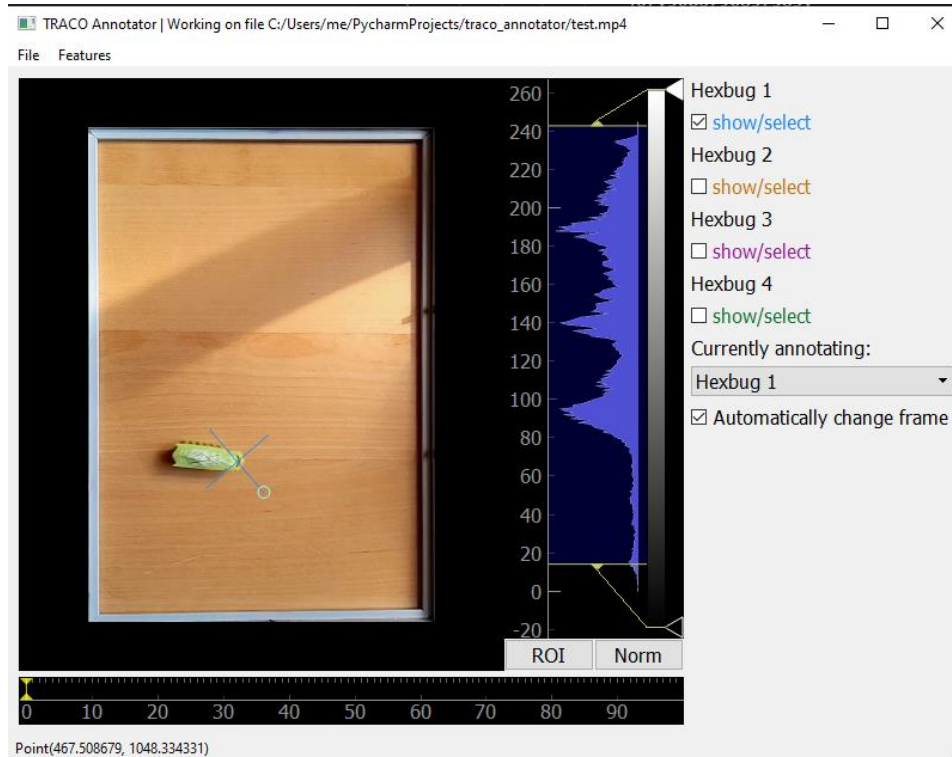
File Name	Format	Size	Time
training01	mp4	1,3 MB	Gestern, 17:06
training010	mp4	1,8 MB	Gestern, 17:06
training0100	mp4	3,0 MB	Gestern, 14:34
training011	mp4	1,4 MB	Gestern, 17:06
training012			

# The annotation

```
test.traco
1  {
2    "rois": [
3      {
4        "z": 0,
5        "id": 0,
6        "pos": [
7          467.5086790857383,
8          1048.334330825735
9        ]
10     },
11     {
12       "z": 1,
13       "id": 0,
14       "pos": [
15         486.343627490922,
16         1053.5662609382857
17       ]
18     },
19     {
20       "z": 2,
21       "id": 0,
22       "pos": [
23         506.2249619186159,
24         1060.8909630958572
25       ]
26     },
27     {
```

# Annotate new data

- You can record any data (we borrow you a Hexbug)
- We offer you our tracking software:  
[https://github.com/ankilab/traco\\_external](https://github.com/ankilab/traco_external)
- You can use Python to run the software 😊



# Timeline

Tuesday

Week 1 – Welcome and expectations, teams

Week 2 – Select algorithm and check data (already work!)

Week 3 – Basics of Computer Vision (Teaching unit)

Week 4 – Basics of deep neural networks (Teaching unit)

Week 5-13 – Algorithm presentations (27 Slots)

Week 14 – Inference with TEST data, final round

Friday

OPEN WORK

Interim

Algorithm Maybe

Interim

Algorithm Maybe

Interim

# Presenting algorithms

- Everyone presents 1 (!) **algorithm** about tracking, such that others can improve their repertoire.
- Each presentation should
  - Last max. 15 minutes (~ 15 slides)
  - Break down the algorithm, such that everyone can understand it!  
**I will ensure that you understood it.**
  - Implement the algorithm or use an existing implementation and test it (e.g. use it on HexBugs, reproduce one of the paper figures, make your own proof of concept).

→ All papers to be selected are online available!



# Available Topics

ID	Paper	Link	TL;DR		
1	Viola, Jones 2001	<a href="https://www.cs.cmu.edu/~efros/course">https://www.cs.cmu.edu/~efros/course</a>	Rapid Object Detection using a Boosted Cascade of Simple Features		
2	Lin et al. 2016	<a href="https://arxiv.org/pdf/1612.03144.pdf">https://arxiv.org/pdf/1612.03144.pdf</a>	Feature Pyramid Networks for Object Detection		
3	Pareira et al. 2022	<a href="https://www.nature.com/articles/s41598-022-13111-1">https://www.nature.com/articles/s41598-022-13111-1</a>	SLEAP: A deep learning system for multi-animal pose tracking		
4	Mathis et al., 2018	<a href="https://www.nature.com/articles/s41598-018-28344-2">https://www.nature.com/articles/s41598-018-28344-2</a>	DeepLabCut: markerless pose estimation of user-defined body parts with deep learning		
5	Pareira et al., 2018	<a href="https://www.nature.com/articles/s41598-018-28344-2">https://www.nature.com/articles/s41598-018-28344-2</a>	Fast animal pose estimation using deep neural networks		
6	Toshev et al., 2013	<a href="https://arxiv.org/abs/1312.4659">https://arxiv.org/abs/1312.4659</a>	DeepPose: Human Pose Estimation via Deep Neural Networks		
7	Wang et al., 2015	<a href="https://openaccess.thecvf.com/conference/2015/ICCV">https://openaccess.thecvf.com/conference/2015/ICCV</a>	Visual tracking using convolutional neural network layers		
8	Dosovitskiy et al., 2015	<a href="https://openaccess.thecvf.com/conference/2015/ICCV">https://openaccess.thecvf.com/conference/2015/ICCV</a>	Learning Optical Flow with CNNs		
9	Redmon et al., 2015	<a href="https://arxiv.org/abs/1506.02640">https://arxiv.org/abs/1506.02640</a>	You Only Look Once CNN for object detection		
10	Liu et al., 2015	<a href="https://arxiv.org/abs/1512.02325">https://arxiv.org/abs/1512.02325</a>	SSD: Single Shot detectors (competitor to YOLO)		
11	Liu et al., 2021	<a href="https://arxiv.org/abs/2103.14030">https://arxiv.org/abs/2103.14030</a>	Swin Transformer - SOTA object detection		
12	He et al., 2017	<a href="https://openaccess.thecvf.com/conference/2017/ECCV">https://openaccess.thecvf.com/conference/2017/ECCV</a>	Mask R-CNN		
13	Girschick et al., 2013	<a href="https://arxiv.org/abs/1311.2524">https://arxiv.org/abs/1311.2524</a>	R-CNN		
14	Ren et al., 2015	<a href="https://proceedings.neurips.cc/paper/">https://proceedings.neurips.cc/paper/</a>	Faster R-CNN		
15	Isard and Blake, 1998	<a href="https://link.springer.com/article/10.1007/s003710058331">https://link.springer.com/article/10.1007/s003710058331</a>	CONDENSATION: Improved Kalman filter technique for tracking		
16	Comaniciu et al., 2003	<a href="https://ieeexplore.ieee.org/document/1297889">https://ieeexplore.ieee.org/document/1297889</a>	Kernel-based Object Tracking		
17	Teknomo and Fernandez, 2015	<a href="https://arxiv.org/abs/1510.00889">https://arxiv.org/abs/1510.00889</a>	Fancy method using binary operations to gain background image		
18	Oliver et al., 2000	<a href="https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=900692">https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=900692</a>	Use of eigenvectors for background subtraction and blob tracking		
19	Lucas and Kanade, 1981	<a href="http://www-cse.ucsd.edu/classes/sp07/cv100/">http://www-cse.ucsd.edu/classes/sp07/cv100/</a>	Optical Flow computation using image registration		
20	Shi and Tomasi, 1994	<a href="https://ieeexplore.ieee.org/document/330688">https://ieeexplore.ieee.org/document/330688</a>	An algorithm to detect strong edges --> i.e. good features to track		
21	Smith and Brady, 1997	<a href="https://link.springer.com/article/10.1007/s003710058331">https://link.springer.com/article/10.1007/s003710058331</a>	A low-level method to find edges		
22	Barnich and Van Brockenbroeck, 2003	<a href="https://scholar.google.de/scholar_url?hl=de&amp;as_surl=https://www.researchgate.net/publication/220611721">https://scholar.google.de/scholar_url?</a>	Cool method that uses pixel proximity for universal background subtraction		

# Presenting papers

Day	Topic	Presenter	Topic
	17		
	18		
	22		Background
	20		
	21		
	23		Edge Detection
	15		
	16		
	1		Object tracking
	19		
	8		
	24		Optical Flow
	9		
	10		
	6		YOLO/SSD/DeepPose
	13		
	14		
	12		RCNN
	5		
	3		
	4		DeepLabCat/(S)LEAP
	2		
	7		
	11		The other cool stuff

In the same spreadsheet:

Go to „Dates“ and write your name next to the topic that you want to present. I pre-selected topics and dates, such that they are grouped towards a common topic.



# Meetings

- Tuesday 10 c.t. (i.e. 10.15 – 11.45)
  - General information
  - Paper presentations
  - Discussions
  - → you **should/must (your paper)** attend!
- Friday 10 c.t. (i.e. 10.15 – 11.45)
  - Voluntary (group) work
  - Someone is around and checking on you
  - → you **can** attend!
  - **EXCEPT ON THE INTERIM REPORTS and TALKS!**

# Friday Interim Reports

- This is a quick pitch meeting for everyone from every team!
- 3 Slides:
  - Your current idea (e.g. implementing algorithm XY)
  - The current status (e.g. show some training curves)
  - A meme of your choice representing your progress
- You may talk for 3 min (we have a stop watch!)

This is to keep everyone on track and engaged 😊

# The last week 17.07. – 21.07.

FRI  
(week  
before)

DEADLINE  
to submit  
your team  
videos

MO

TUE

WED

THU

FRI  
10 - 12



RUN FINAL INFERENCE ON CHALLENGE DATA

=> Get in touch with us, as we would arrange access to a workstation, such that you can run your code on the full challenge dataset.

# How do get your grade?

- Talk (50% of grade)
- Report in paper-style (50% of grade)
  - Outline: Introduction, Methods, Results, Discussion, References
- Documentation of your algorithm
- Code examples
- Additional work (annotations, custom data collections, etc.)
- 10-15 pages JMLR style

<https://de.overleaf.com/latex/templates/template-for-journal-of-machine-learning-research-jmlr-with-jmlr2e-dot-sty/vjcpxhvvztrjn>

