BIOHLIT

Development of algorithms and web service for automation of data analysis for the behavioral test «Morris Water Maze»

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JINR

On behalf of the BIOHLIT group

Joint Institute for Nuclear Research
Meshcheryakov Laboratory of Information Technologies
10 GRID2023
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10th International Conference
"Distributed Computing and Grid Technologies in Science and Education"

GRID 2023

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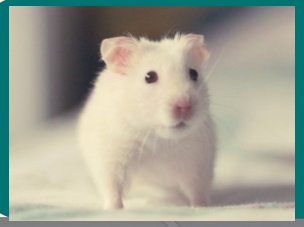

BIOHLIT: Web service for automation of data analysis for the «Morris Water Maze» behavioral test

(Joint project of MLIT and LRB JINR)

Within the framework of the joint project of MLIT and LRB JINR we created prototype of web service, which allows to automate the data analyses for «Morris Water Maze» behavioral test

The experiment performed on small laboratory animals (SLA) exposed to ionizing radiation.

To solve such problems, neural network approaches are actively implemented. Database development is the initial phase. To obtain the SLA movement trajectory in «Morris Water Maze» behavioral test an algorithm and web service were developed.

«Morris Water Maze»

behavioral test

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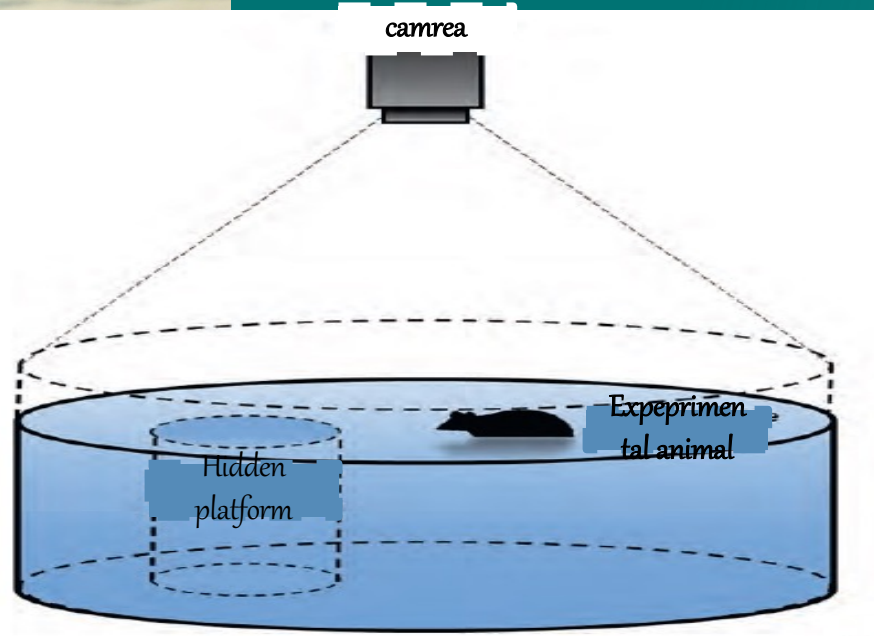

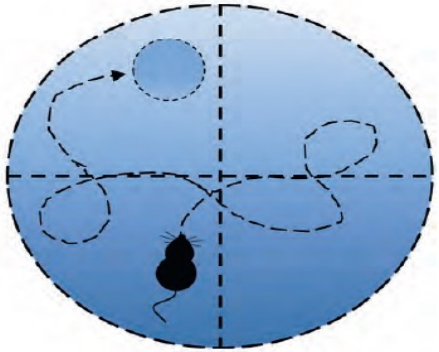

1. It's a critical test in neuroscience
2. Included in neurotoxicity test battery
3. Often used in pre-clinical studies

The test is developed to assess the spatial memory and learning process in SLA. For «Morris water maze» behavioral test visual, optical or olfactory orientations are not required.

There are 2 rodents group using in experiment

I. Group exposed to ionizing radiation
II. Control group

The experimental animal is placed in a circular pool filled with water. At the certain part the pool under a small layer of water is hidden a platform. During the experiment, the small laboratory animal must find and climb the platform. If platform is not found within 60 seconds, the experiment is stopped. The test is conducted in several stages in several days.

Pic: DOI 10.23946/2500-0764-2017-2-2-62-69

«Morris Water Maze»

behavioral test

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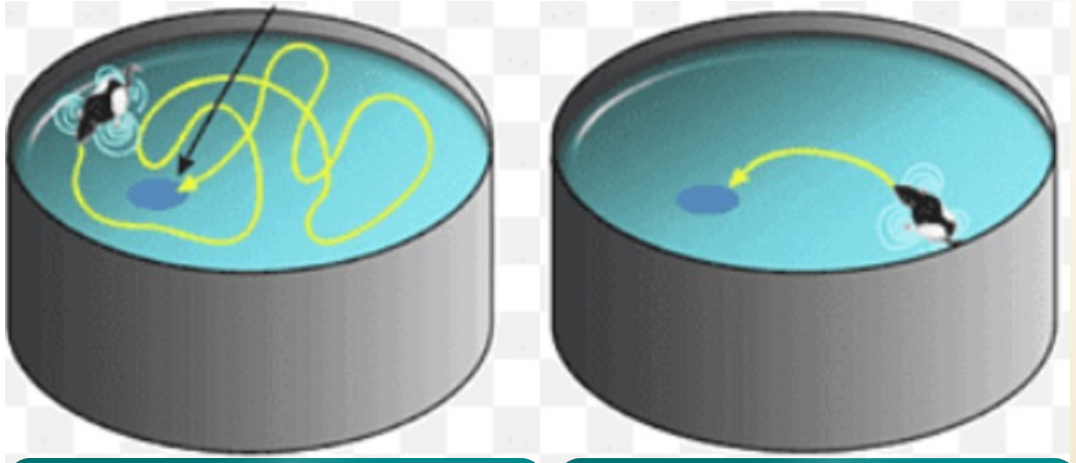
The SLA's trajectory, total distance, speed, time in the water are recorded. The trajectories vary depending on rodents central nervous system (CNS). For example, a normal (intact) rodent is more likely to find the platform with direct path, with very slight deviations. And a rodent that deviates or is exposed to external influences have hippocampus independ search strategies.

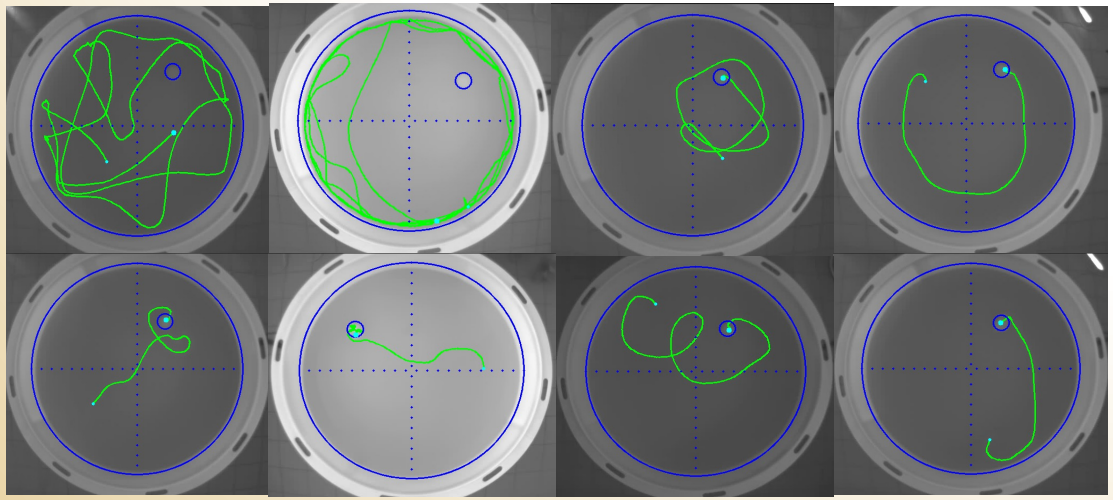
It has been proved that depending on its CNS damage, SLA can use different strategies to find the hidden platform.



Rodent with damaged CNS

Intact rodent

Pic: https://sg.news.yahoo.com/history-morris-water-maze-inception-181321698.html



The experiment is accumulating a huge amount of materials. To make the MWN tests analysis faster and more precise, this project aims to build an online framework to process the tests' data by firstly reconstructing the SLA trajectory in the labyrinth and then identifying the type of the reconstructed trajectory.

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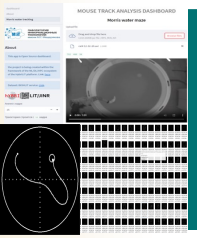


«Morris Water Maze»

behavioral test

GOALS

1. Development of an algorithm for constructing trajectories (creation of a training sample)

1. Creating a prototype of web service for dataset formation

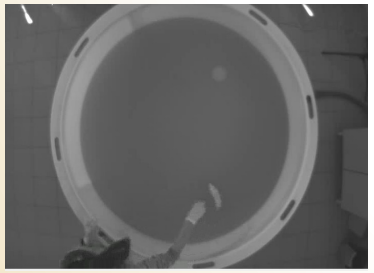
2. Creating a prototype of web service to classify the trajectories

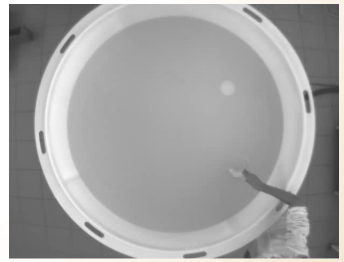
TASK: Object tracking

The approach is based on computer vision algorithms

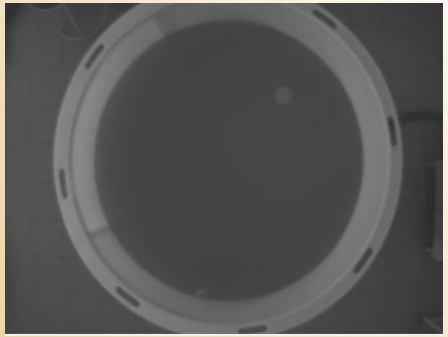
Algorithm development for trajectory construction (creating training sample)

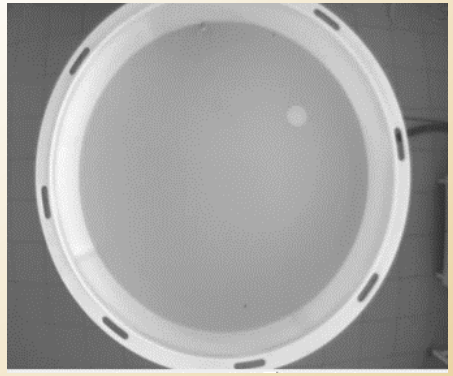
DIFICULTS





- Different conditions for each video/experiment (water reflection, lighting, movable background, size of lab. animal)
- Determination of the beginning of motion of a laboratory animal
- Problem with detecting moving object





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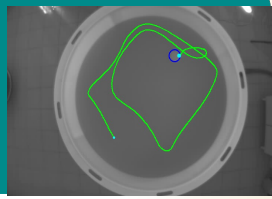
TASK: Object tracking

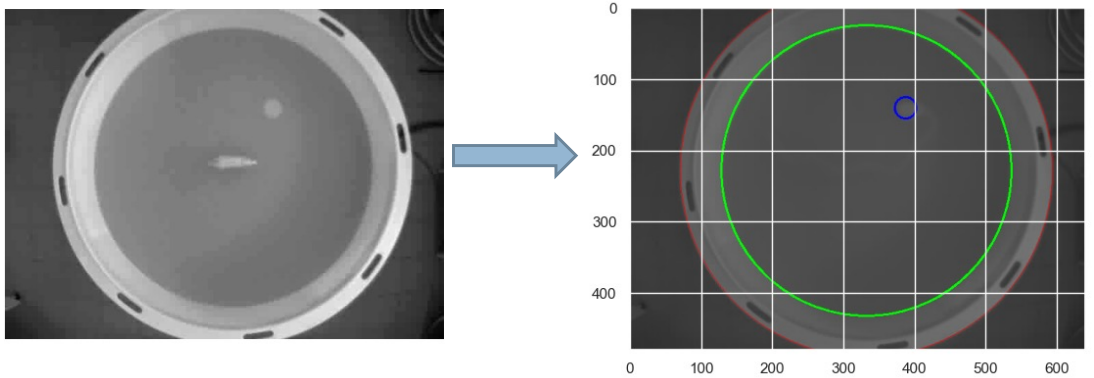
The approach is based on computer vision algorithms



Algorithm development for trajectory construction (creating training sample)

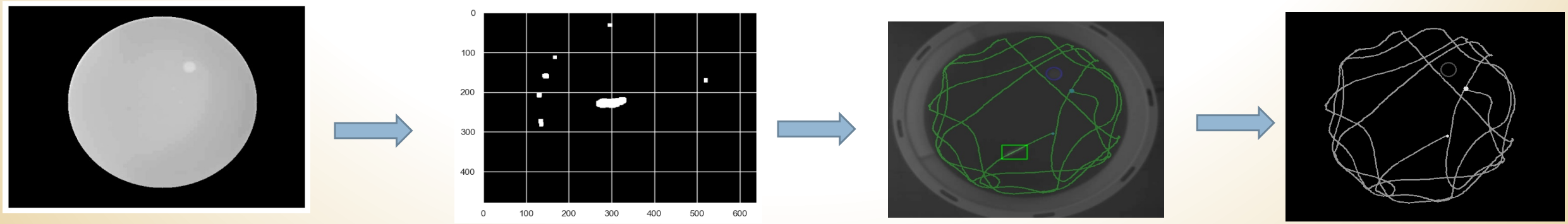
Algorithm

- Median image construction
- Filtering
- Hough transformation



Setup field marking

- Finding external boundary of the pool
- Finding internal boundary (ROI)
- Finding platform location



Tracking (modification):

Addition of local tracking (after detection of object on first frames, further detected in limited area)

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Prototype web service for dataset of «Morris Water Maze» behavioral test

dashboard
About
Morris water trecking

ЛАБОРАТОРИЯ ИНФОРМАЦИОННЫХ ТЕХНОЛОГИЙ имени М.Г. Мещерякова

About

This app is Open Source dashboard.

the project is being created within the framework of the ML/DL/HPC ecosystem of the HybriLIT platform. Link: here.

Dataset: BIOHLIT service: Link.

hYBRI LIT/JINR

Анализ с кадра:

15

Траектория строится с 15 кадра

MOUSE TRACK ANALYSIS DASHBOARD

Morris water maze

Upload file

Drag and drop file here
Limit 200MB per file • MP4, MOV, AVI
Browse files

rat4 12-32-20.avi 1.9MB

752 480 30

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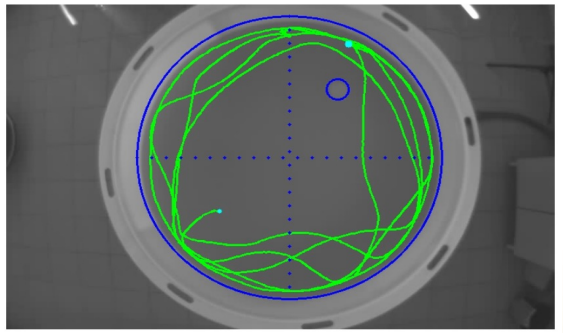
Траектория строится с 15 кадра

12

Траектория



Morris water trecking

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Анализ с кадра:

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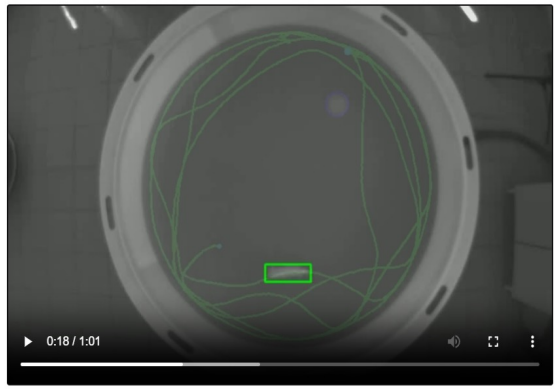
Траектория строится с 15 кадра

Видео файл для проверки правильности построенной траектории

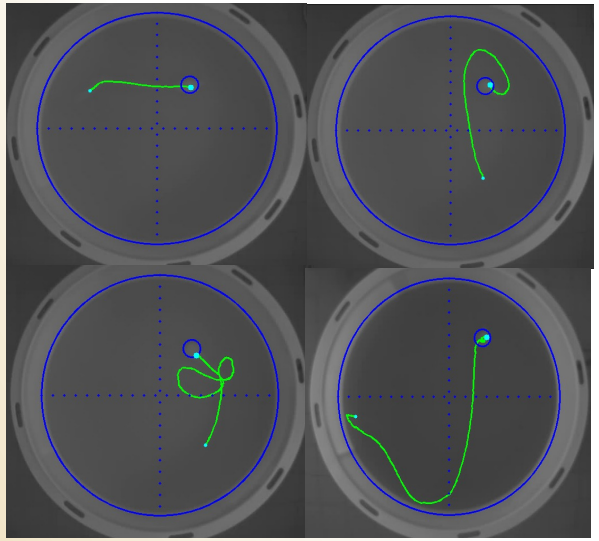
Запись видеофайла с FPS =

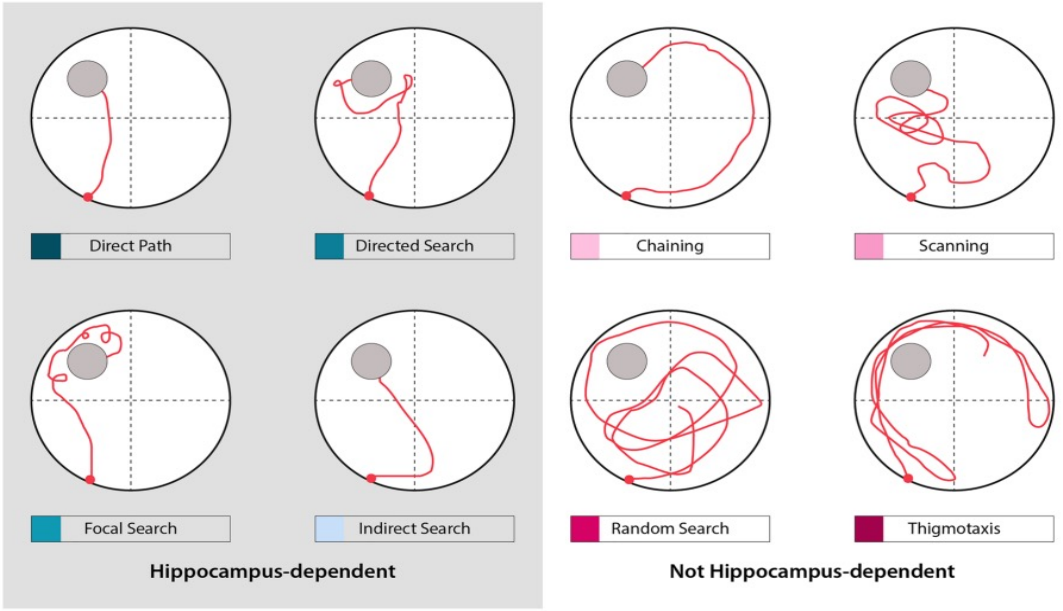
30

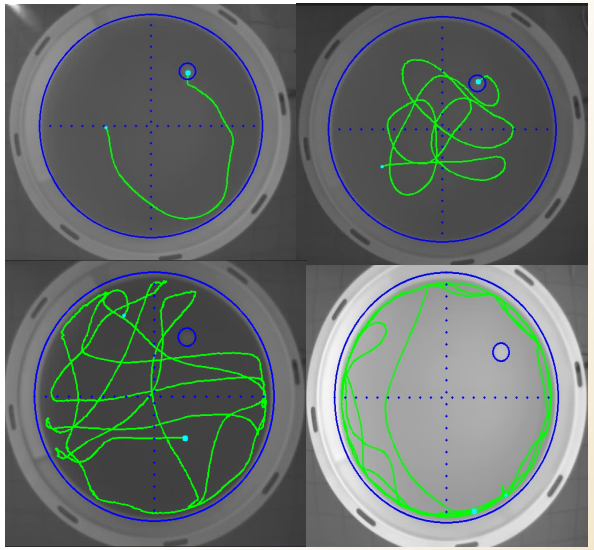
The current FPS is 30



Trajectory classification







Search strategy analysis of Tg4-42 Alzheimer Mice in the Morris Water Maze reveals early spatial navigation deficits Nadine Curdt, Franziska Schmitt, Caroline Bouter at all Springer Nature Logo March 2022 Scientific Reports 12(1):5451 DOI: 10.1038/s41598-022-09270-1 LicenseCC BY 4.0

SCIENTIFIC REPORTS
nature research

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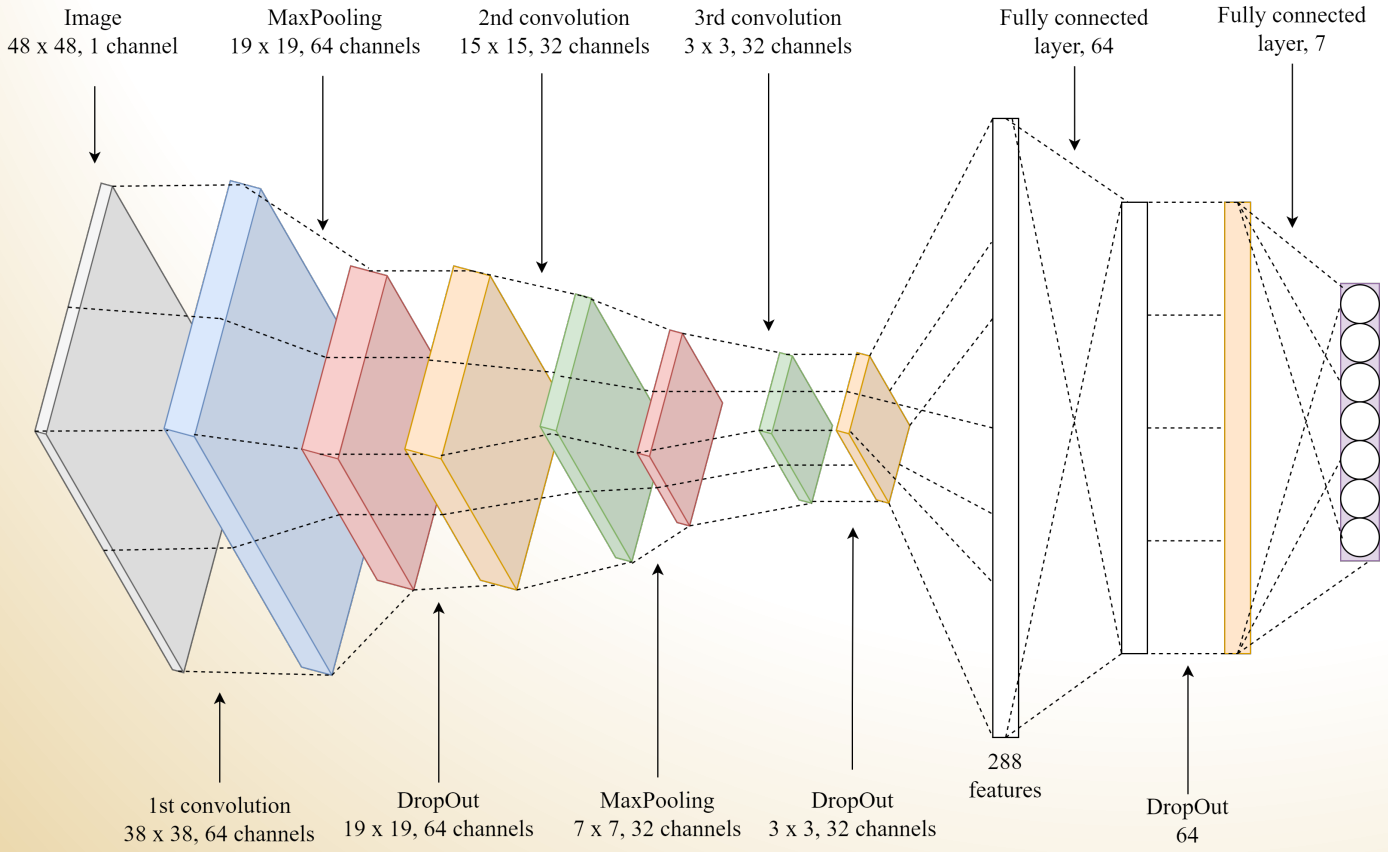
Development of an algorithm based on a **neural network approach** for trajectory classification «Morris Water Maze» behavioral test

Neural network architecture



Keras

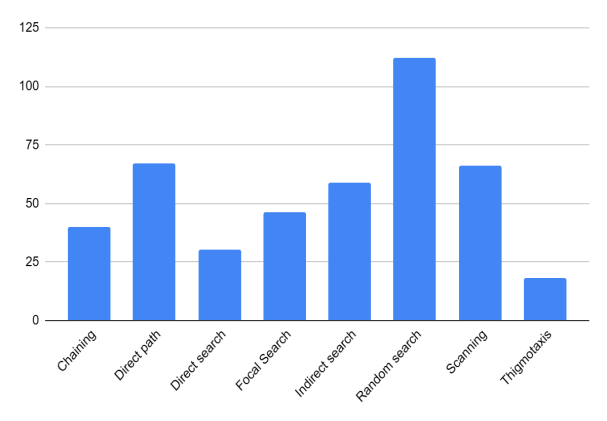
PyTorch

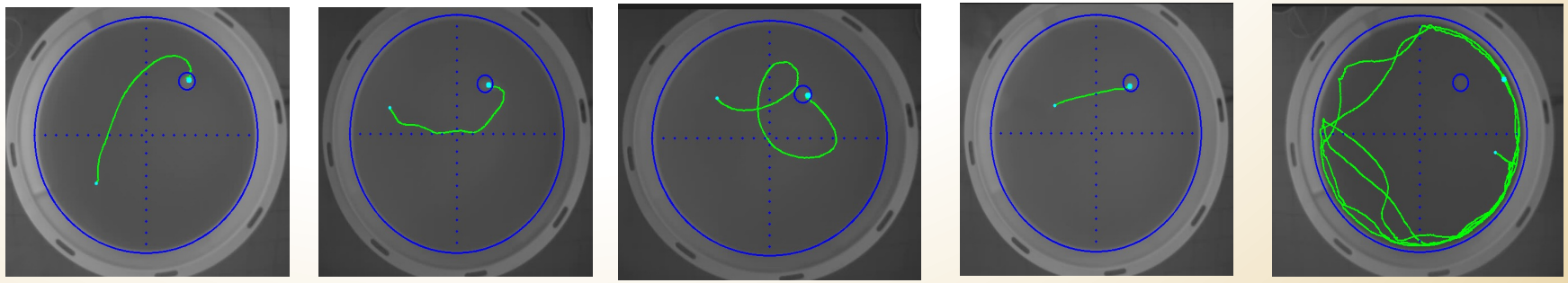
BIOHLIT

Development of an algorithm based on a neural network approach for trajectory classification

Flews of dataset:

- It is a fairly small set (~ 475 images)
- Significant imbalance (8 classes)
- Trajectories are not always detected (trajectory/line size problem)
- Trajectories of different classes are very similar, which negatively affects the quality of the model





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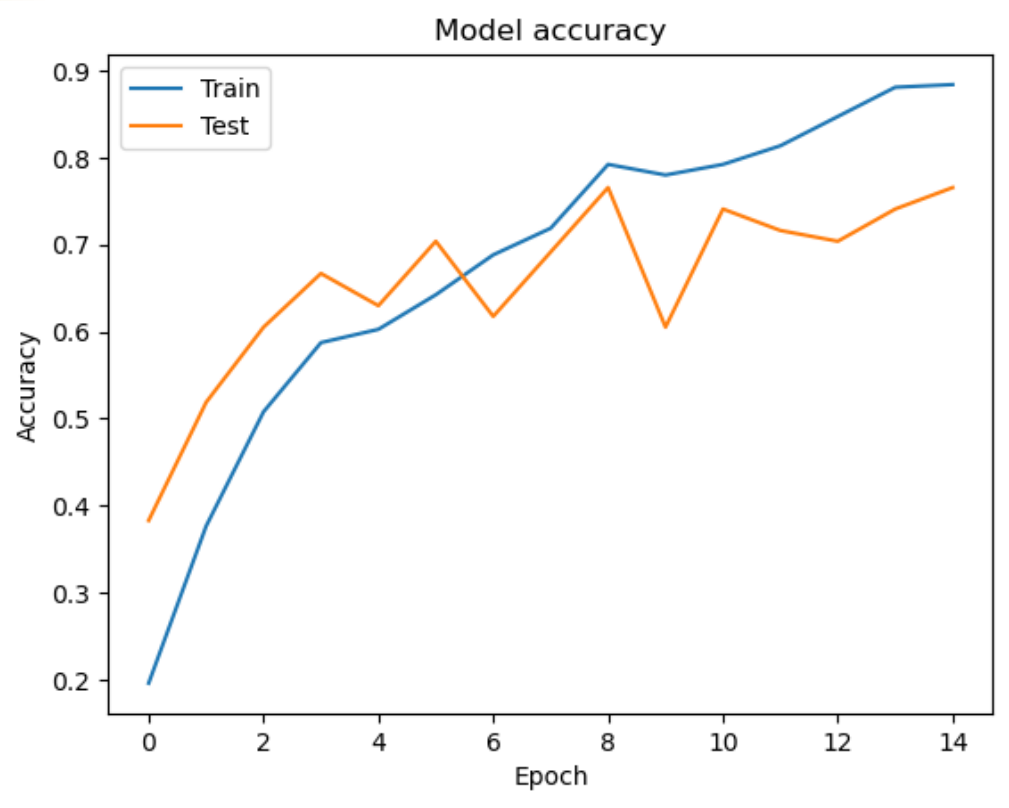
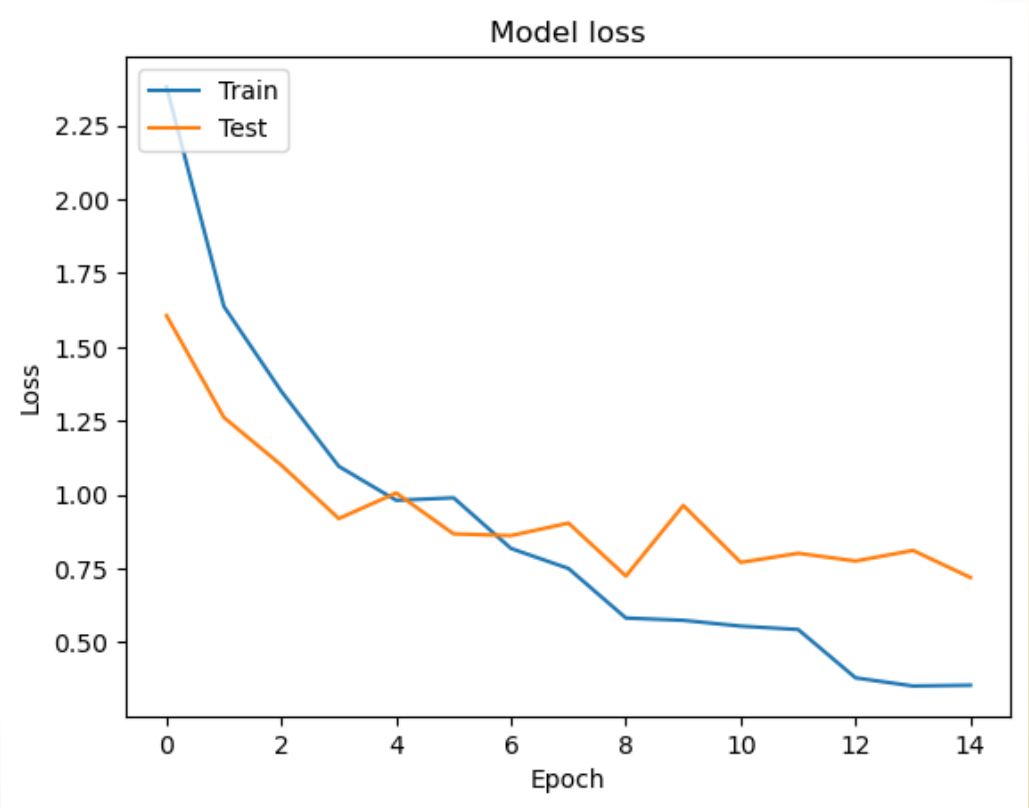
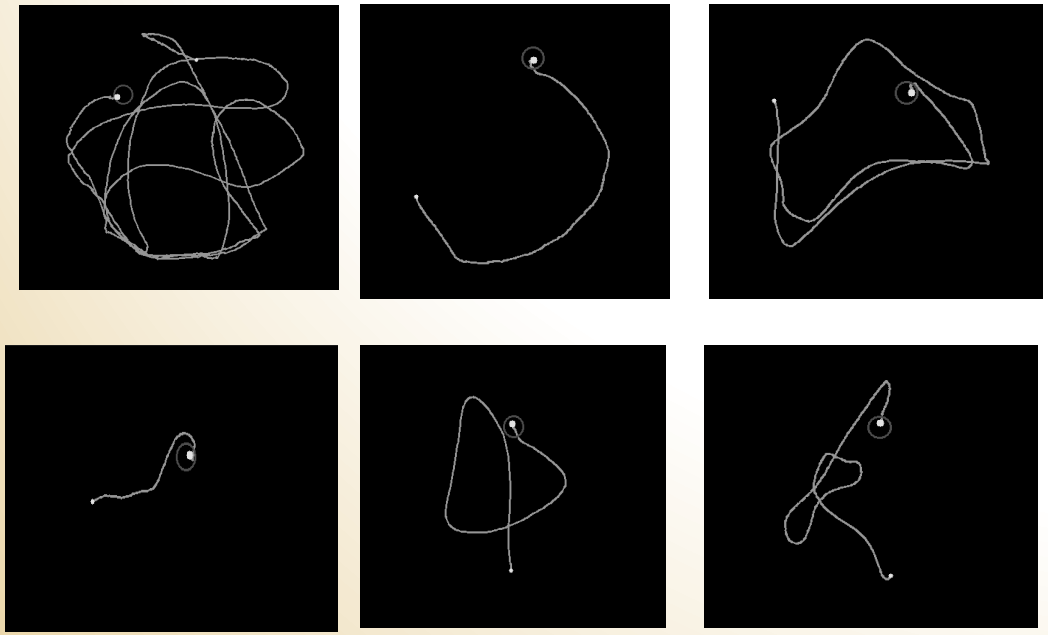




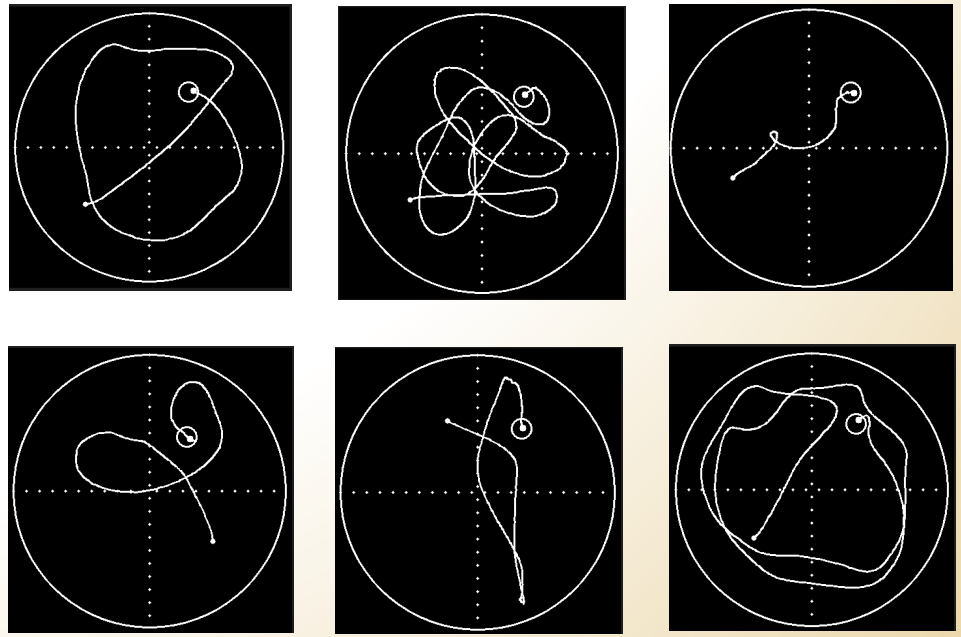
Development of an algorithm based on a neural network approach for trajectory classification «Morris Water Maze» behavioral test

Dataset generating

Approach 1



Approach 2



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RESULTS

1. Developed and tested algorithm for more than 475 experimental data (video files)
2. Created a training sample for more than 475 trajectories
3. Received trajectories are annotated
4. Developed prototype of a Web service for dataset
5. Developed prototype of a Web service based on a neural network approach for classifying the trajectories

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Thank you for your

Save our trajectory