

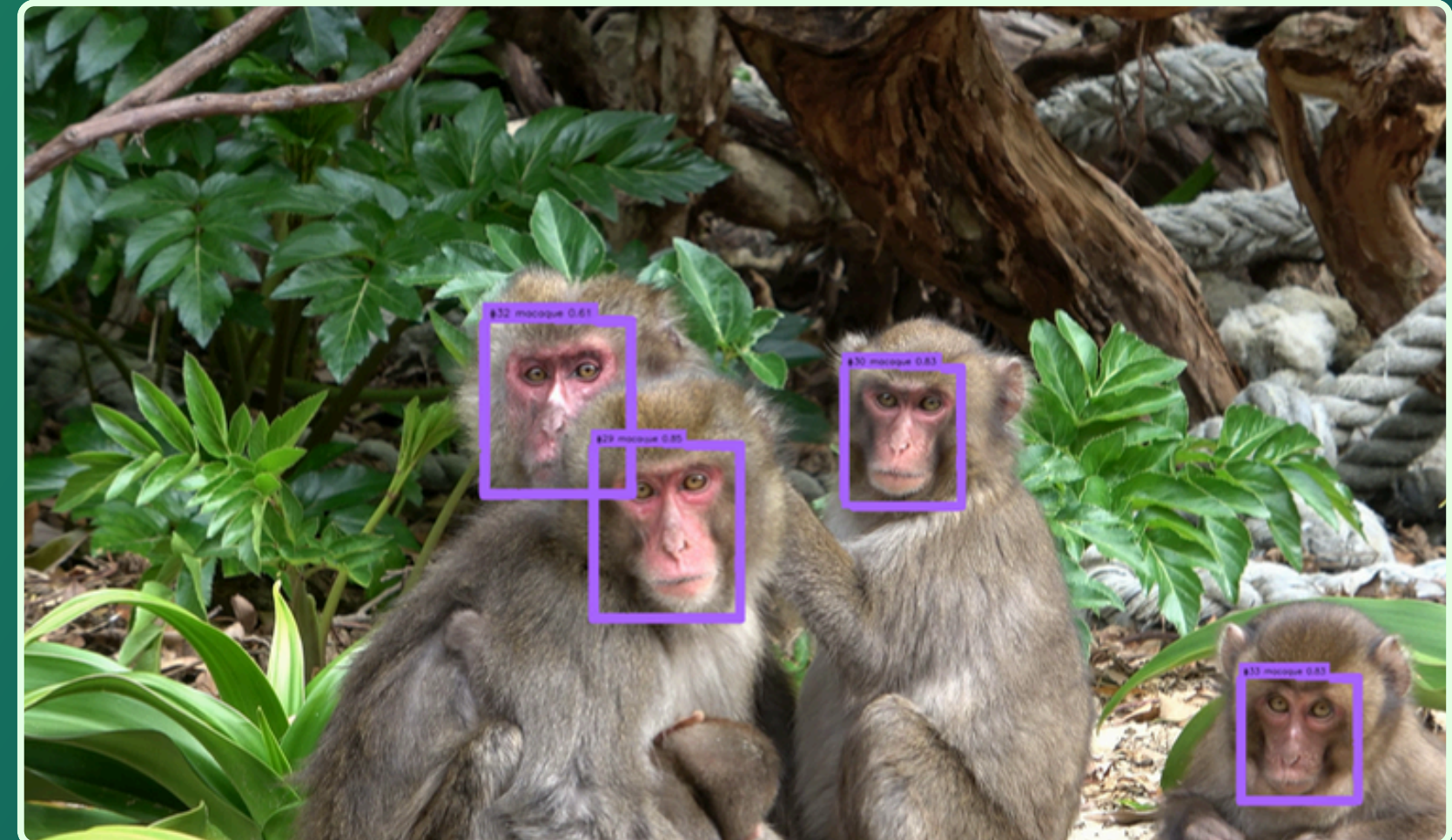
DEEP LEARNING FOR FACIAL & BEHAVIORAL RECOGNITION IN JAPANESE MACAQUES

TOWARD A COMPREHENSIVE AI-DRIVEN PRIMATE SOCIETY STUDY

Julien Paulet

Supervised by Cédric Sueur & Shinya Yamamoto

IN2P3/IRFU Machine Learning
Workshop 2024



PROJECT CONTEXT

Field of study

Ethology
Study of Animal Behavior

...and so on

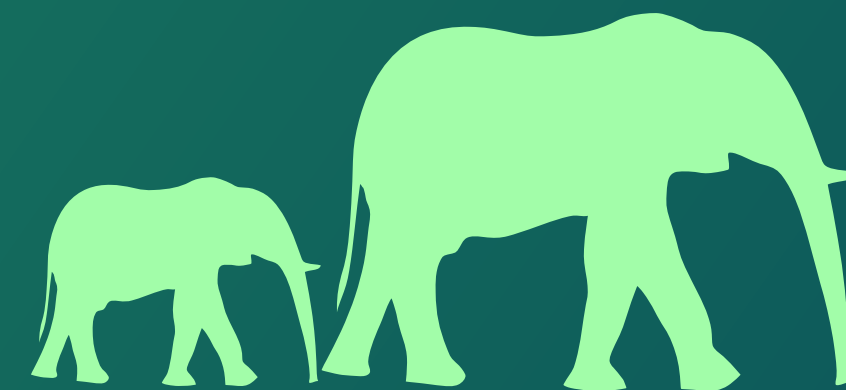
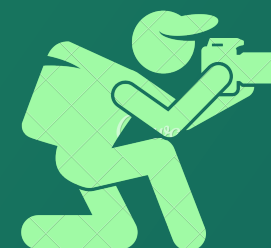
Feeding & Predation

Communication

Reproduction

Orientation & Migration

Cognition



PROJECT CONTEXT

Ethological framework

Animal societies



PROJECT CONTEXT

Ethological framework

Animal societies

- Large & enduring cooperative groups



PROJECT CONTEXT

Ethological framework

Animal societies

- Large & enduring cooperative groups
- Social organisation



PROJECT CONTEXT

Ethological framework

Animal societies

- Large & enduring cooperative groups
- Social organisation
- Intra-specific diversity ? Which determinants ?



PROJECT CONTEXT

Ethological framework

Animal societies

- Large & enduring cooperative groups
- Social organisation
- Intra-specific diversity ? Which determinants ?
- Animal culture



PROJECT CONTEXT

Ethological framework

Animal societies

- Large & enduring cooperative groups
- Social organisation
- Intra-specific diversity ? Which determinants ?
- Animal culture
- Unique behaviors to specific population, socially transmitted

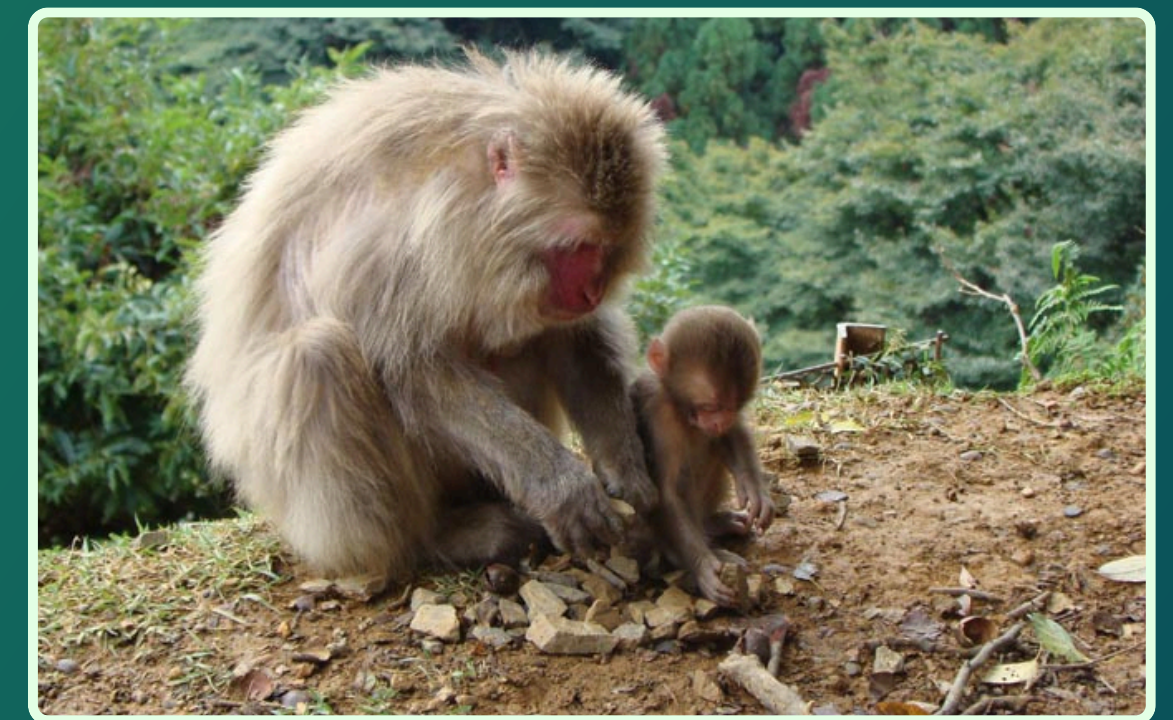
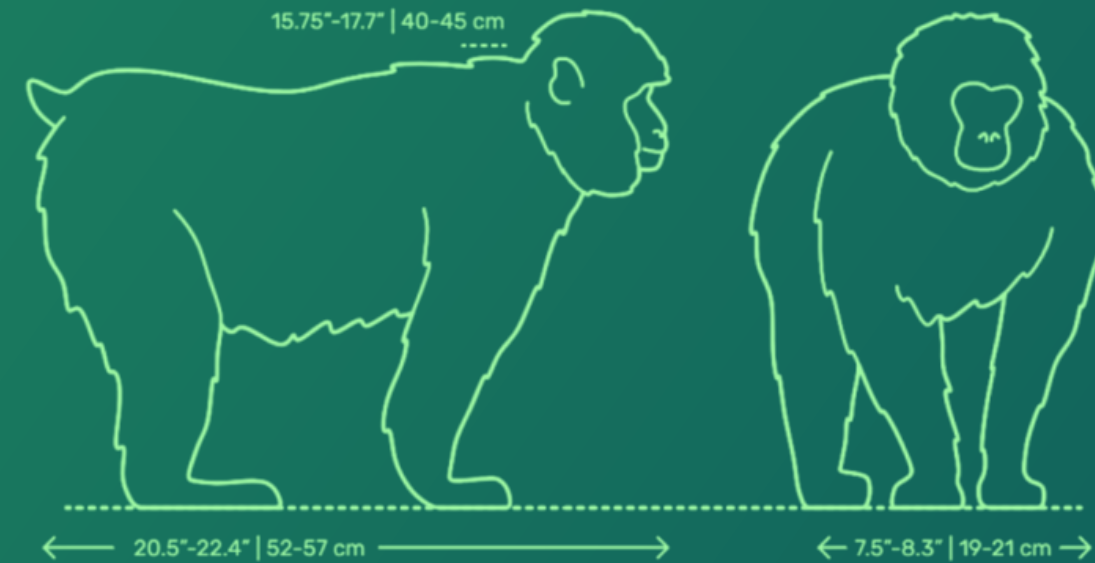


PROJECT CONTEXT

Study model

Animal societies

Japanese Macaques
Macaca fuscata



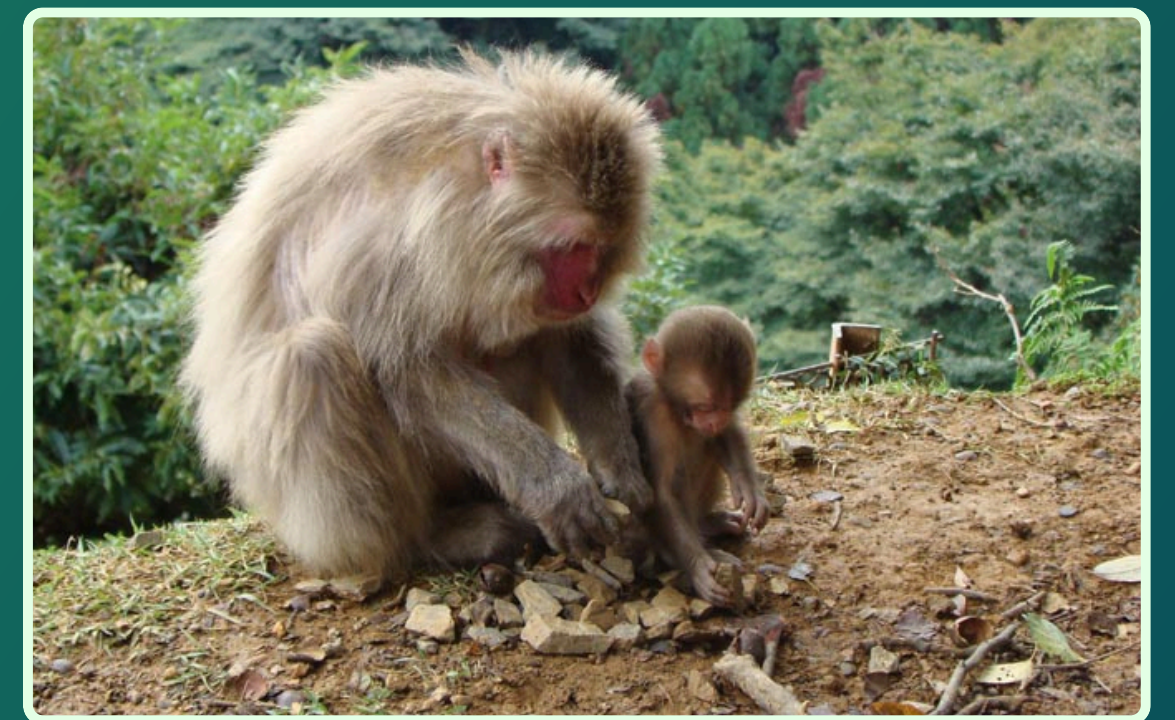
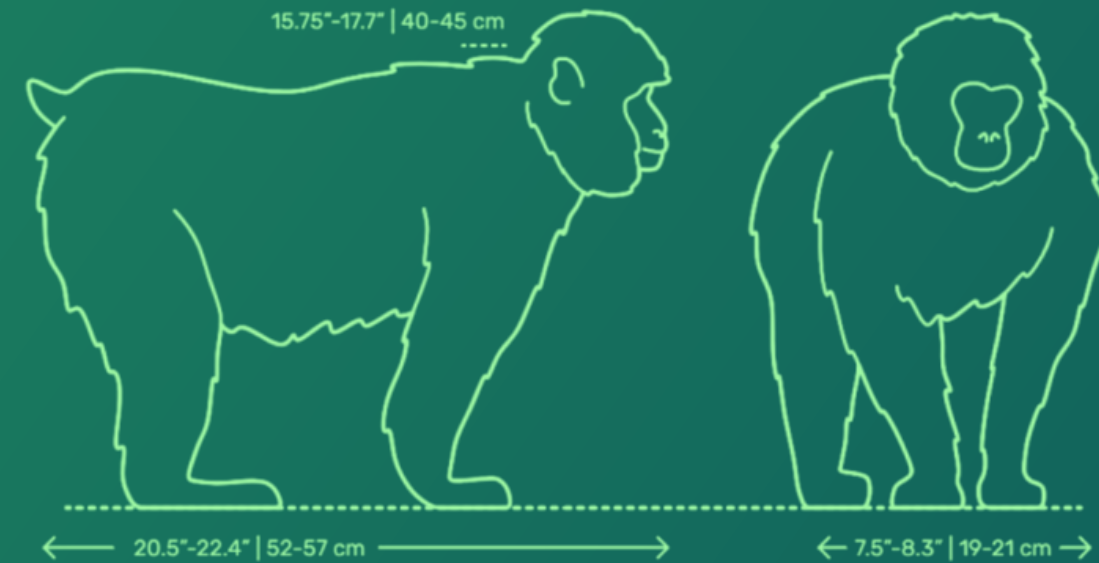
PROJECT CONTEXT

Study model

Animal societies

Japanese Macaques
Macaca fuscata

Multiple populations



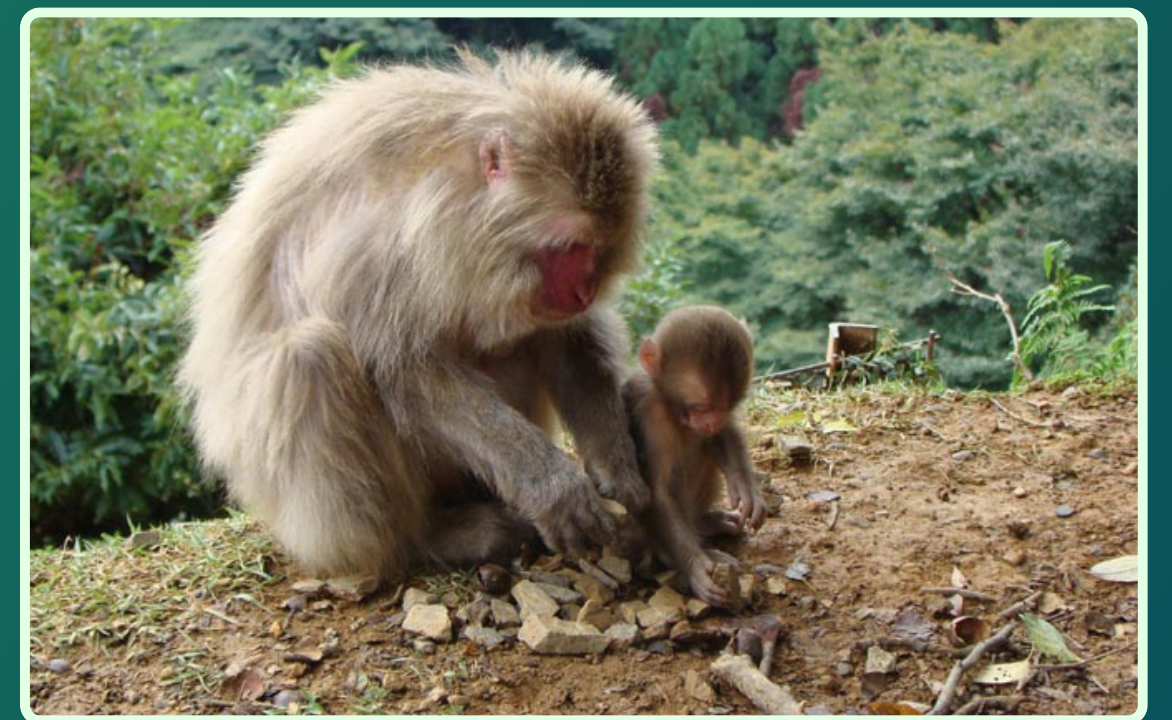
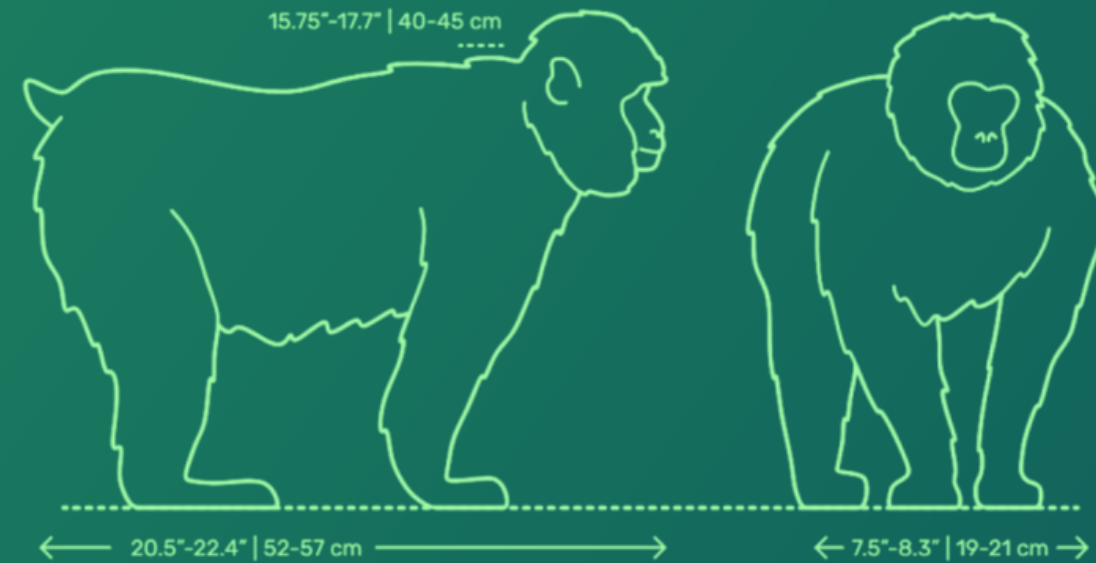
PROJECT CONTEXT

Study model

Animal societies

Japanese Macaques
Macaca fuscata

- Multiple populations
- Social Organisation



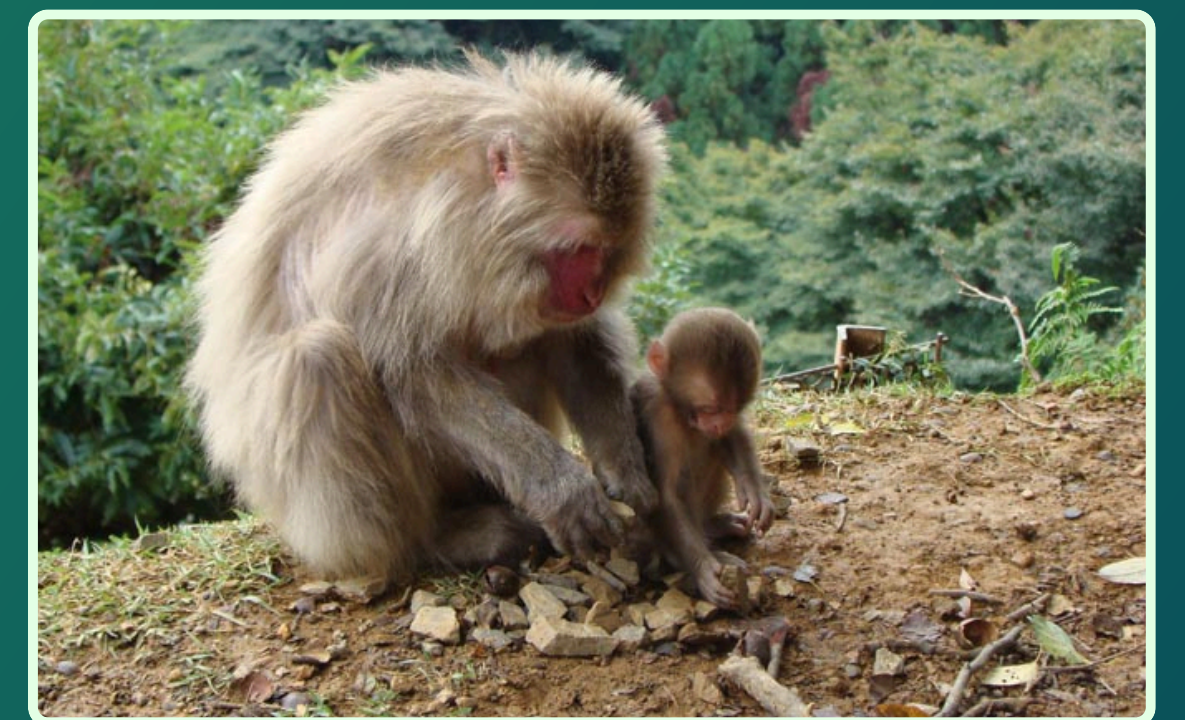
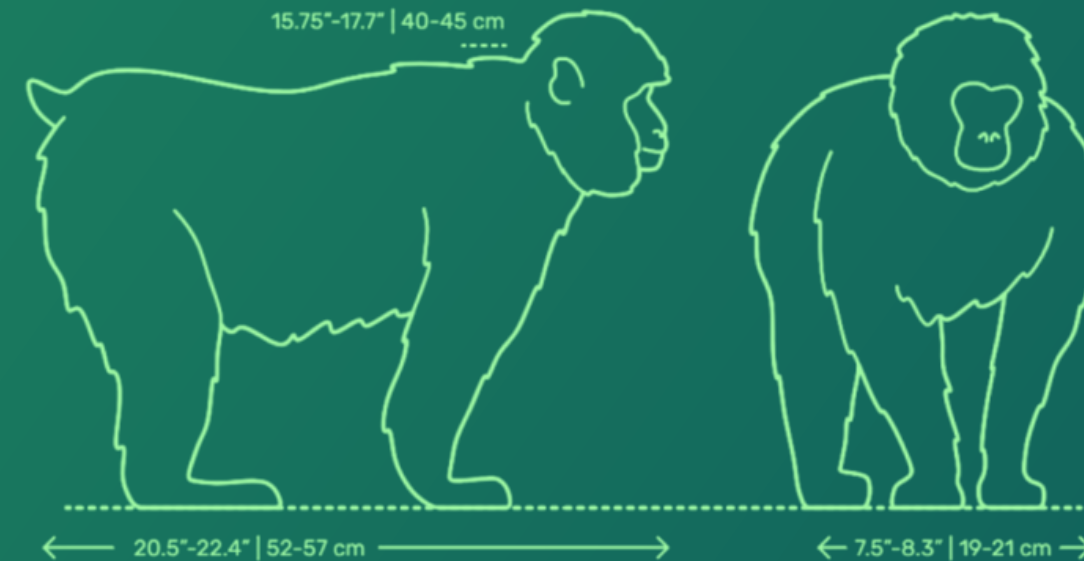
PROJECT CONTEXT

Study model

Animal societies

Japanese Macaques
Macaca fuscata

- Multiple populations
- Social Organisation
- Cultural traits



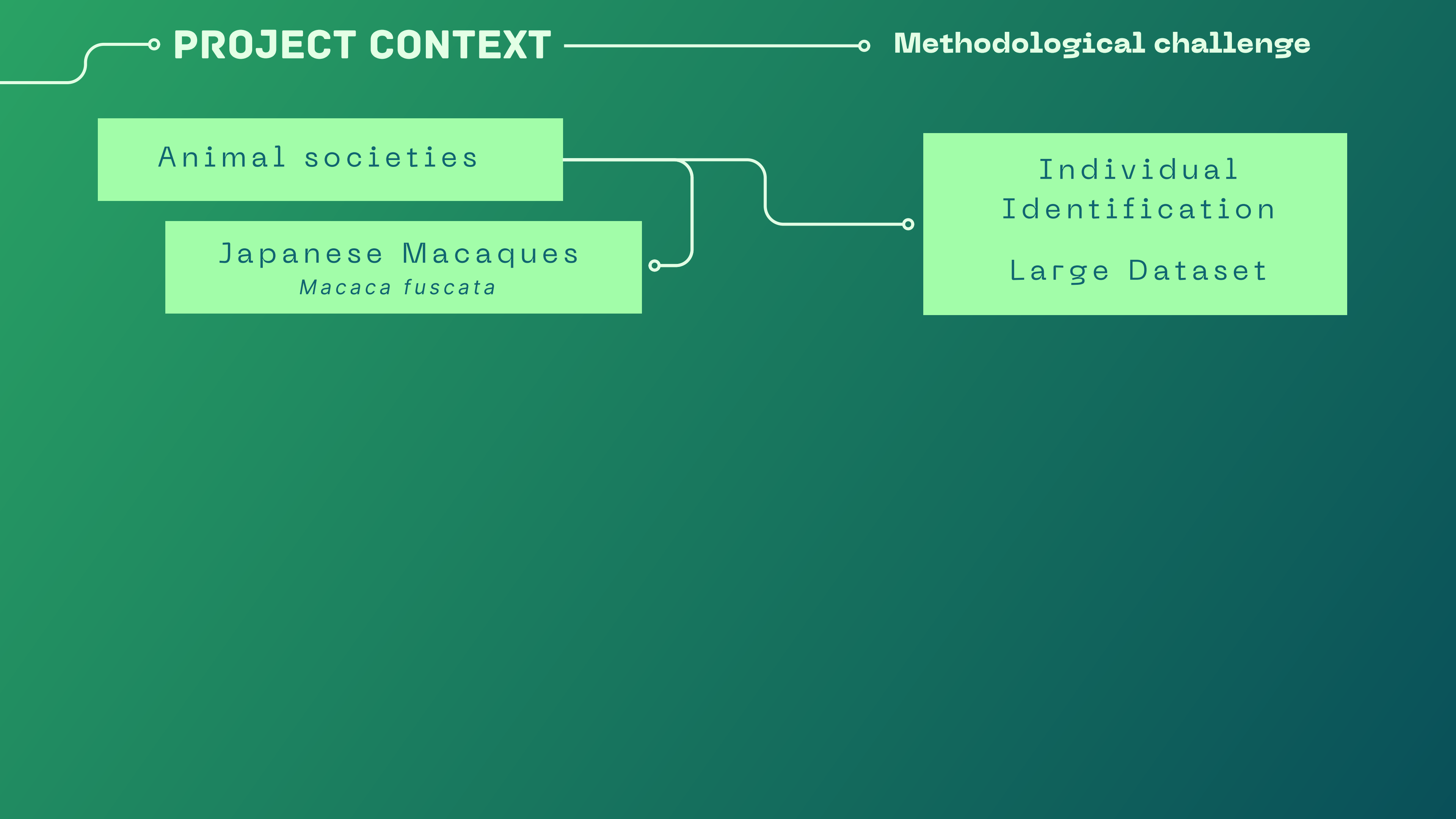
PROJECT CONTEXT

Methodological challenge

Animal societies

Japanese Macaques
Macaca fuscata

Individual
Identification
Large Dataset



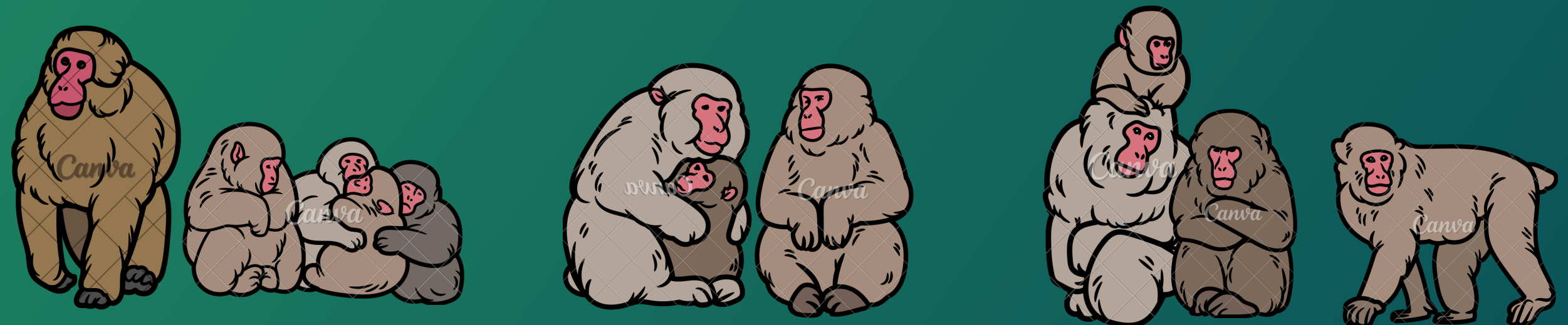
PROJECT CONTEXT

Methodological challenge

Animal societies

Japanese Macaques
Macaca fuscata

Individual
Identification
Large Dataset



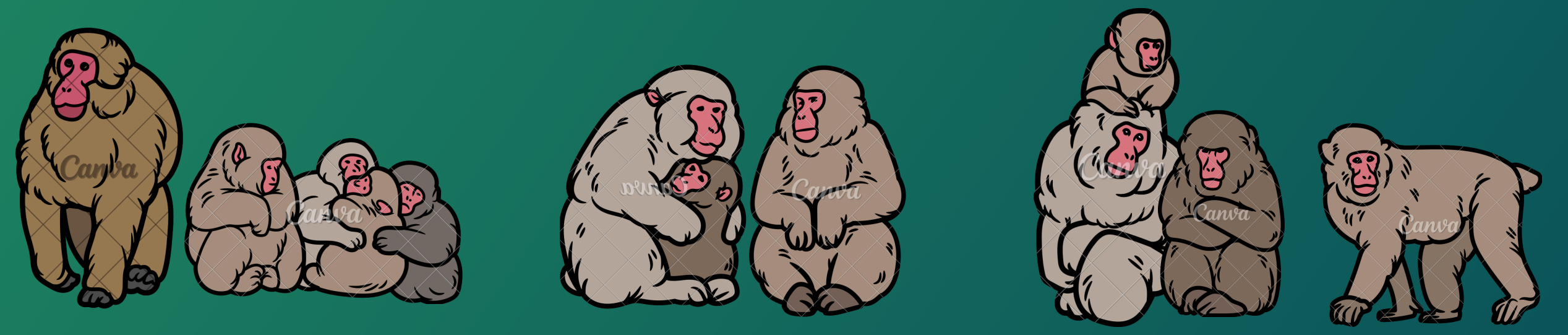
PROJECT CONTEXT

Methodological challenge

Animal societies

Japanese Macaques
Macaca fuscata

Individual
Identification
Large Dataset



PROJECT CONTEXT

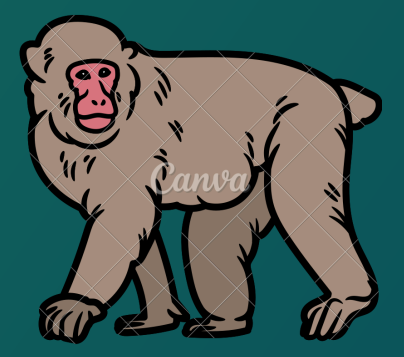
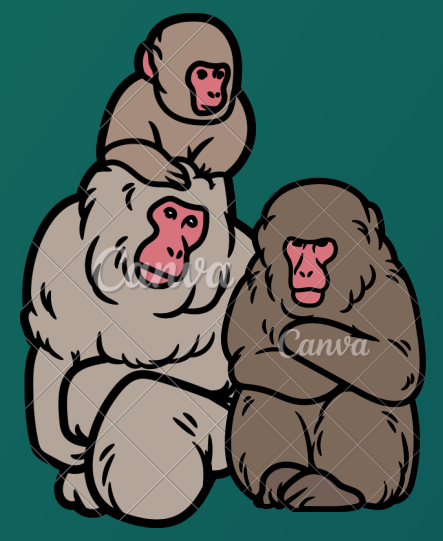
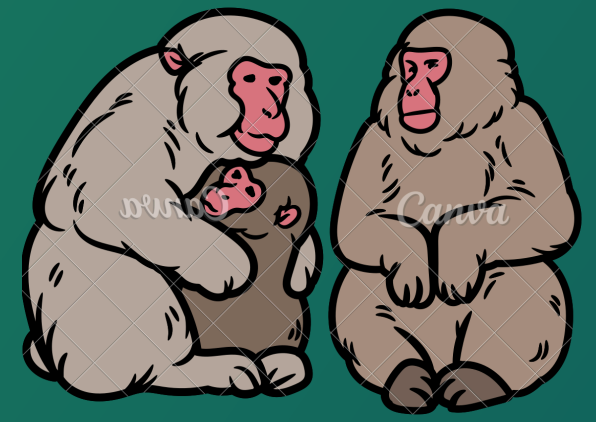
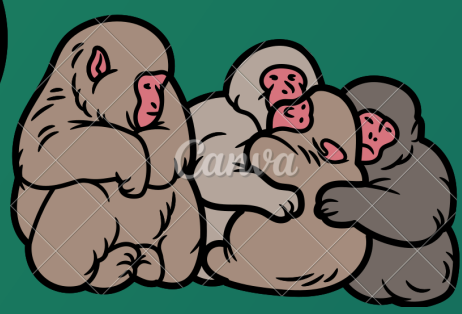
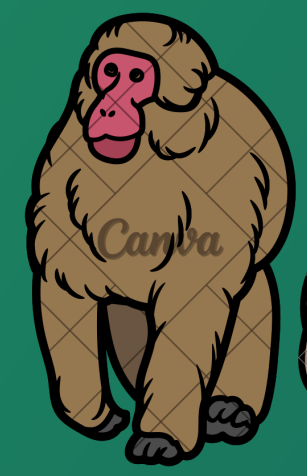
Methodological challenge

Animal societies

Japanese Macaques
Macaca fuscata

Individual
Identification

Large Dataset



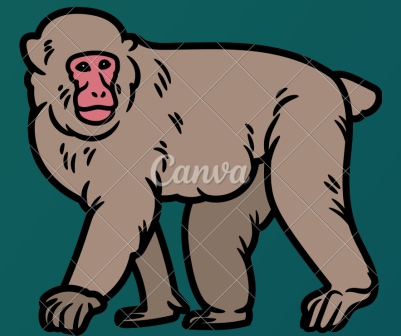
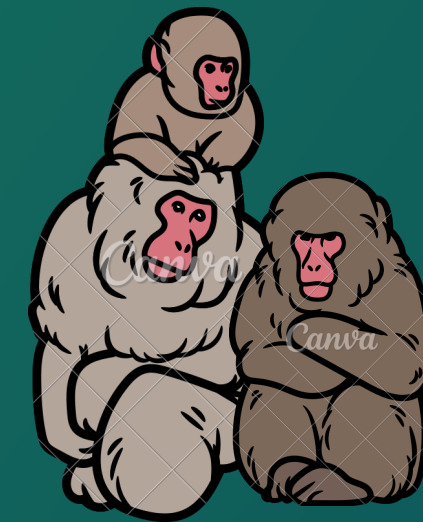
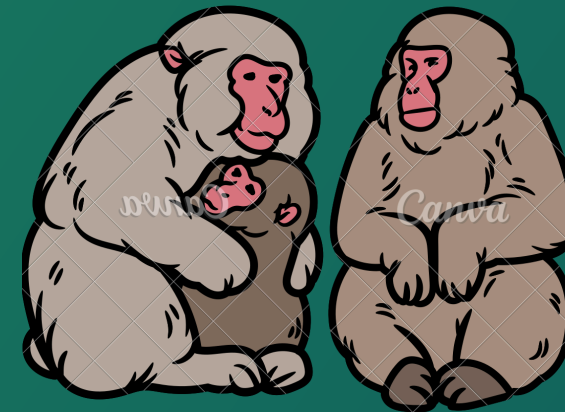
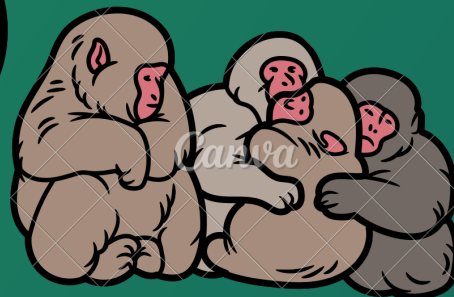
PROJECT CONTEXT

Methodological challenge

Animal societies

Japanese Macaques
Macaca fuscata

Individual
Identification
Large Dataset



PROJECT CONTEXT

Methodological opportunity

Animal societies

Japanese Macaques
Macaca fuscata

Deep Learning

Individual
Identification
Large Dataset



PROJECT CONTEXT

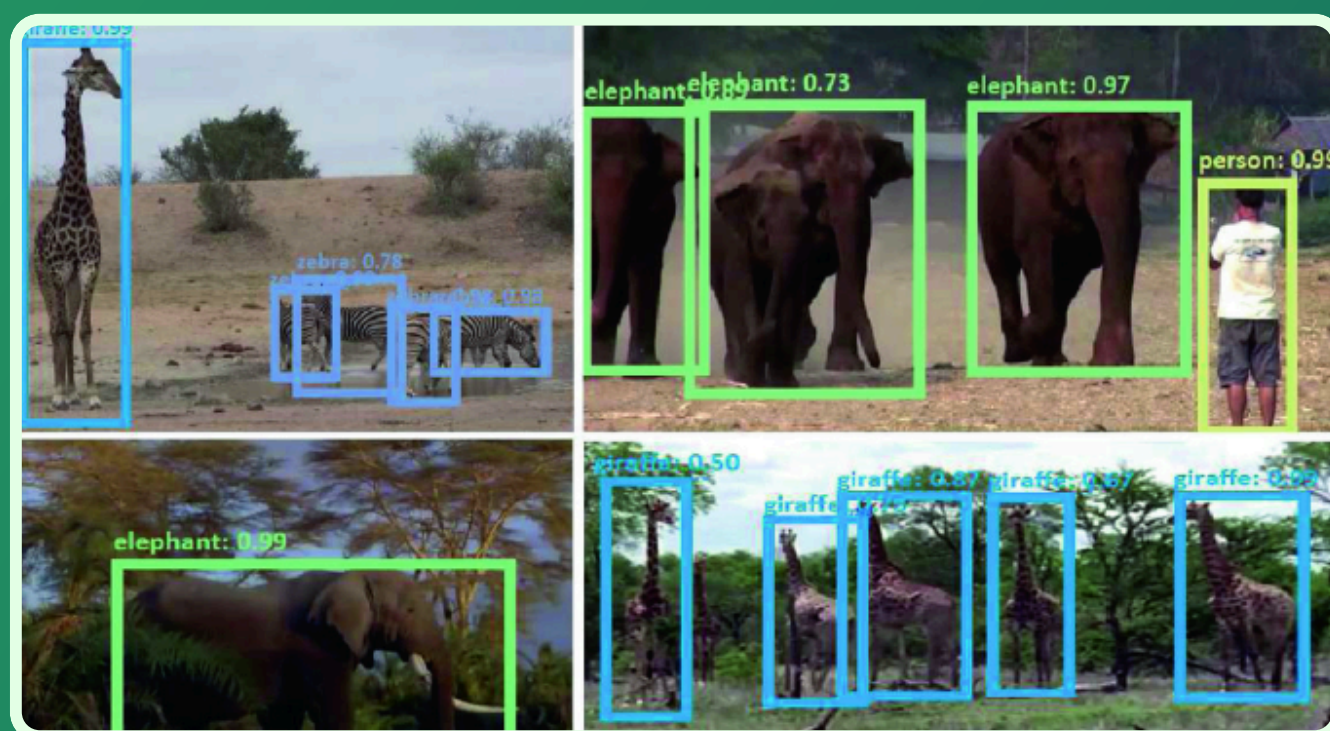
Methodological opportunity

Animal societies

Japanese Macaques
Macaca fuscata

Deep Learning

Individual Identification
Large Dataset



PROJECT CONTEXT

Methodological opportunity

Animal societies

Japanese Macaques
Macaca fuscata

Deep Learning

Individual Identification
Large Dataset



PROJECT CONTEXT

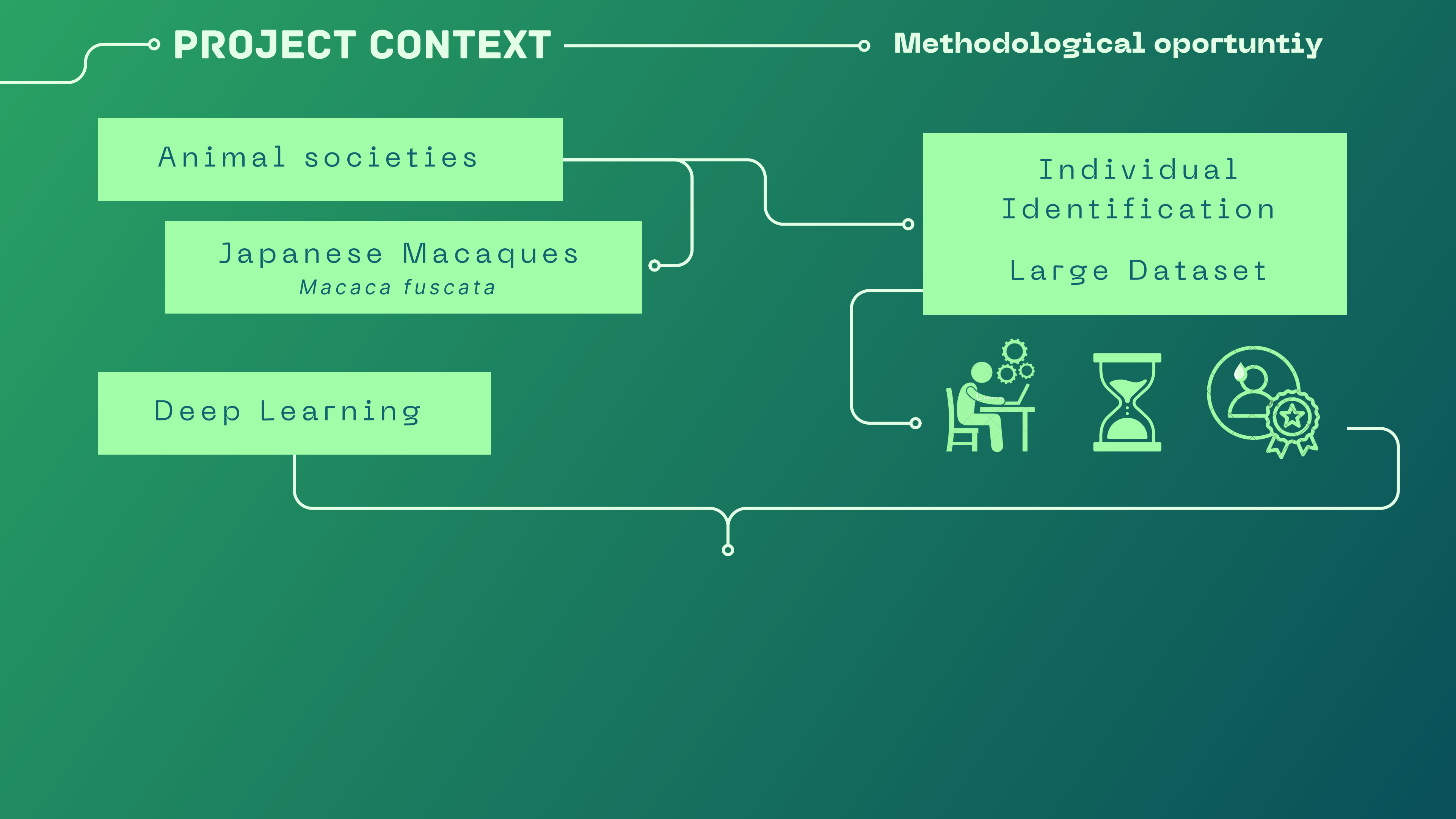
Methodological oportuntiy

Animal societies

Japanese Macaques
Macaca fuscata

Deep Learning

Individual
Identification
Large Dataset



PROJECT CONTEXT

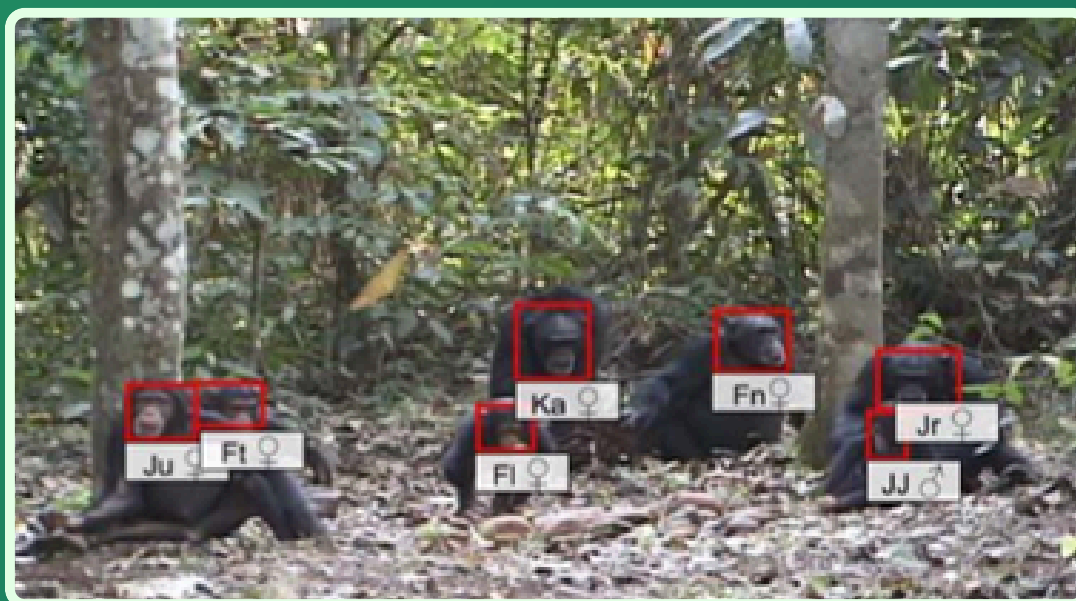
Methodological opportunity

Animal societies

Japanese Macaques
Macaca fuscata

Deep Learning

Individual
Identification
Large Dataset



AUTOMATED IDENTIFICATION AND SOCIAL NETWORK DESCRIPTION OF KOJIMA MACAQUES WITH DEEP LEARNING



AUTOMATED IDENTIFICATION AND SOCIAL NETWORK DESCRIPTION OF KOJIMA MACAQUES WITH DEEP LEARNING



It's Yotsuba and Binega !



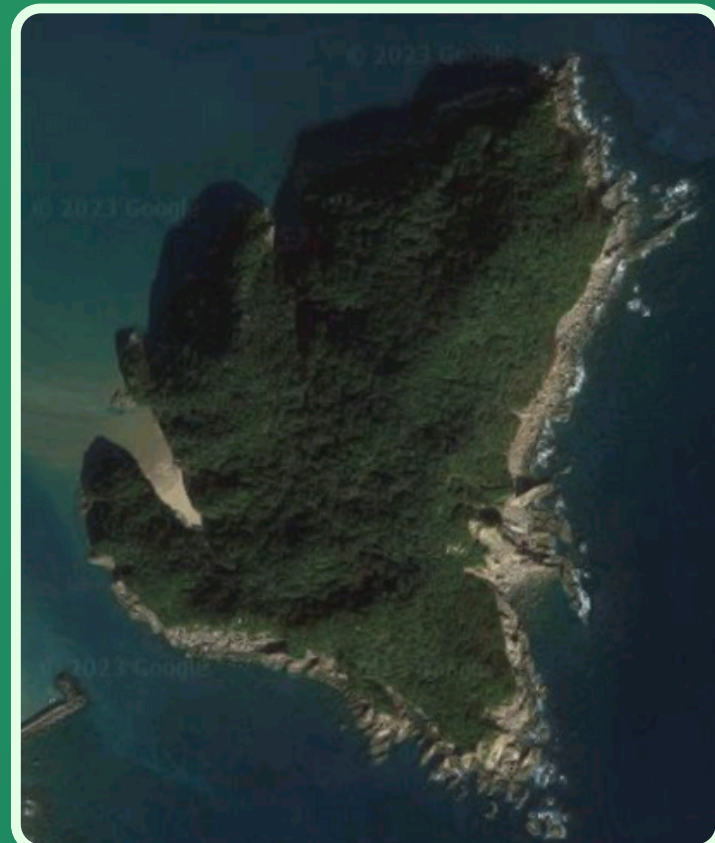
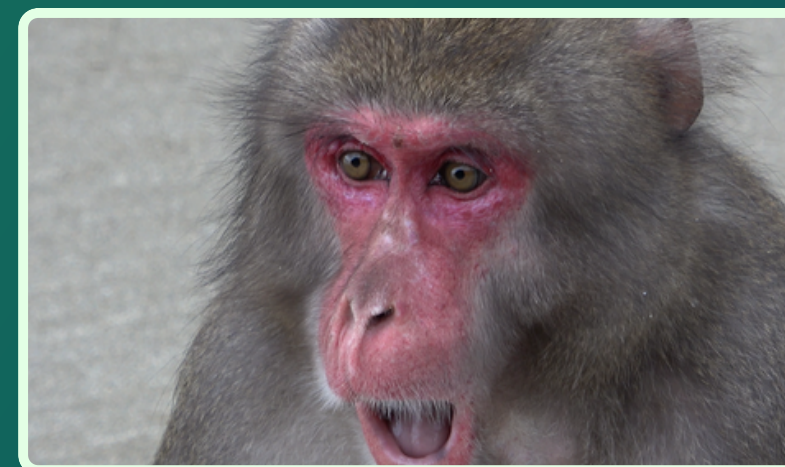
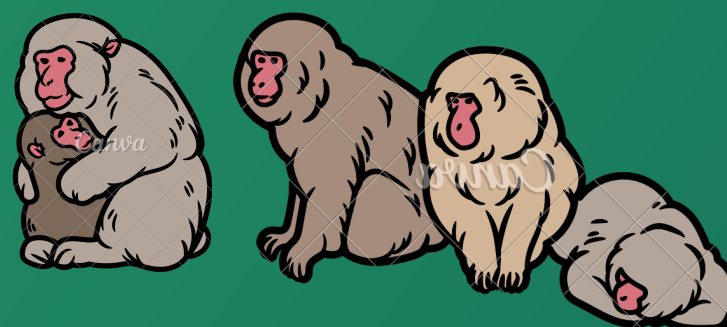
It's Yotsuba and Binega !



Dataset Collection



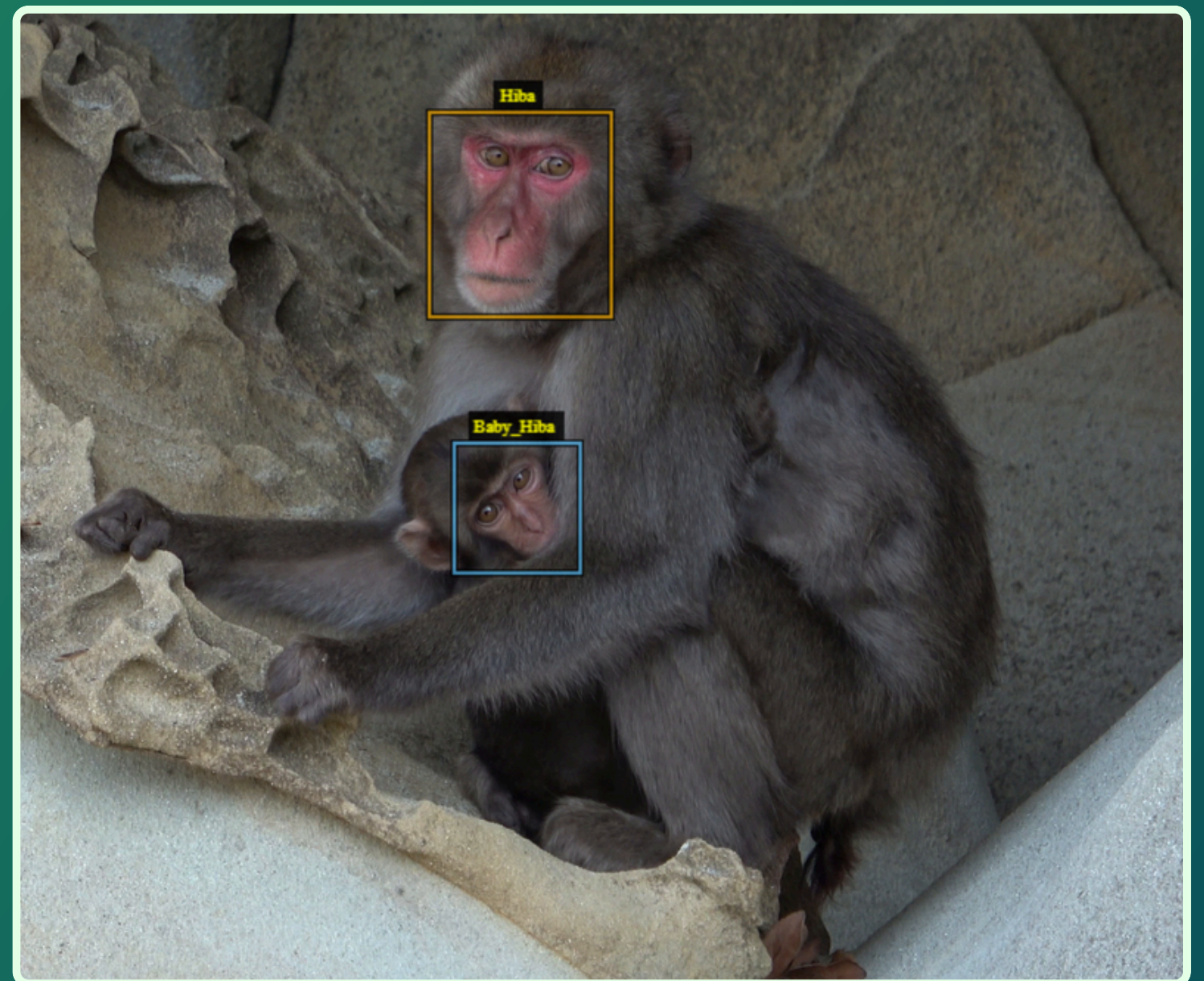
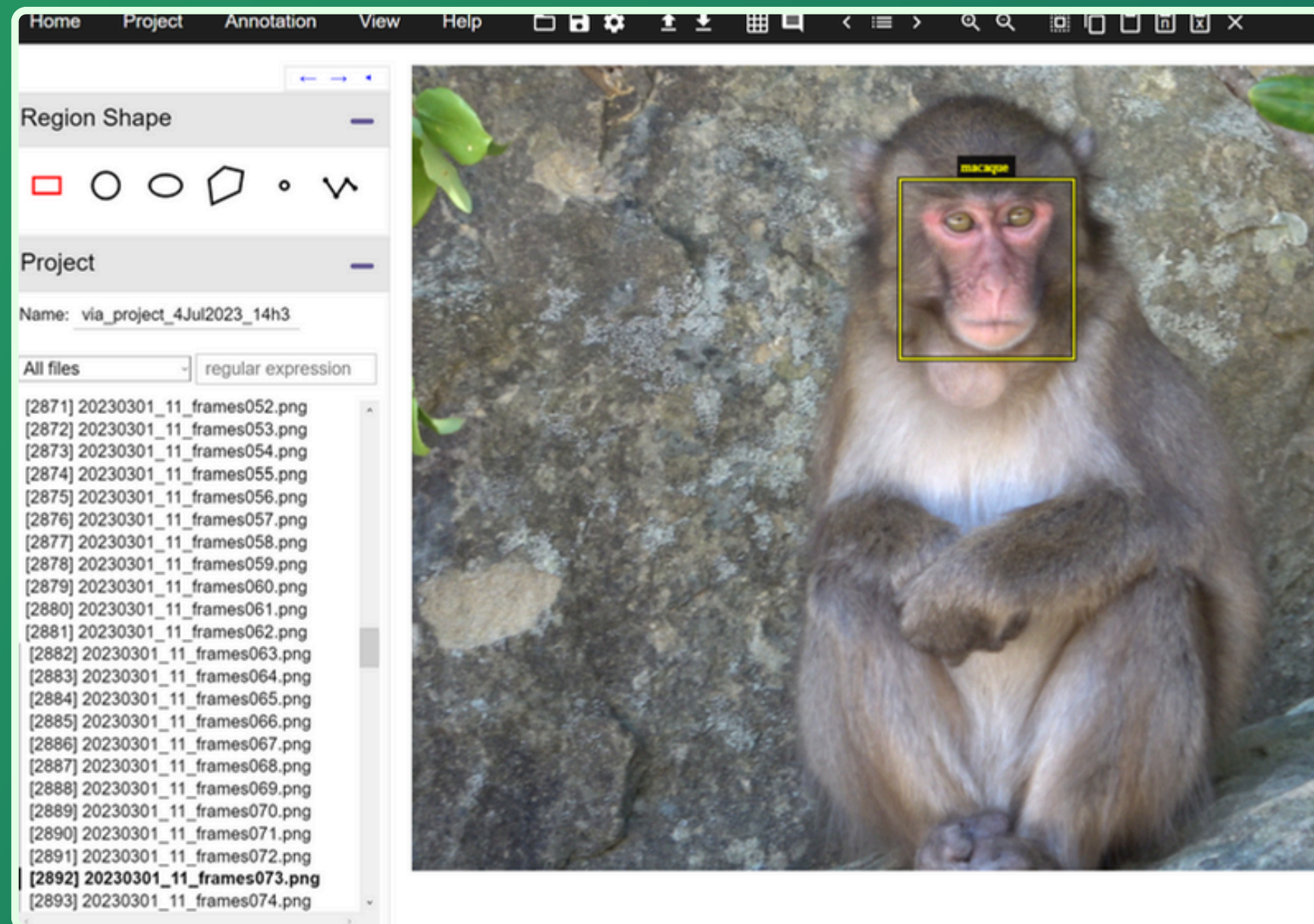
KOSHIMA ISLAND



- 42 macaques
 - ▷ ♀ 26 ♂ 11 ♀ 5
- ~20 hours of video
 - ▷ 2'30 focal samplings
 - ▷ 370 videos
- 2 months
 - ▷ Feb. – March 2023

Annotation

- Box on face
- Label with macaque's name



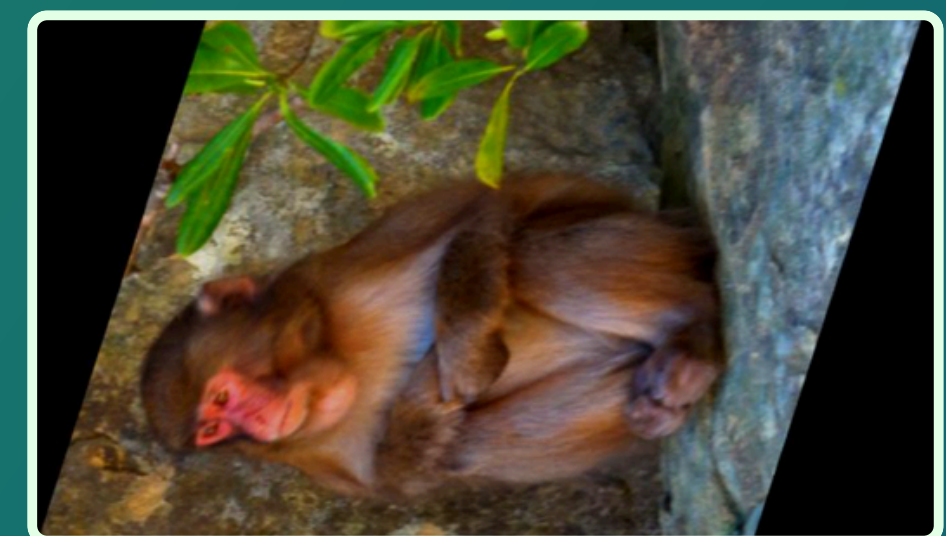
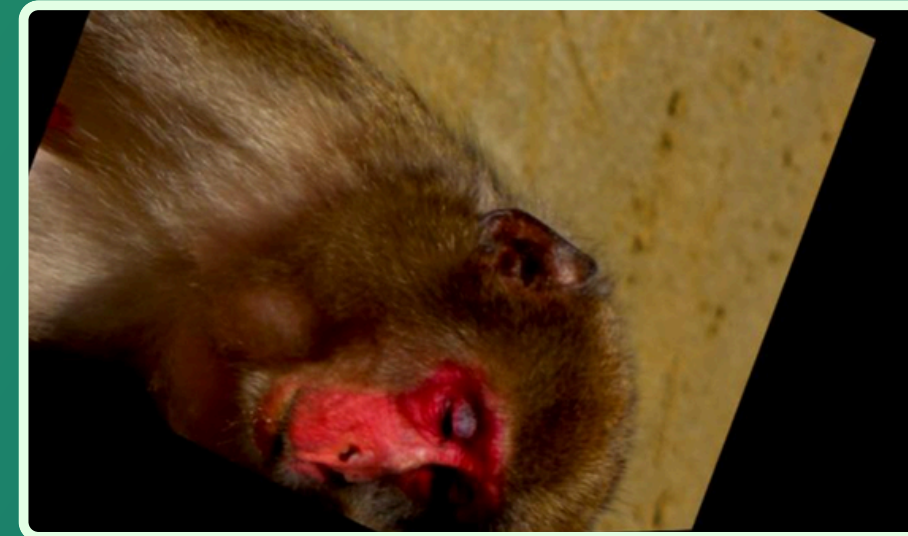
M2 INTERNSHIP

Material & Methods

Annotation

Data Augmentation

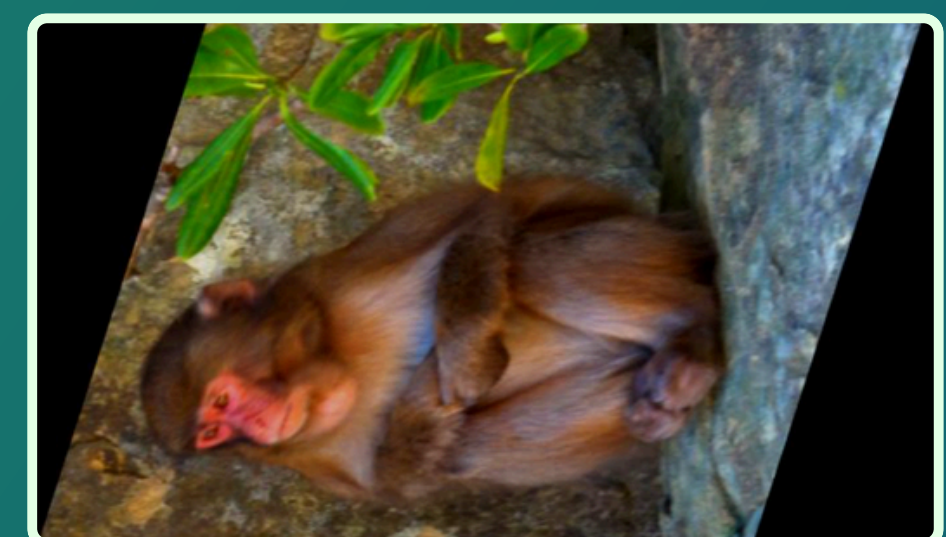
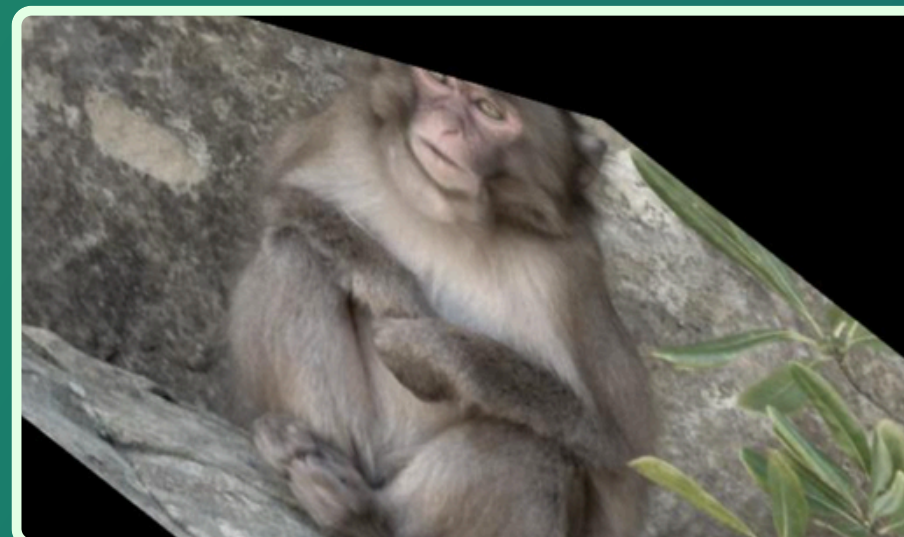
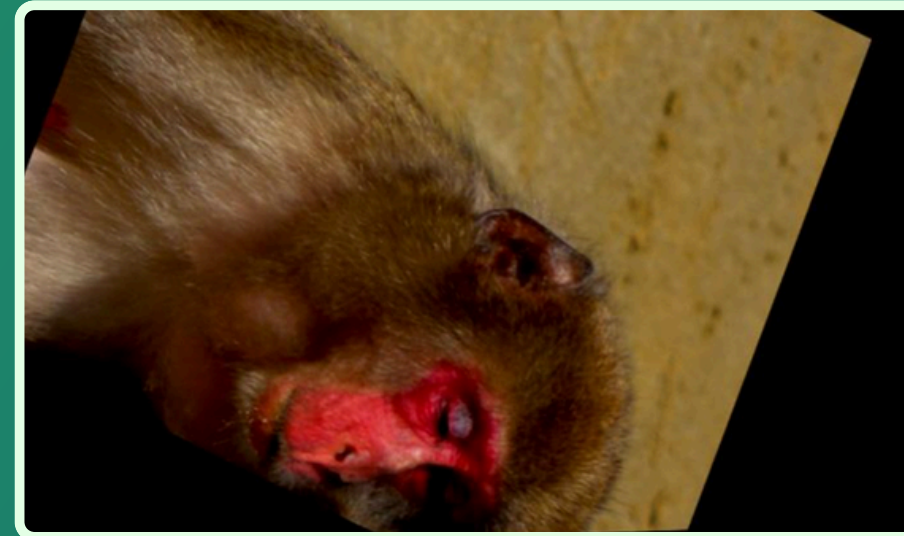
- New frames generation
- Rotations
- Stretch
- Black & white
- Saturation
- Luminosity
- Exposition
- Blur



Annotation

Data Augmentation

- New frames generation
- Rotations
- Stretch
- Black & white
- Saturation
- Luminosity
- Exposition
- Blur
- Avoid overfitting



Input Video



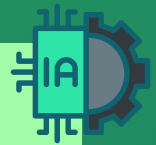
M2 INTERNSHIP

Program

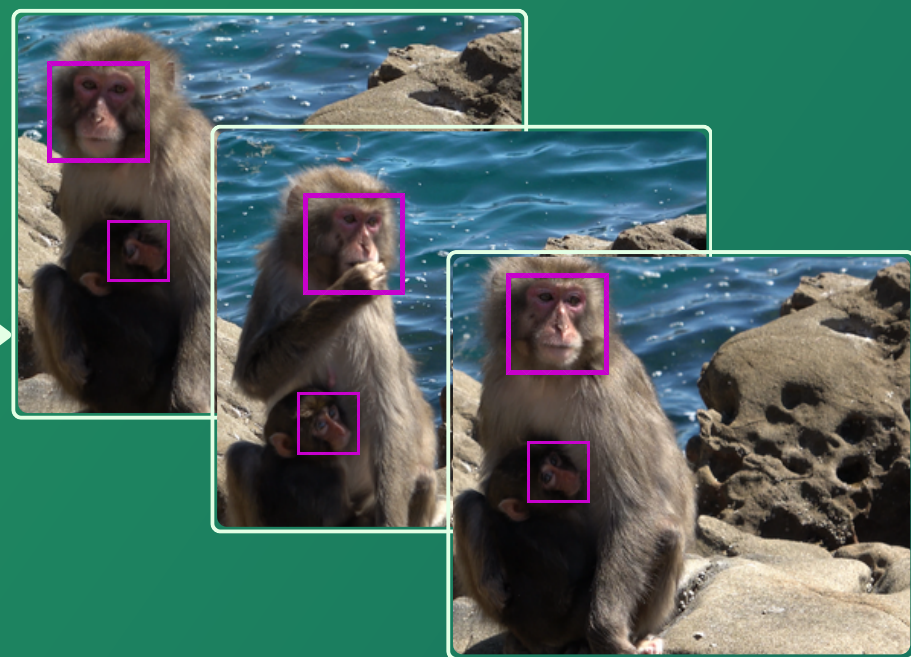
Input Video



Facial
Detection



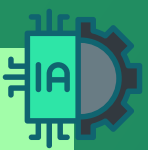
yolov8
model



Input Video



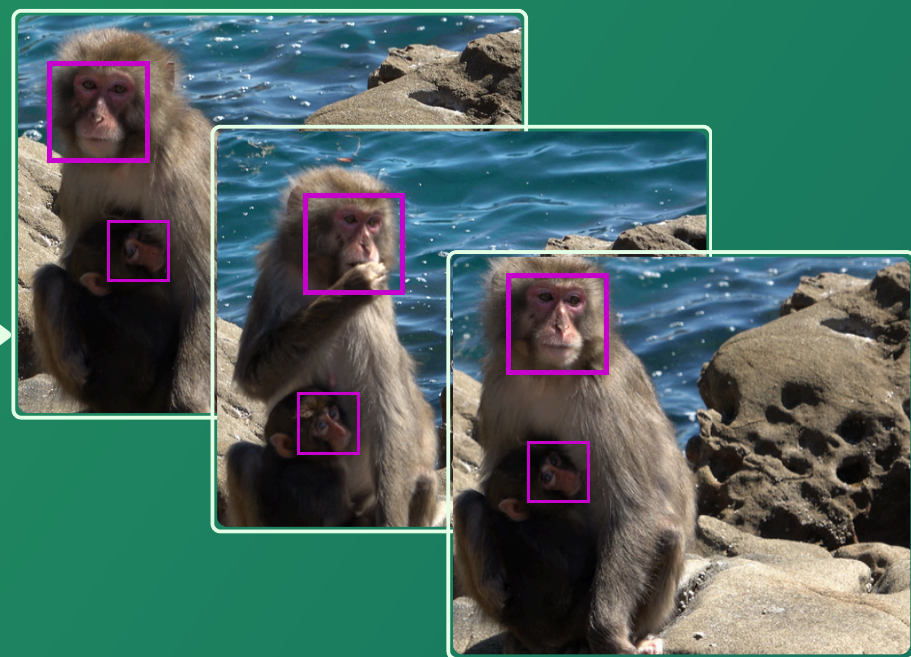
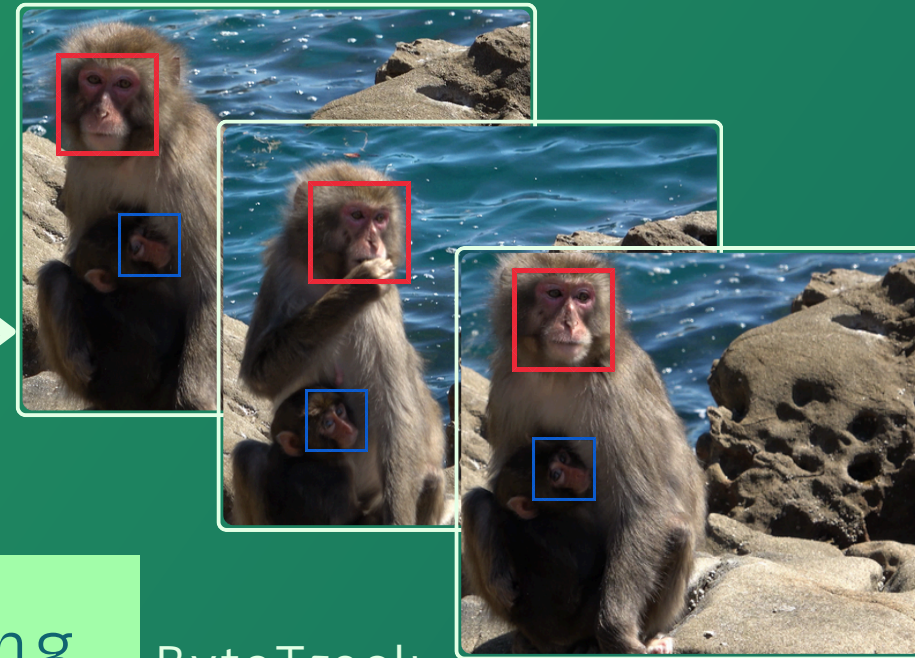
Facial
Detection



yolov8
model

Tracking

ByteTrack
algorithm



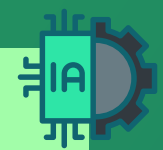
M2 INTERNSHIP

Program

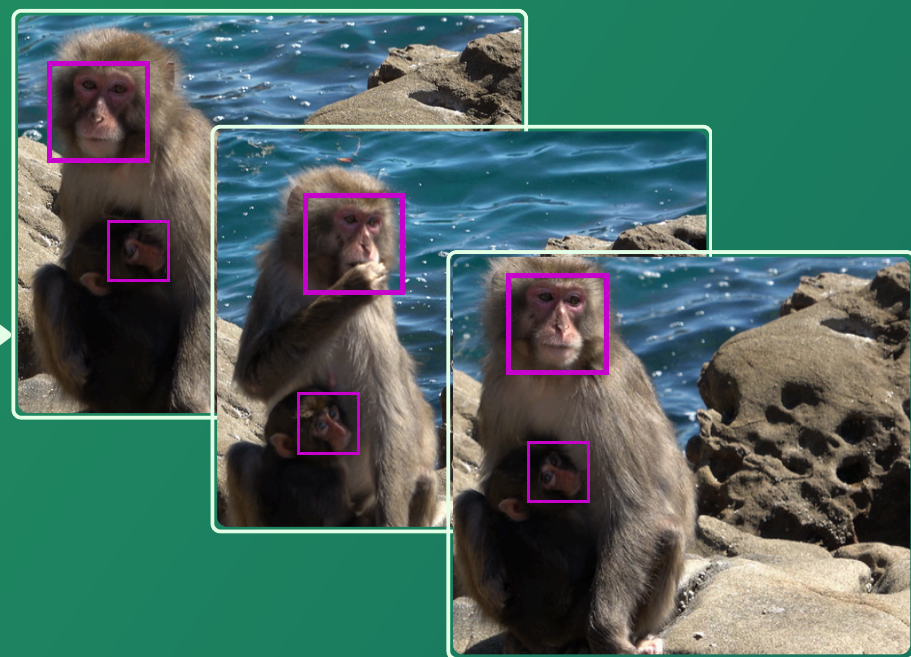
Input Video



Facial
Detection

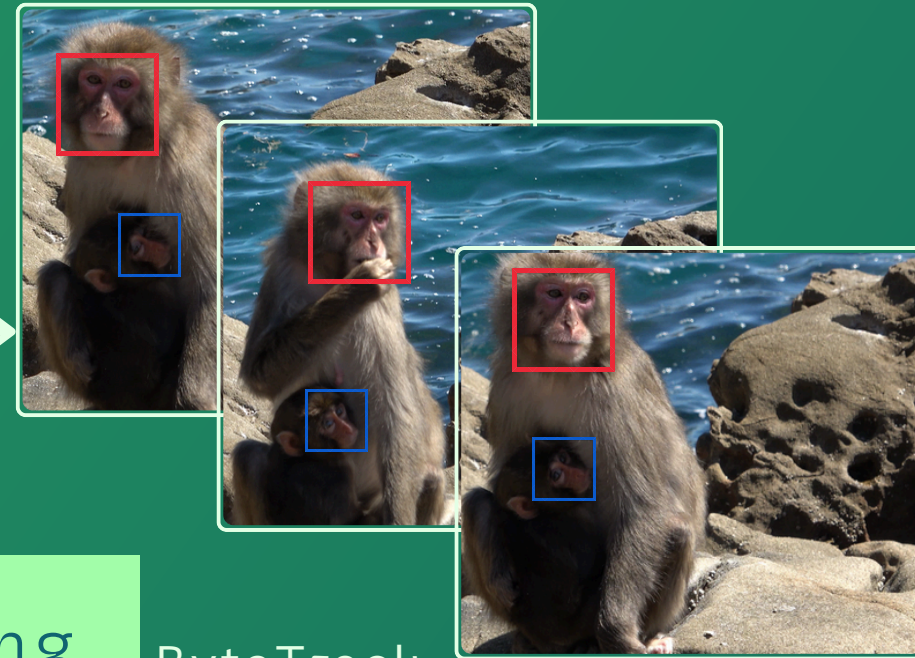


yolov8
model

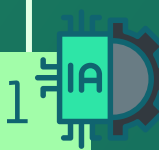


Tracking

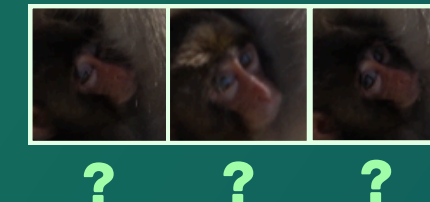
ByteTrack
algorithm



Individual
Classifier



yolov8
model



M2 INTERNSHIP

Program

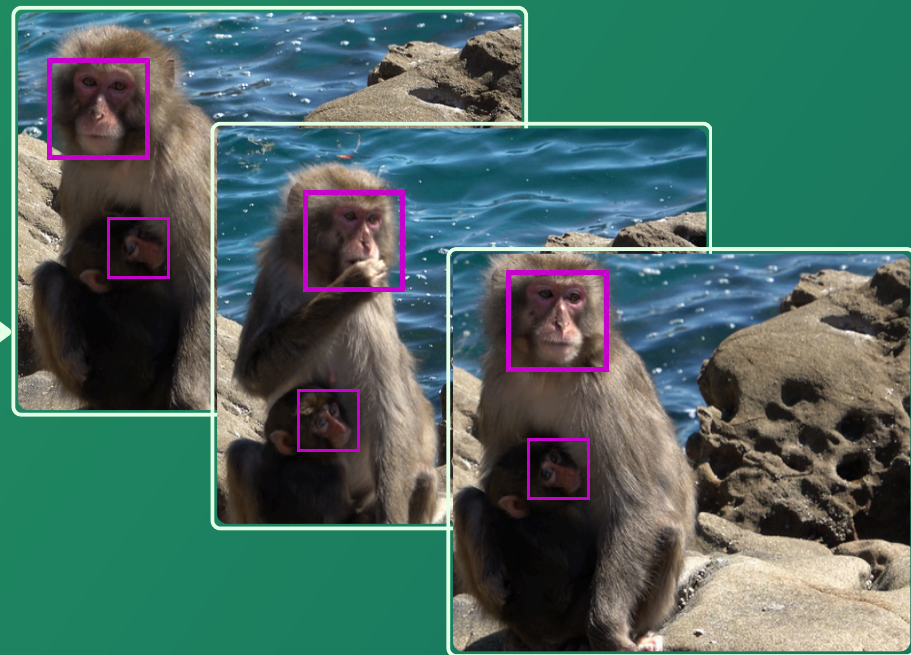
Input Video



Facial
Detection

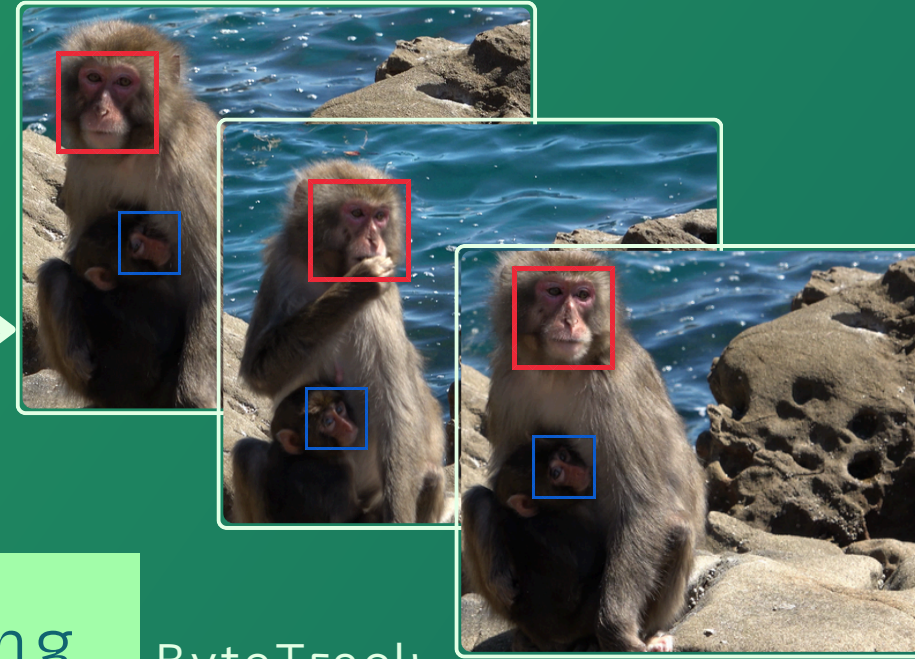


yolov8
model

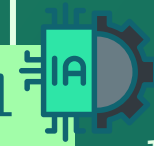


Tracking

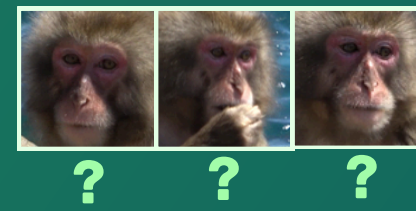
ByteTrack
algorithm



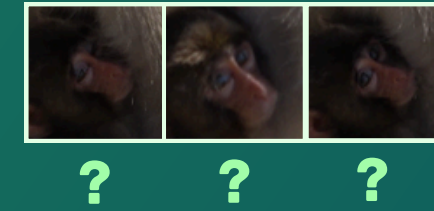
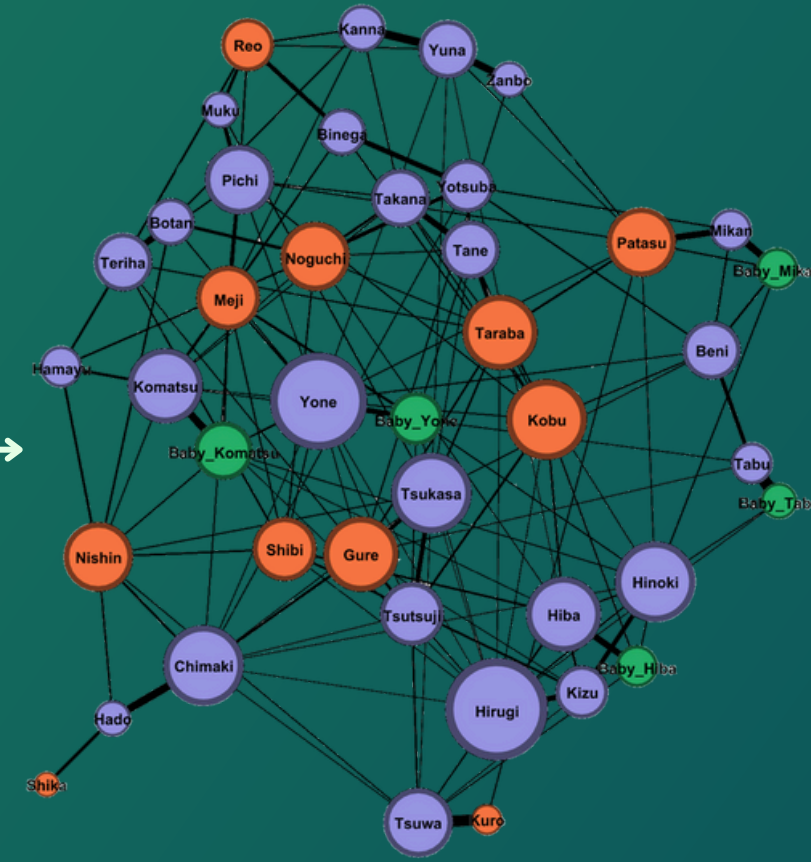
Individual
Classifier



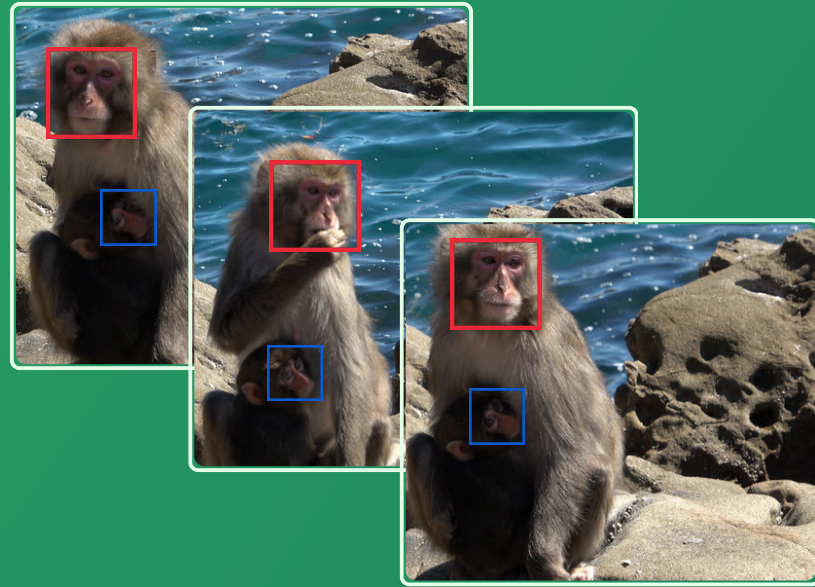
yolov8
model



Social
Network

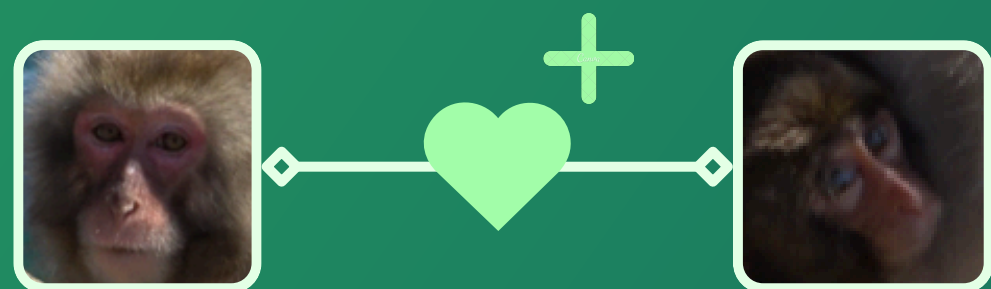
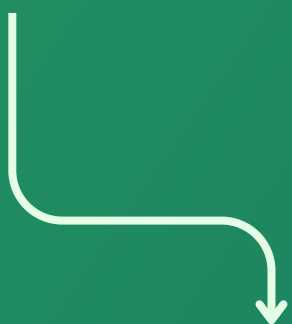
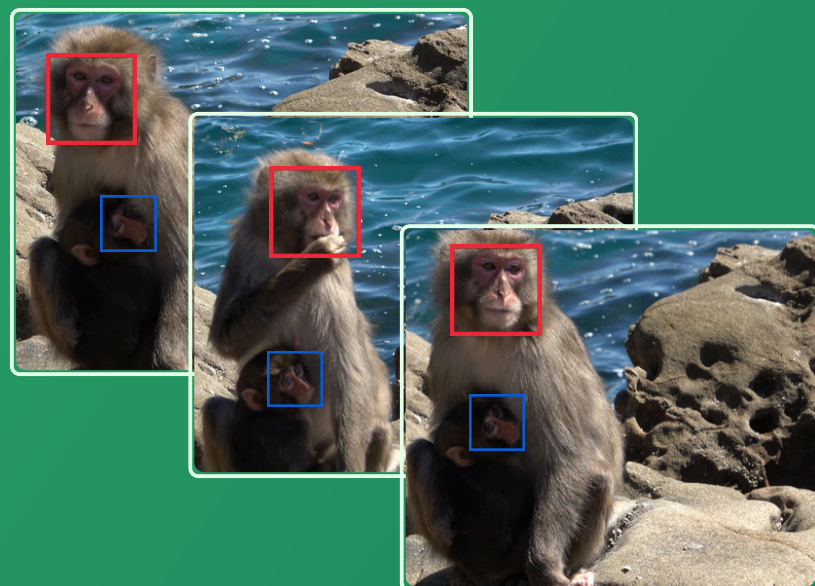


M2 INTERNSHIP Program



M2 INTERNSHIP

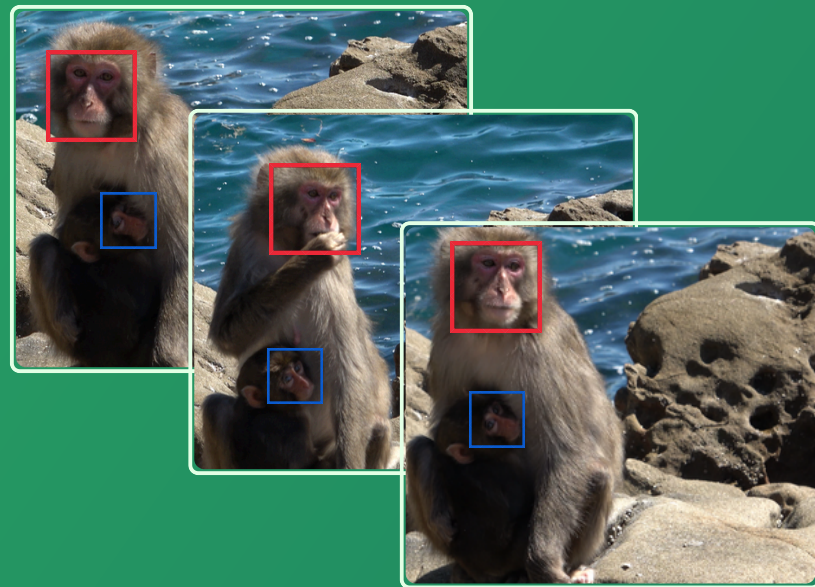
Program


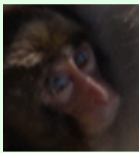


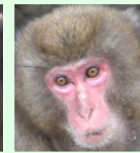







Komatsu




Chimaki



					
	0	0,68 ⁺	0,04	0,12	0,52
	0,68 ⁺	0	0,27	0,69	0,03
	0,04	0,27	0	0,51	0,02
	0,12	0,69	0,51	0	0,1
	0,52	0,03	0,02	0,1	0

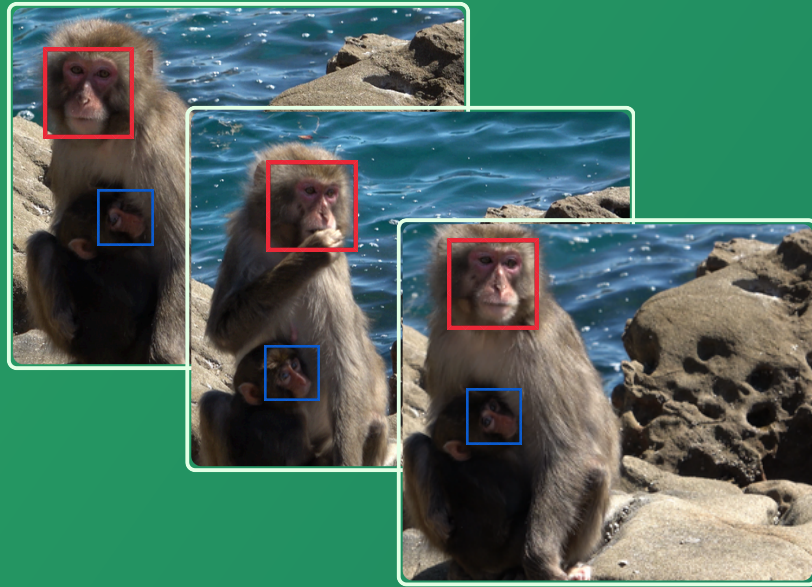
Matrice de proximité




Komatsu

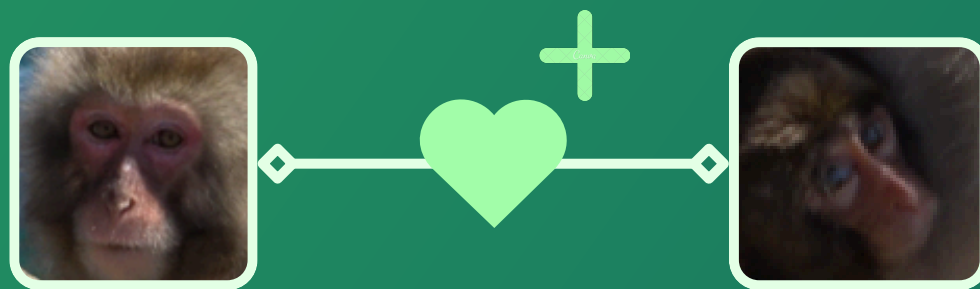
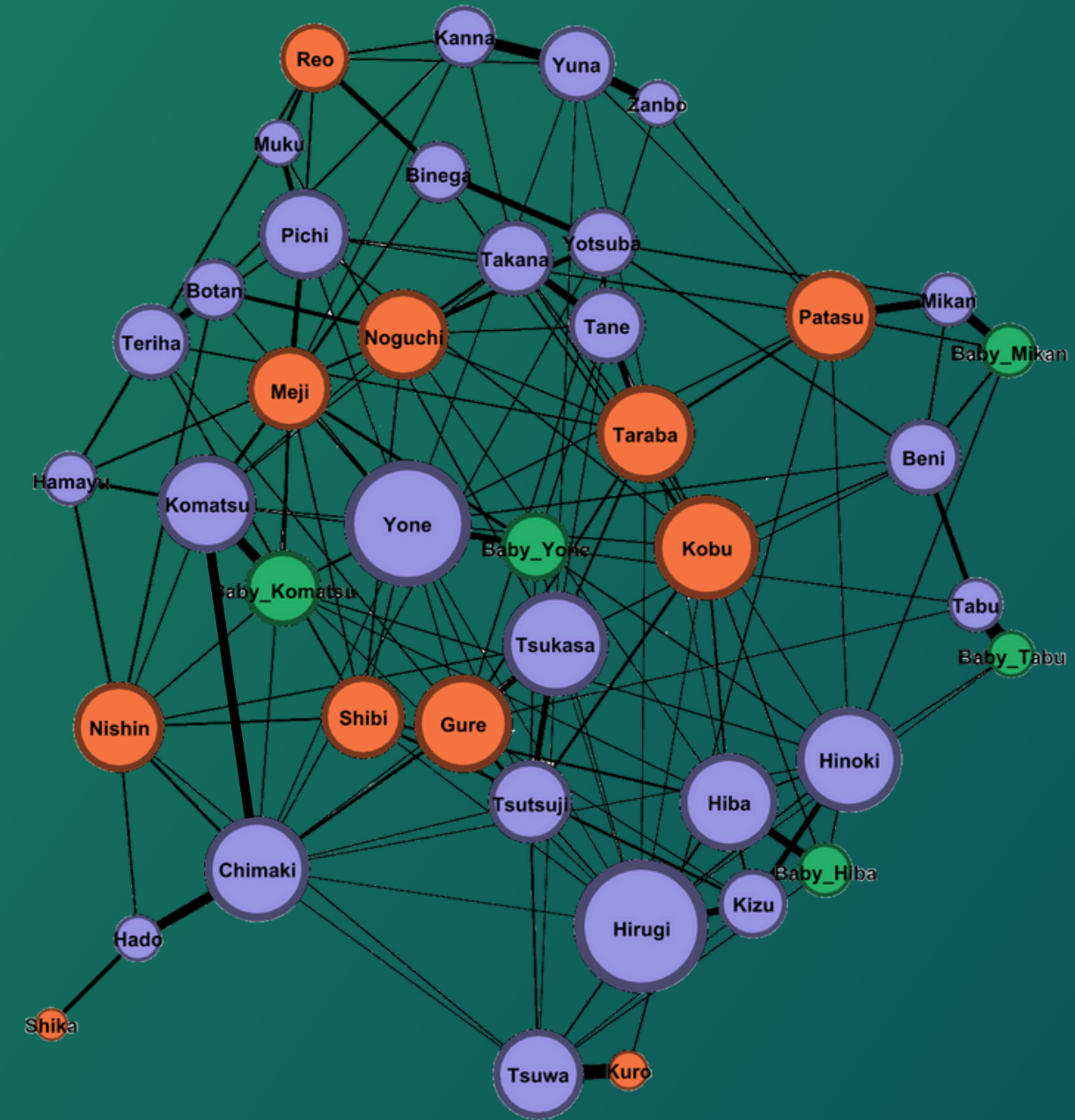

Chimaki





	0	0,68 ⁺	0,04	0,12	0,52
	0,68 ⁺	0	0,27	0,69	0,03
	0,04	0,27	0	0,51	0,02
	0,12	0,69	0,51	0	0,1
	0,52	0,03	0,02	0,1	0

Matrice de proximit 



Komatsu

Chimaki



1. FACE DETECTION PRECISION : 98,3%

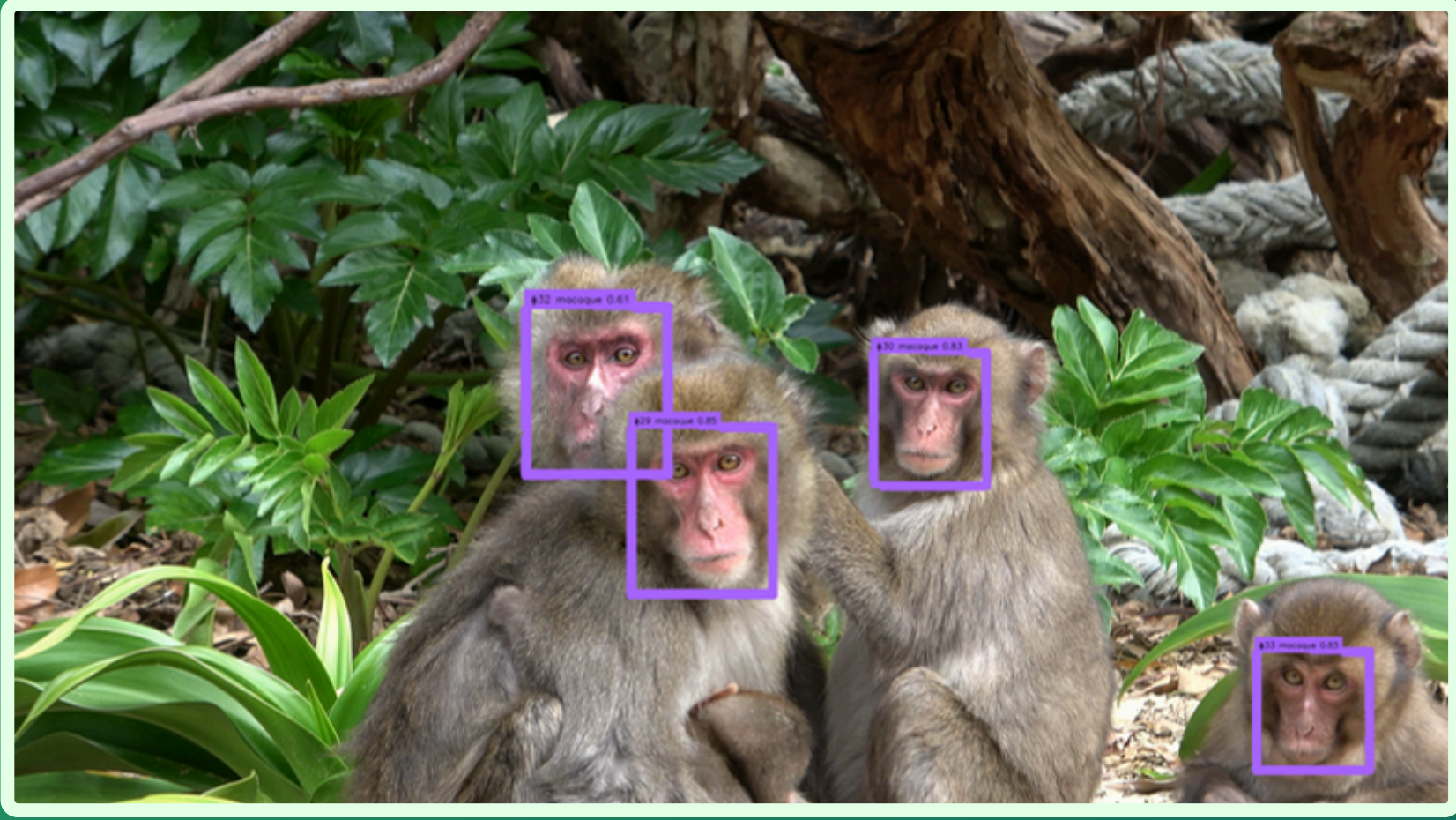


input

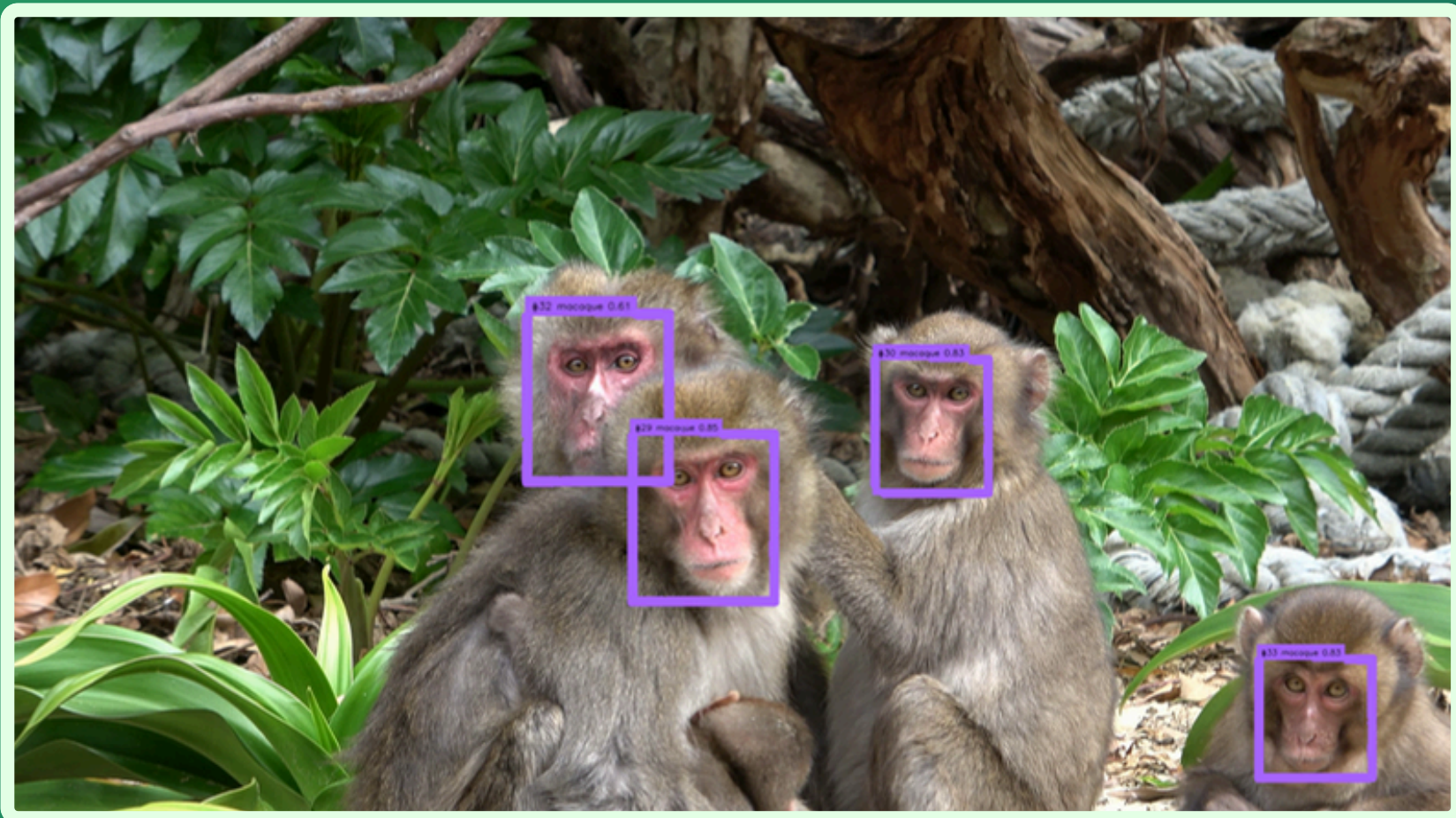
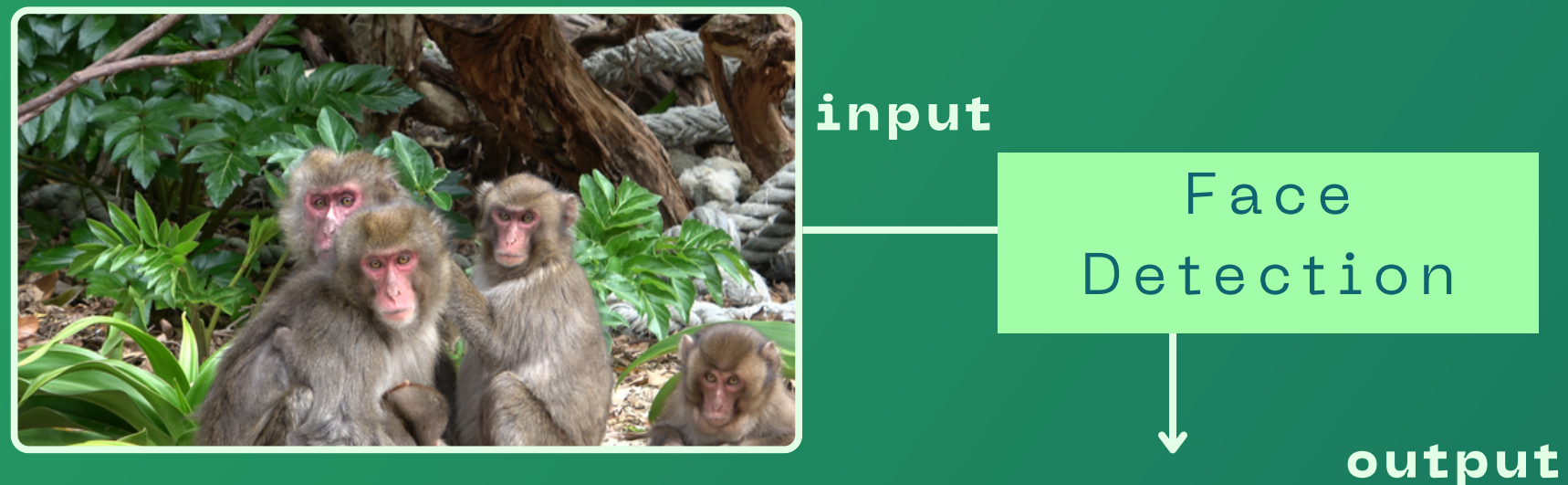
Face
Detection



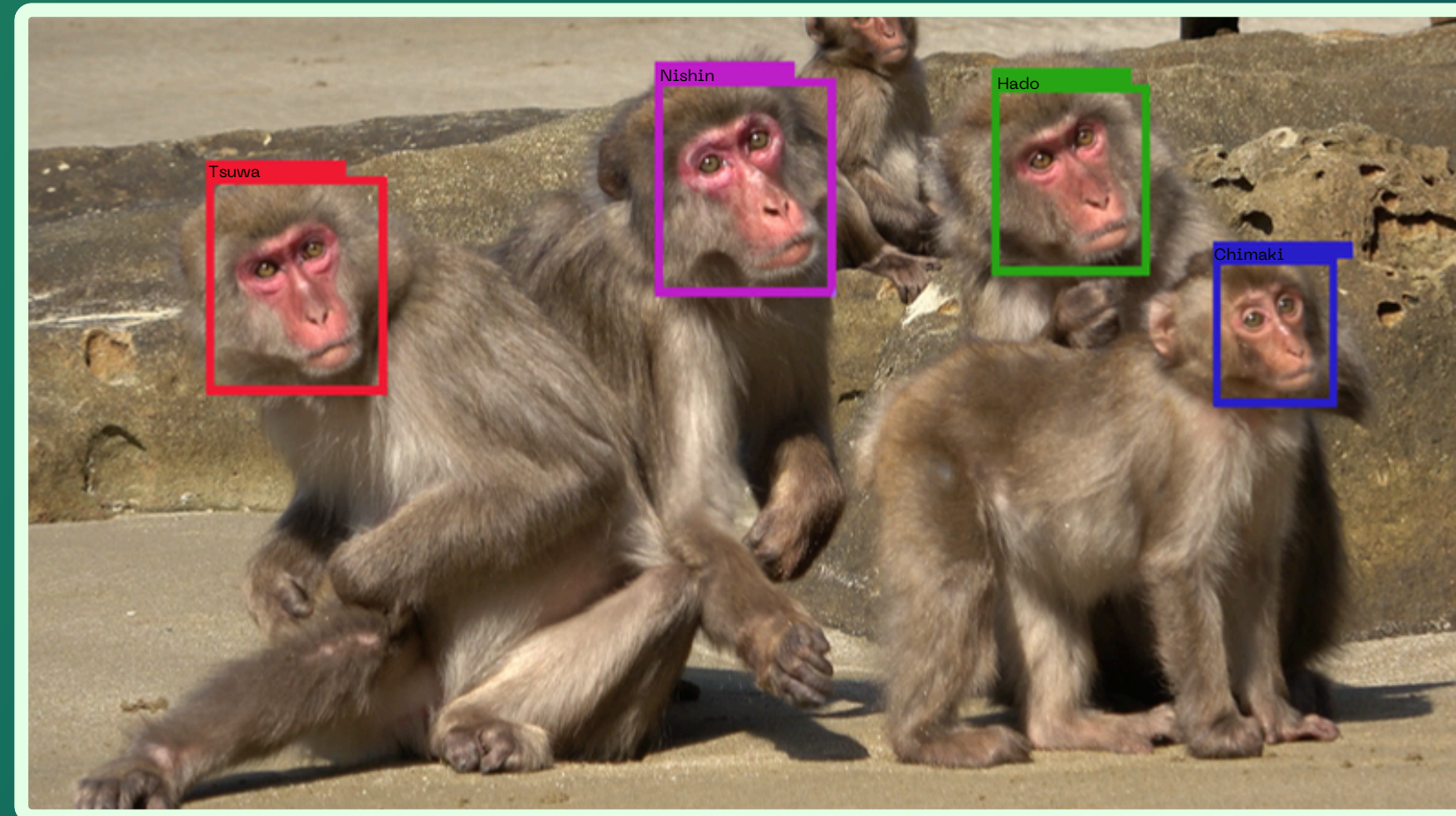
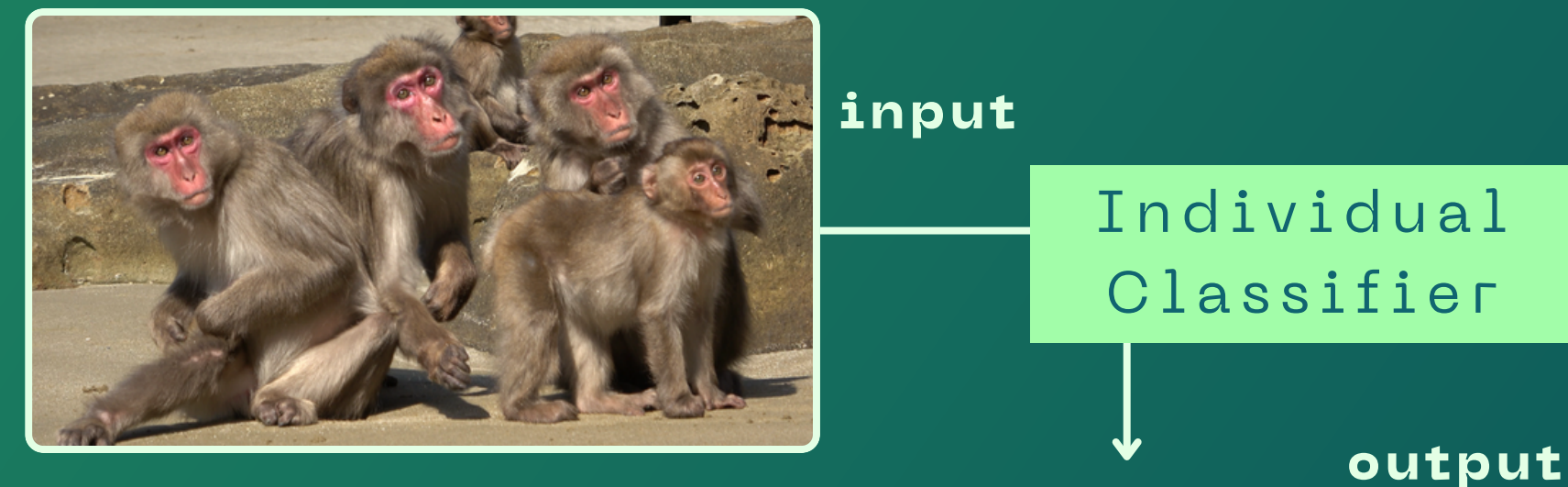
output



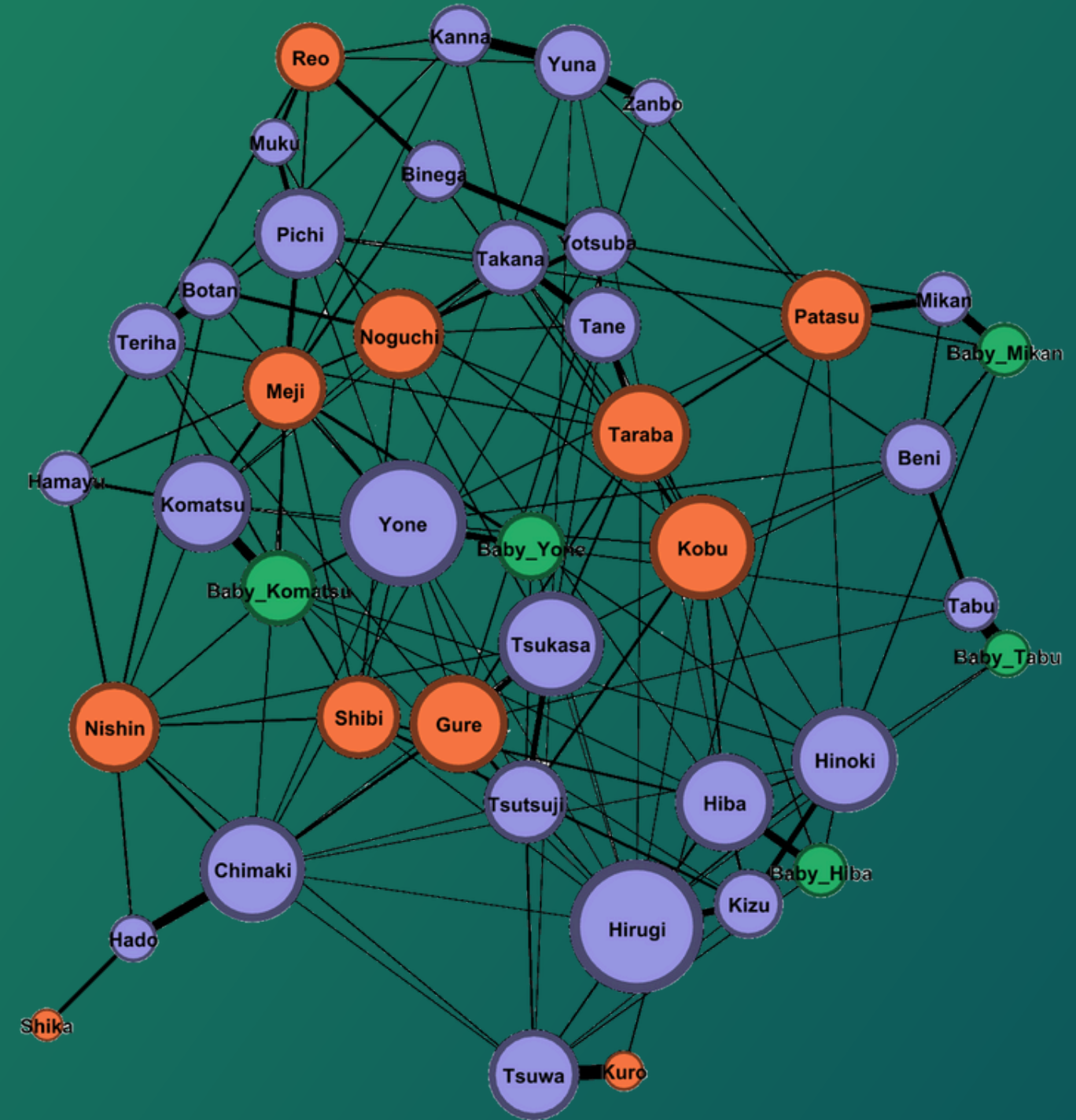
1. FACE DETECTION PRECISION : 98,3%



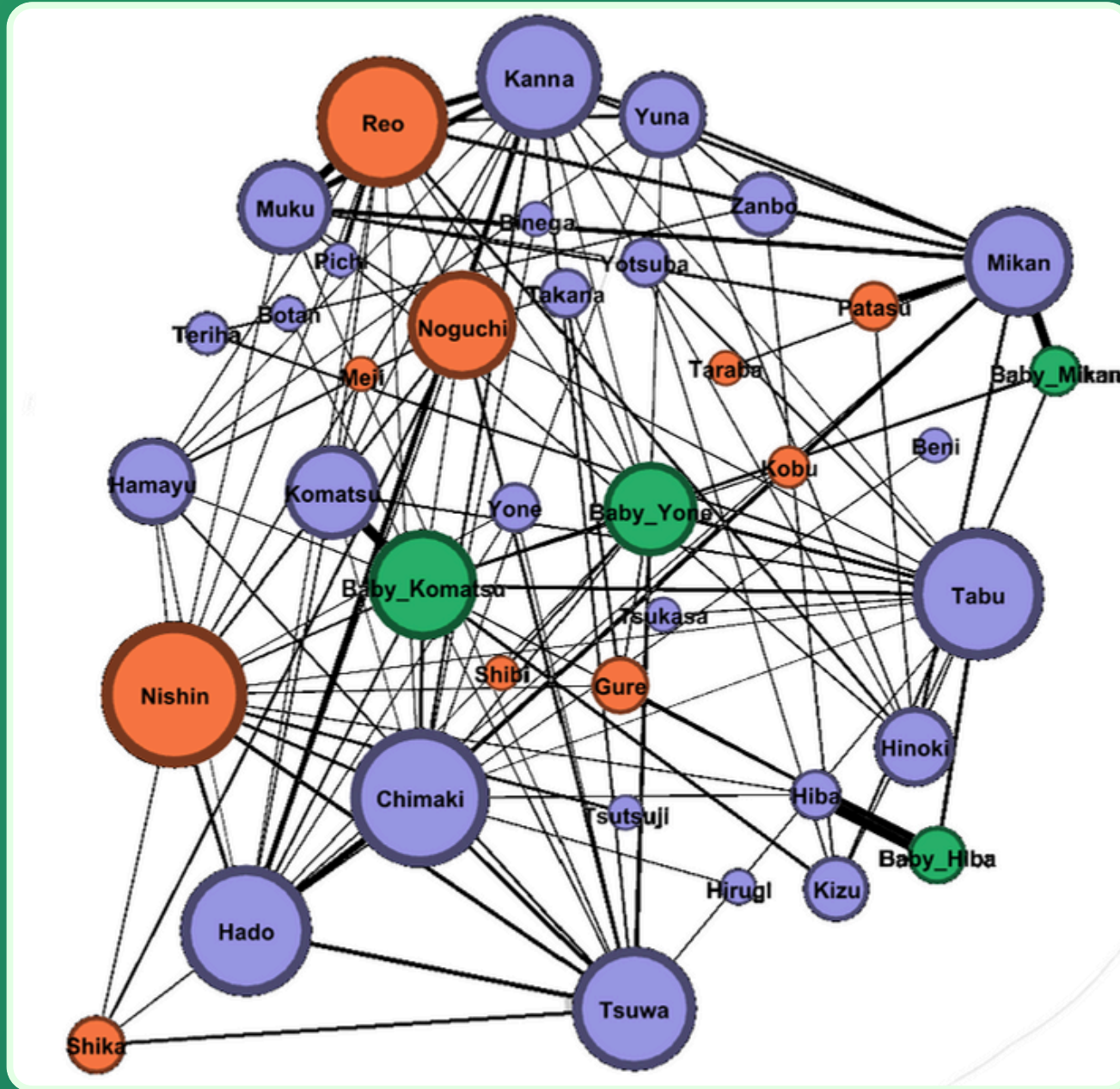
2. IDENTITY RECOGNITION PRECISION : 87,9%



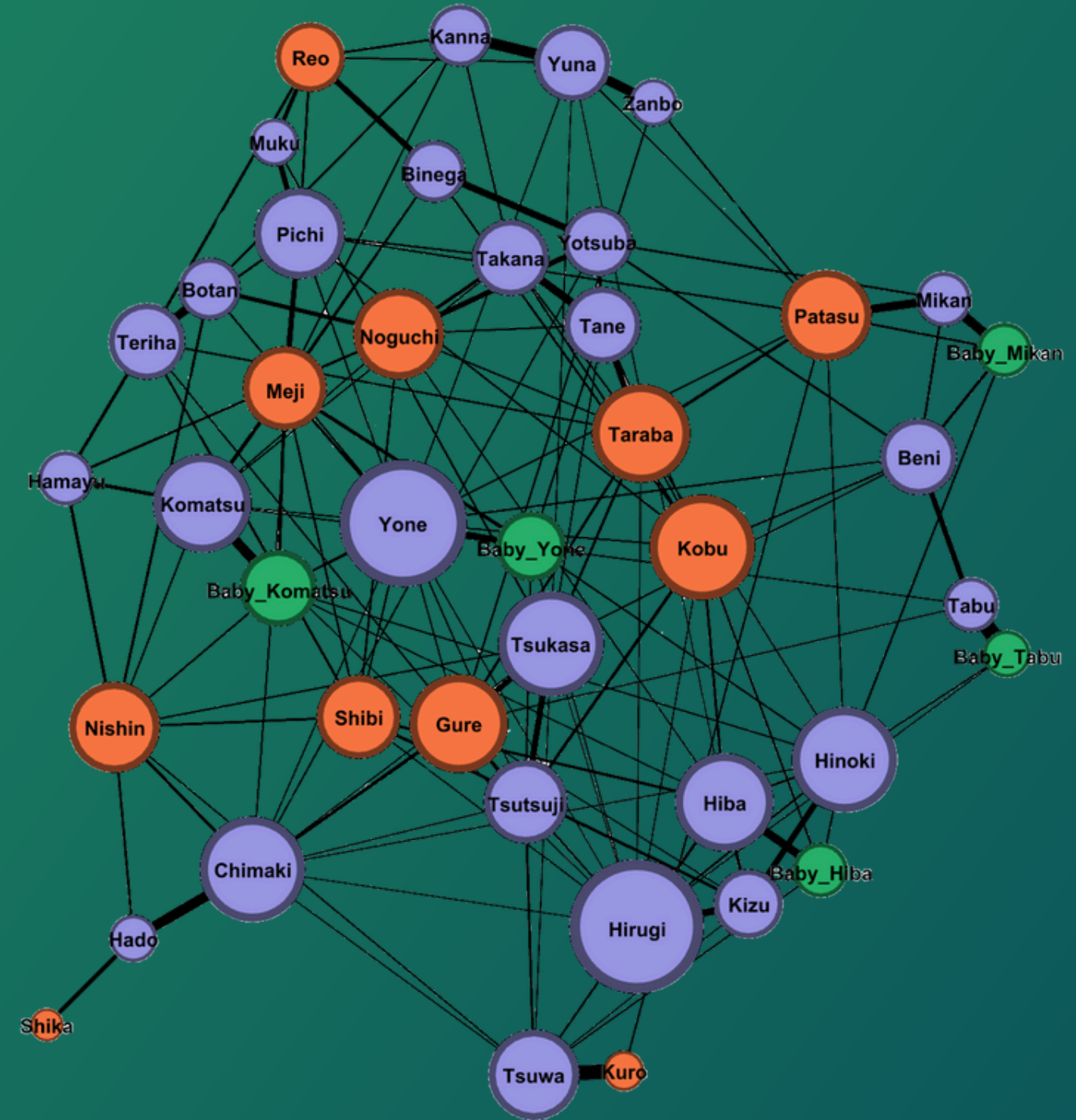
Full network
Traditional method



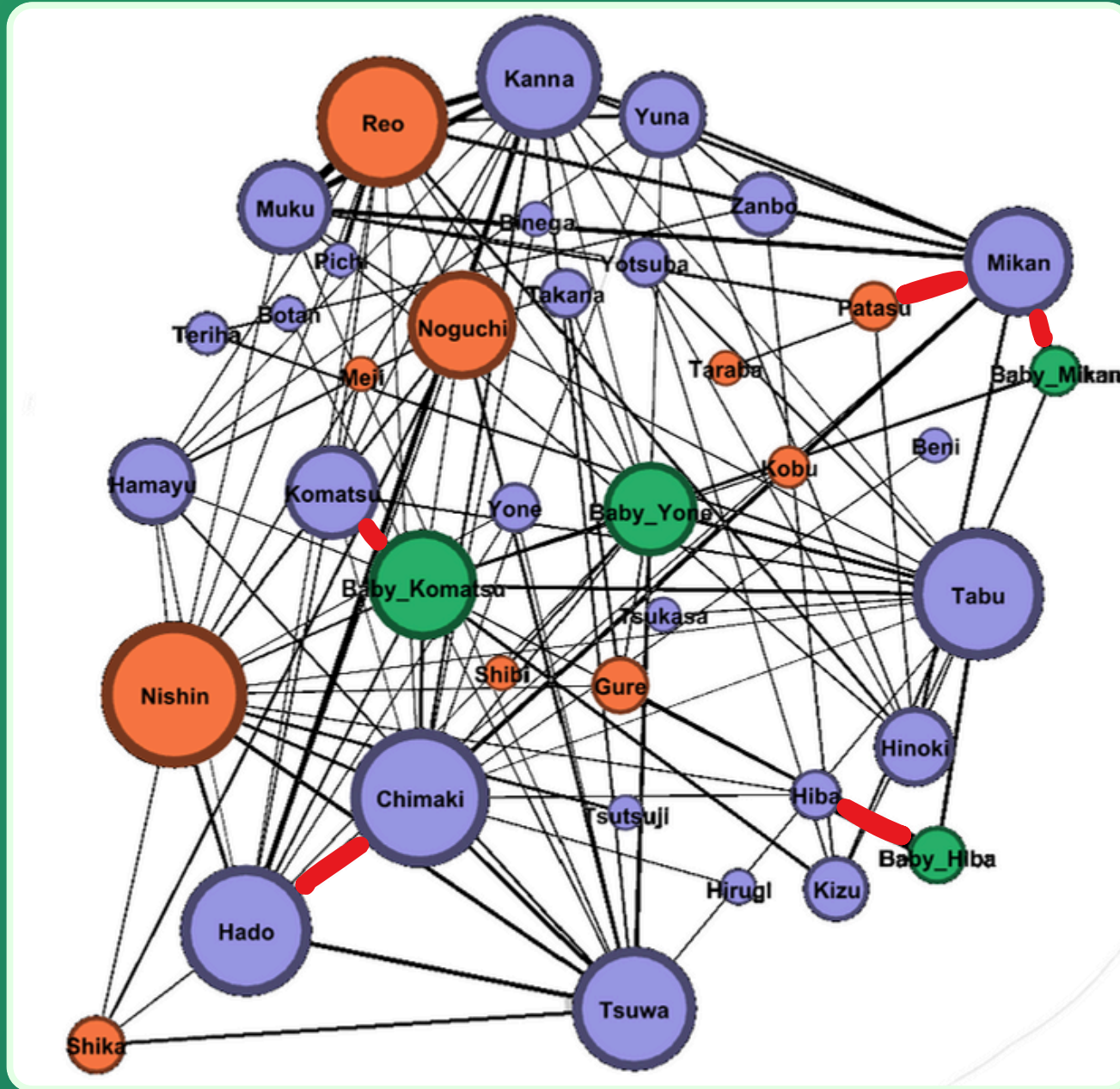
Partial network
Automatically generated



Full network
Traditional method



Partial network
Automatically generated



Consistent mother-infant link

Full network
Traditional method



LIMITS

Need to identify behaviors...

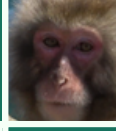
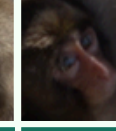










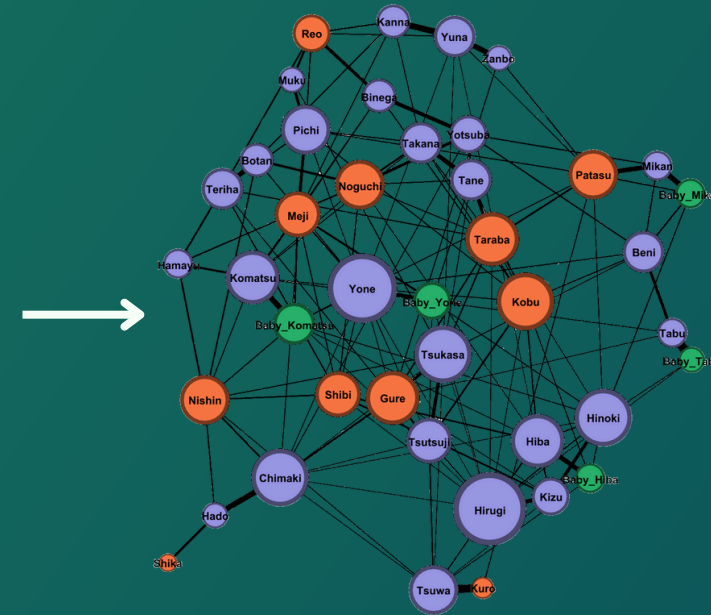
Affiliation 



Aggression 



					
	0	0,68	0,04	0,12	0,52
	0,68	0	0,27	0,69	0,03
	0,04	0,27	0	0,51	0,02
	0,12	0,69	0,51	0	0,1
	0,52	0,03	0,02	0,1	0



PHD PROJECT

General Objective

**STUDY OF SOCIAL AND CULTURAL DIVERSITY
AND ITS DETERMINANTS IN JAPANESE
MACAQUES WITH DEEP LEARNING**

STUDY OF SOCIAL AND CULTURAL DIVERSITY AND ITS DETERMINANTS IN JAPANESE MACAQUES WITH DEEP LEARNING

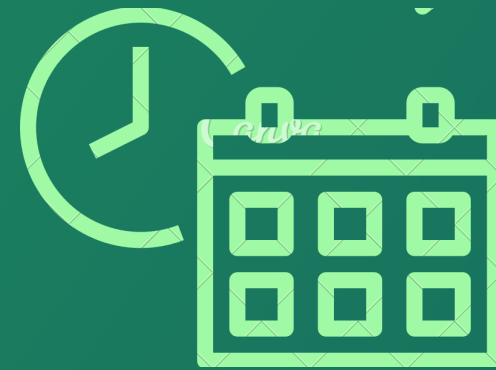


Data robustness

STUDY OF SOCIAL AND CULTURAL DIVERSITY AND ITS DETERMINANTS IN JAPANESE MACAQUES WITH DEEP LEARNING



Data robustness

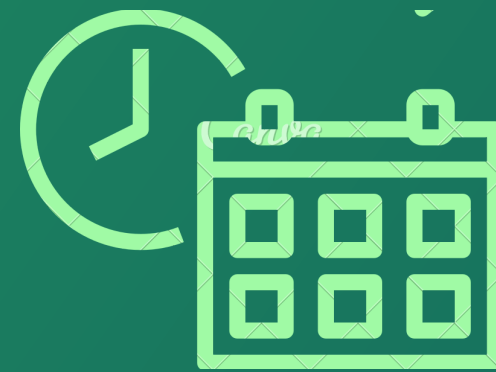


Long-time autonomy

STUDY OF SOCIAL AND CULTURAL DIVERSITY AND ITS DETERMINANTS IN JAPANESE MACAQUES WITH DEEP LEARNING



Data robustness



Long-time autonomy

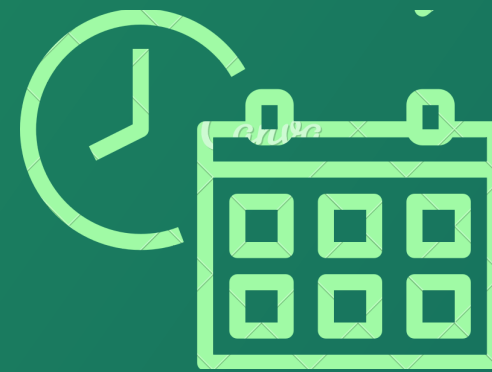


Multi-sites applicability

STUDY OF SOCIAL AND CULTURAL DIVERSITY AND ITS DETERMINANTS IN JAPANESE MACAQUES WITH DEEP LEARNING



Data robustness



Long-time autonomy



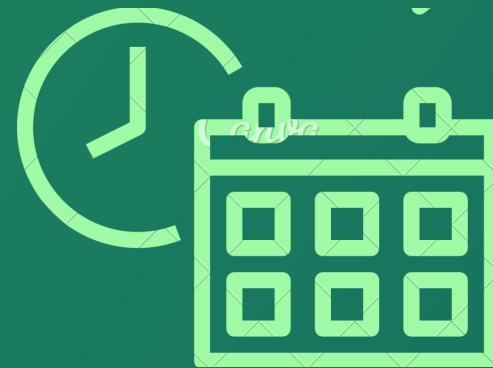
Multi-sites applicability

**AXE 1 : SOCIAL
STRUCTURE DIVERSITY**

STUDY OF SOCIAL AND CULTURAL DIVERSITY AND ITS DETERMINANTS IN JAPANESE MACAQUES WITH DEEP LEARNING



Data robustness



Long-time autonomy



Multi-sites applicability

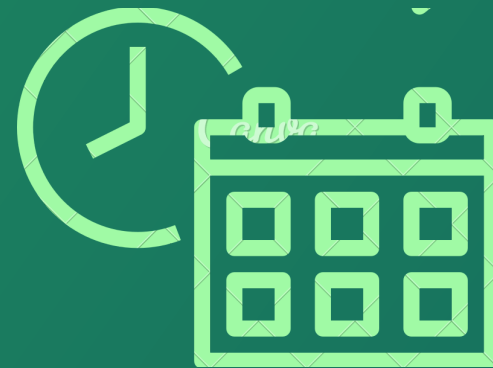
**AXE 1 : SOCIAL
STRUCTURE DIVERSITY**

**AXE 2 : CULTURAL
BEHAVIOR DIVERSITY**

STUDY OF SOCIAL AND CULTURAL DIVERSITY AND ITS DETERMINANTS IN JAPANESE MACAQUES WITH DEEP LEARNING



Data robustness



Long-time autonomy



Multi-sites applicability

**AXE 1 : SOCIAL
STRUCTURE DIVERSITY**

**AXE 2 : CULTURAL
BEHAVIOR DIVERSITY**

**AXE 3 : ANHTROPOGENIC
IMPACT**

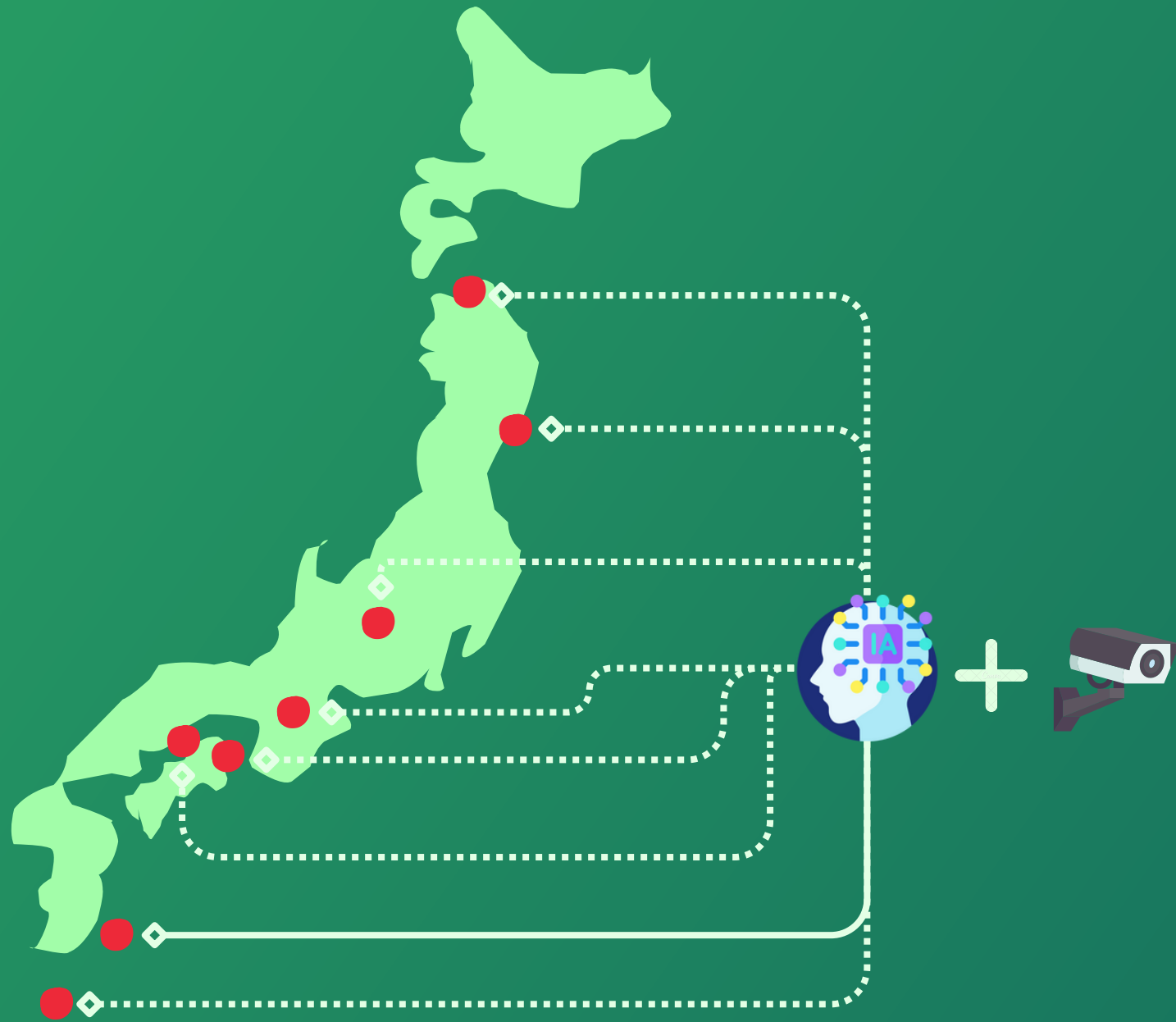
PHD PROJECT

Objective 1 : Social diversity



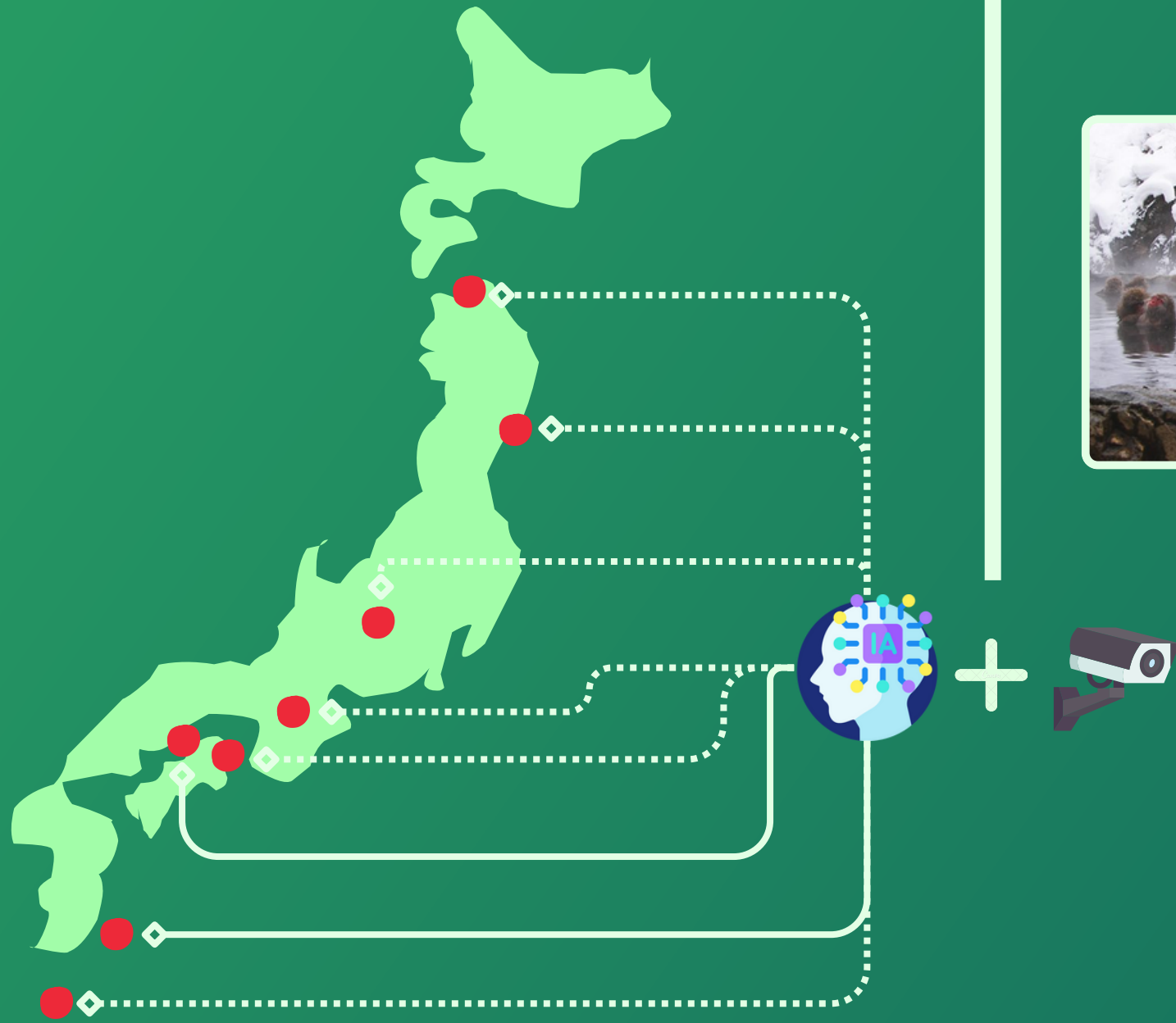
PHD PROJECT

Objective 1 : Social diversity



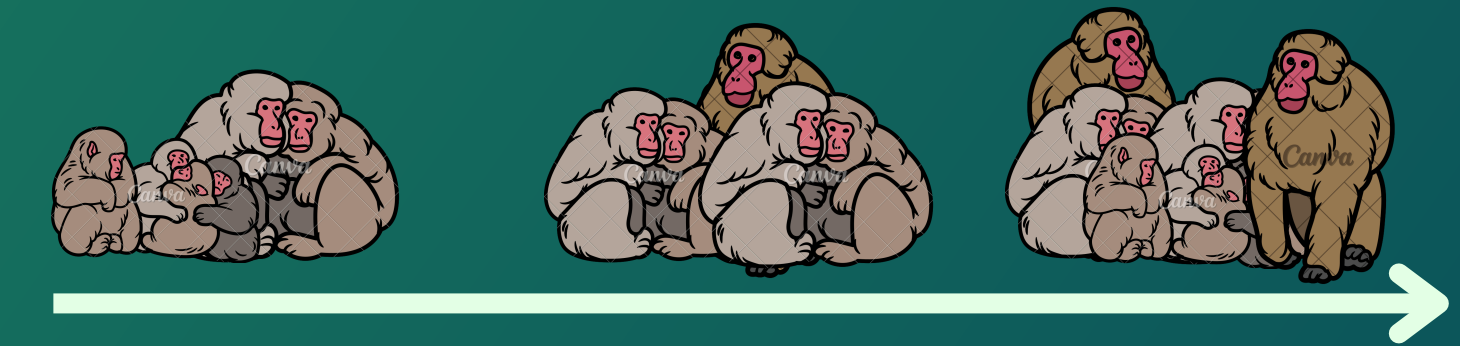
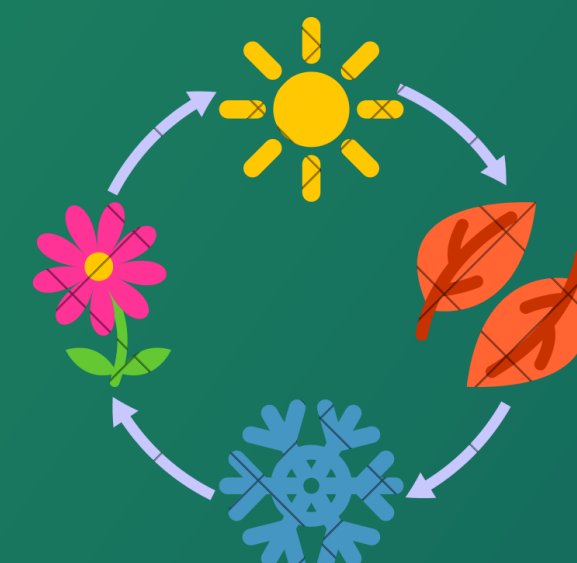
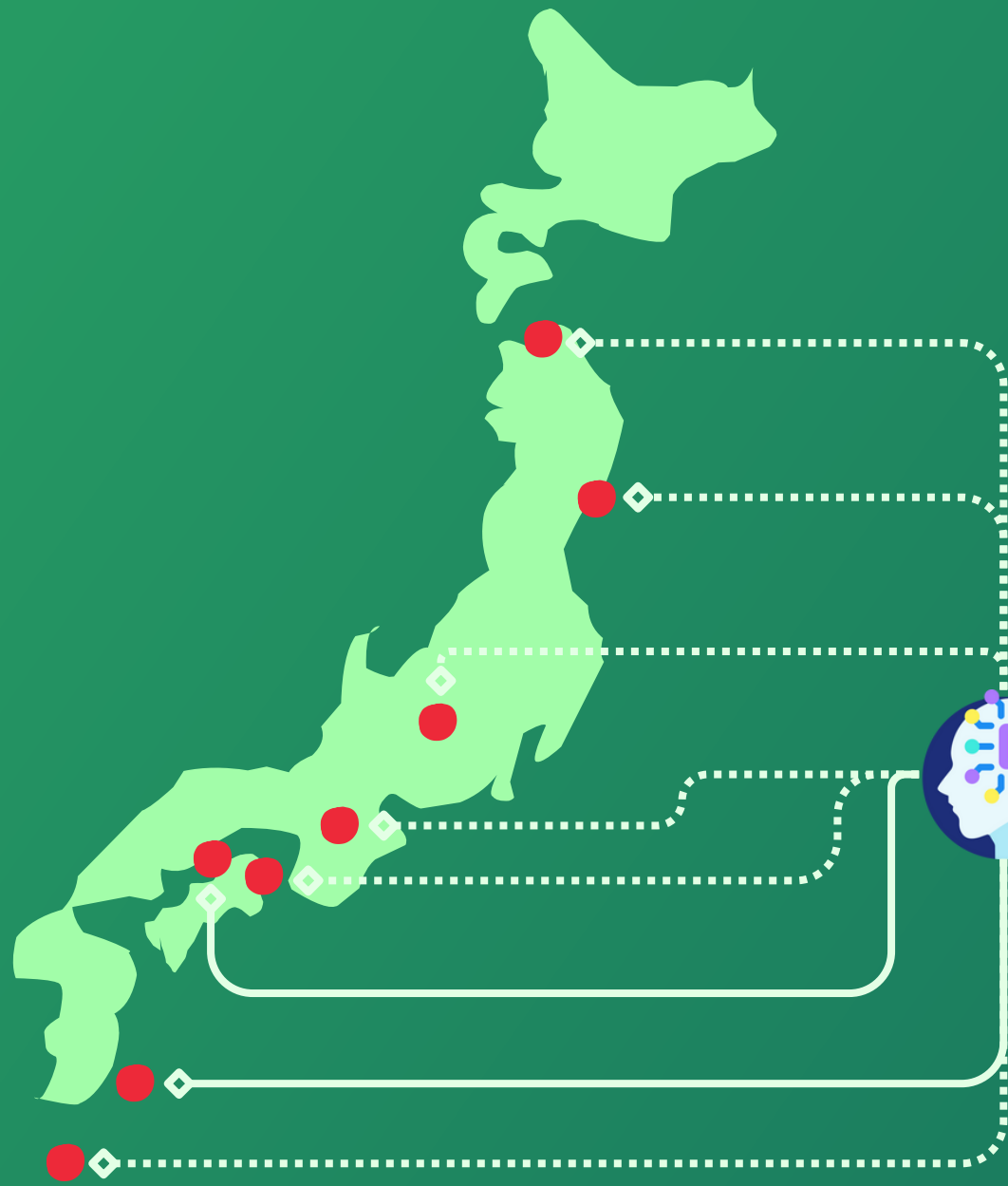
PHD PROJECT

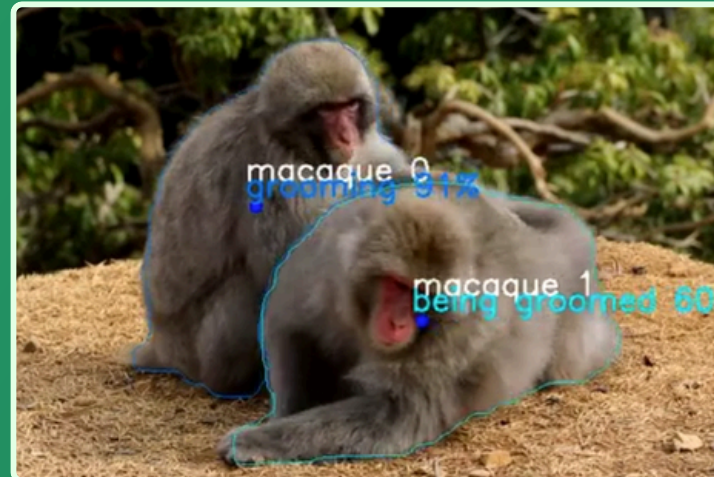
Objective 1: Social diversity



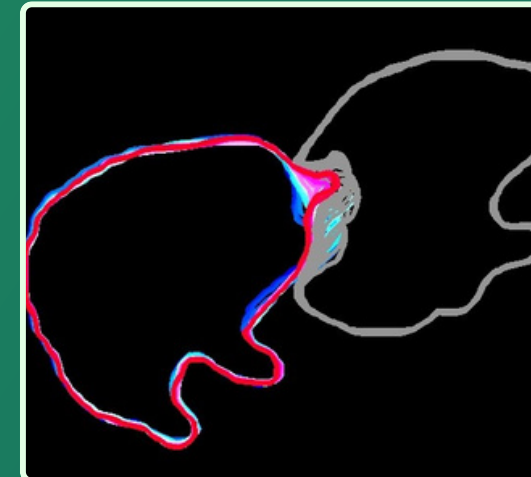
PHD PROJECT

Objective 1: Social diversity





Ardoin & Sueur (2024), Primates



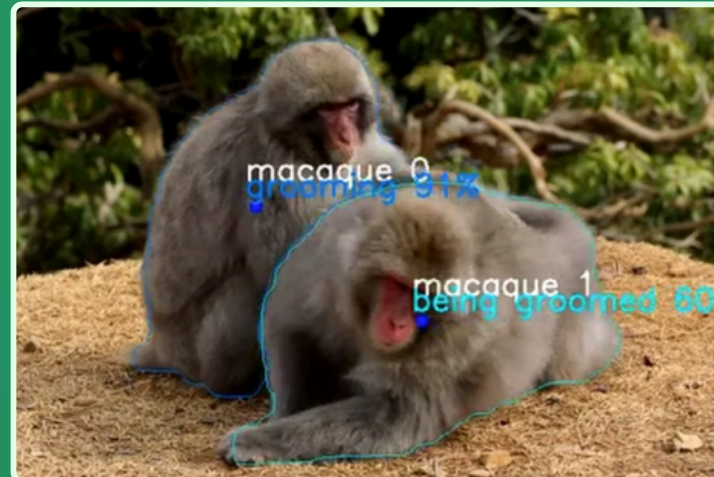
Behavior recognition



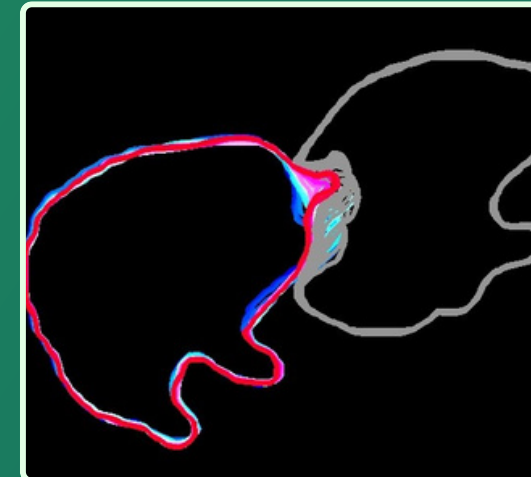
Sociodemographic and ontogenic impact

PHD PROJECT

Objective 2 : Behavioral diversity



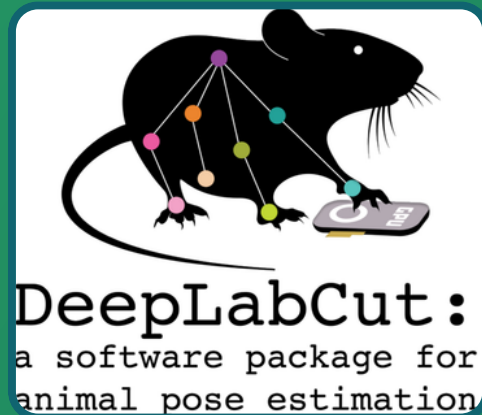
Ardoin & Sueur (2024), Primates



Behavior recognition

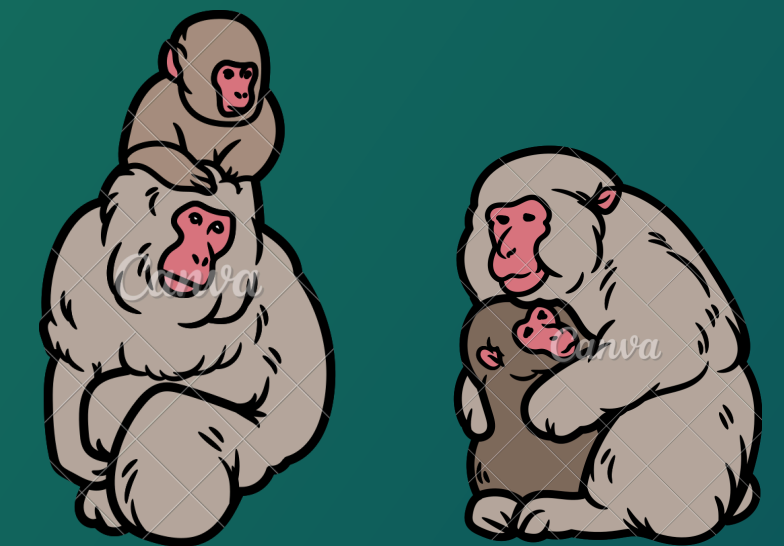


Sociodemographic and ontogenic impact



Labuguen et al. (2021), Front. Behav. Neurosci.

Movements recording



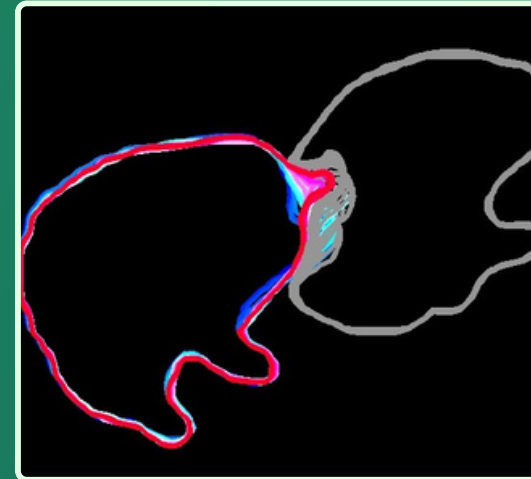
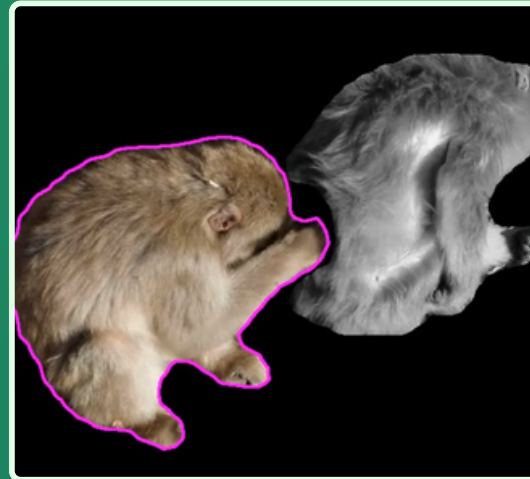
Social network impact

PHD PROJECT

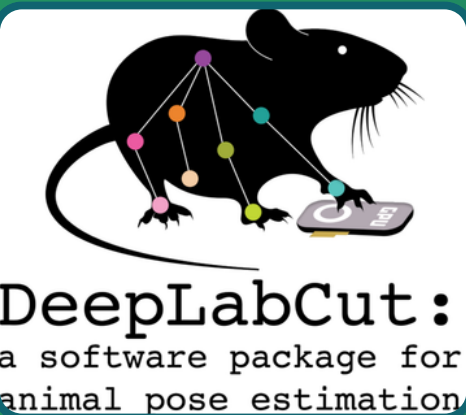
Objective 2 : Behavioral diversity



Ardoin & Sueur (2024), Primates



Behavior recognition



DeepLabCut:
a software package for
animal pose estimation



Labuguen et al. (2021), Front. Behav. Neurosci.

Movements recording



Inter-population
diversity



PHD PROJECT

Objective 3 : Anthropogenic impact



PHD PROJECT

Objective 3 : Anthropogenic impact



PHD PROJECT

Objective 3 : Anthropogenic impact



PHD PROJECT

Objective 3 : Anthropogenic impact



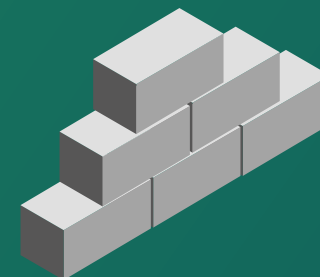
PHD PROJECT

Objective 3 : Anthropogenic impact



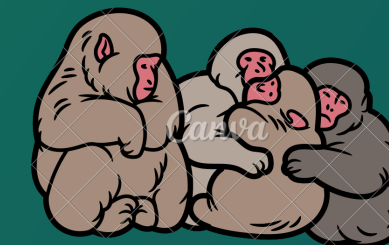
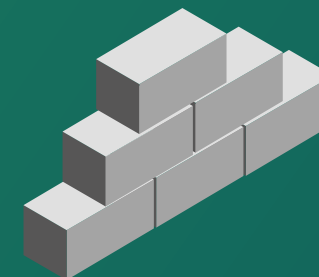
PHD PROJECT

Objective 3 : Anthropogenic impact



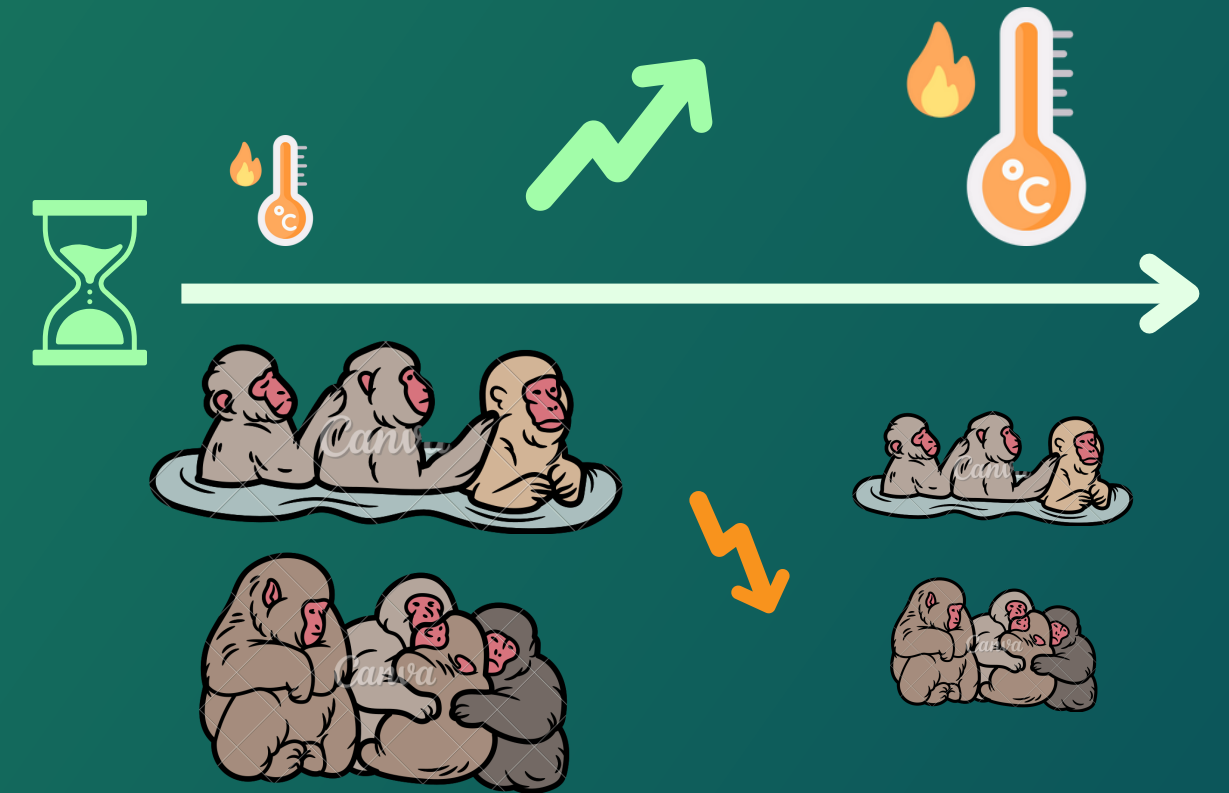
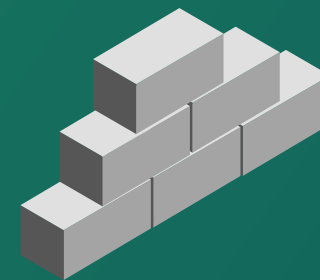
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Objective 3 : Anthropogenic impact



PHD PROJECT

Objective 3 : Anthropogenic impact



THANK YOU FOR YOUR ATTENTION !

