UNIVERSITÀ DI PAVIA
Department of Electrical, Computer and Biomedical Engineering

MORPHEUS

L'intelligenza artificiale applicata alle biotecnologie riproduttive

Danilo Cimadomo, Laboratorio di Biologia e Biotecnologie della Riproduzione

Giovanna Nicora, Laboratorio di Informatica Biomedica «Mario Stefanelli»

Pavia, June 19th 2025

UNIVERSITÀ DI PAVIA
BIO-MEDICAL INFORMATICS "Mario Stefanelli"
DBB Dipartimento di Biologia e Biotecnologie "L. Spallanzani"
Laboratorio di Biologia & Biotecnologie della Riproduzione LBBR

Population Decline in the World

1 su 7 coppie è infertile (OMS)

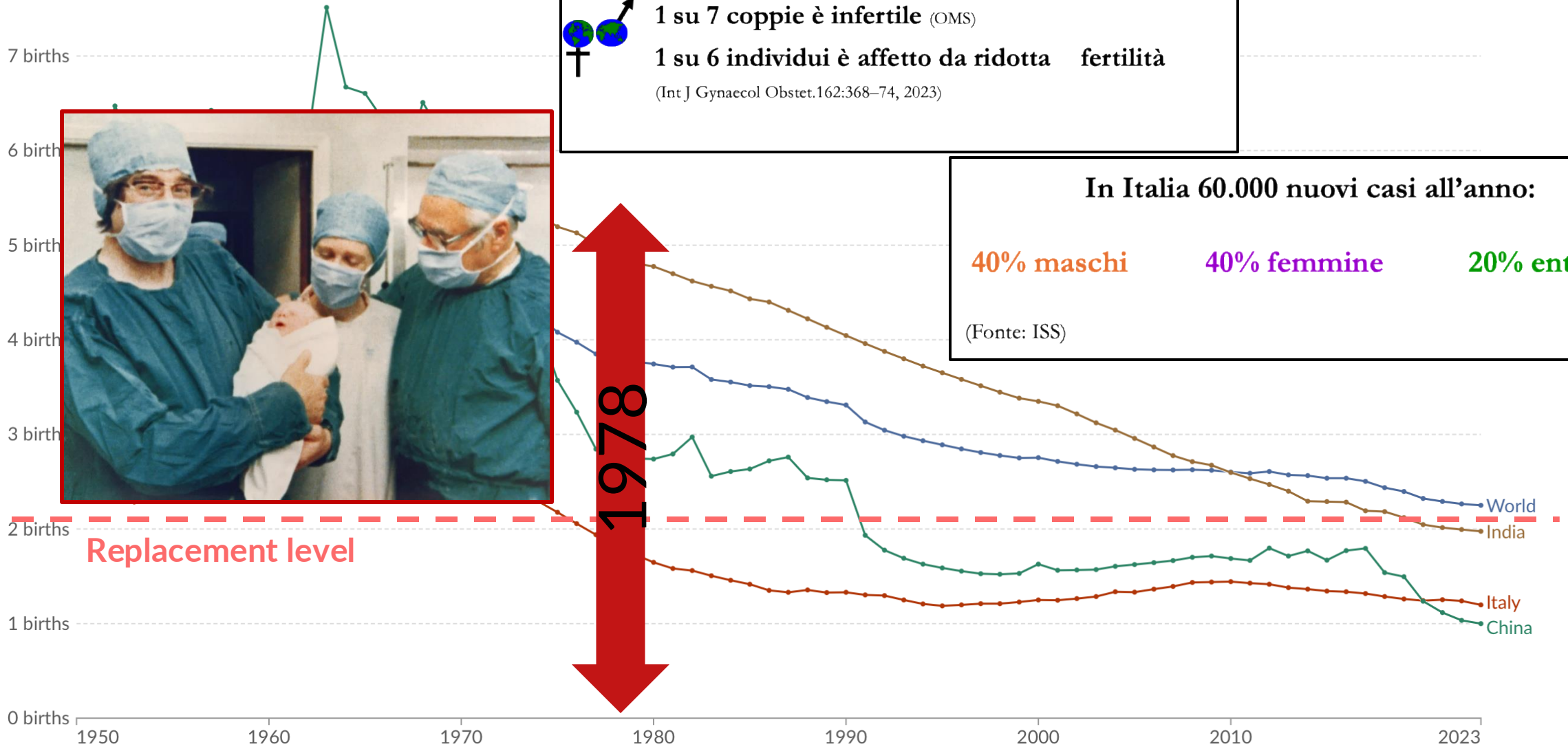
1 su 6 individui è affetto da ridotta fertilità

(Int J Gynaecol Obstet.162:368–74, 2023)

In Italia 60.000 nuovi casi all'anno:

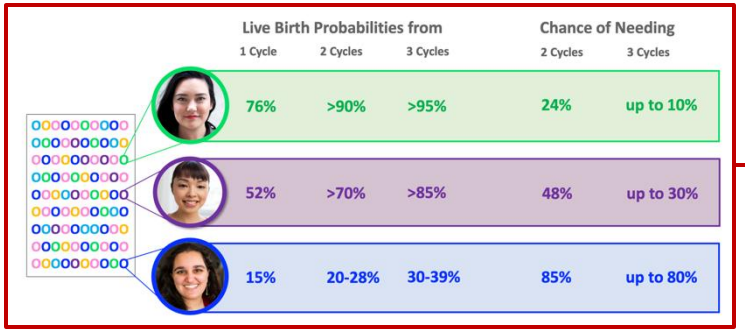
40% maschi **40% femmine** **20% entrambi**

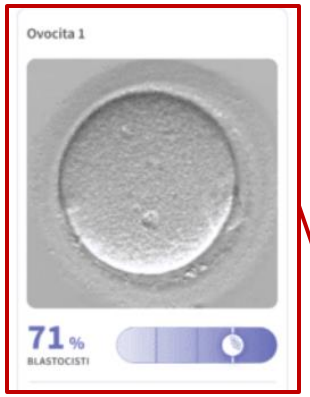
(Fonte: ISS)

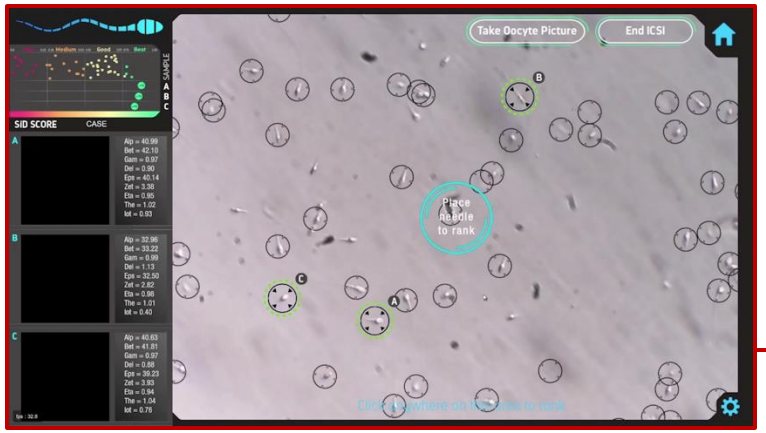


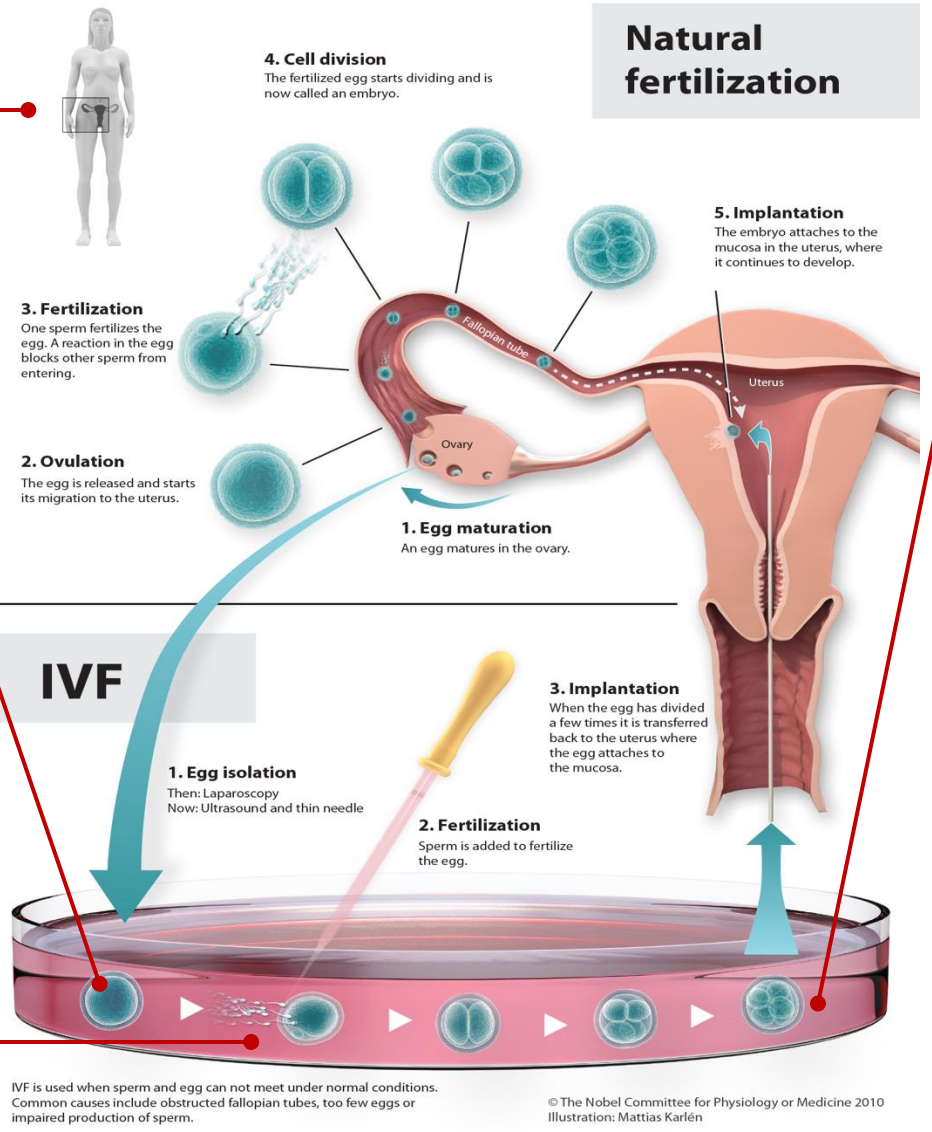
IFFS, Human Reproduction Update, 2024

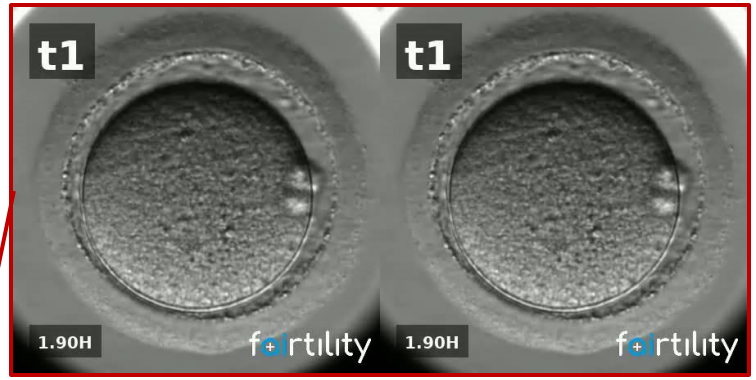
In vitro fertilization and AI

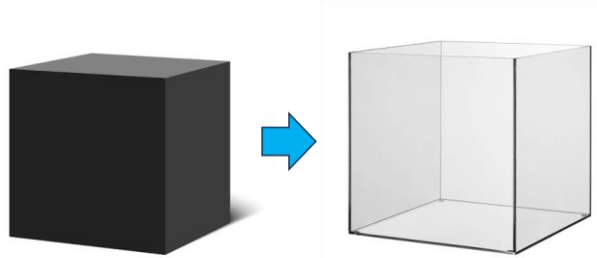












A tool combining **MORPH**ometrics and dynamics of 3D-reconstructed **E**mbryos to support IVF co**U**n**S**eling with explainable AI

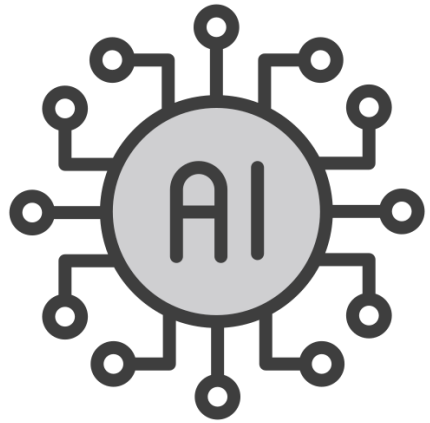
Morpheus: the greek god of nightmares and dreams

MORPHEUS

IVIRMA Global Research Alliance

UNIVERSITÀ DI PAVIA

EXPLAINABLE



- STUDY
- UNDERSTAND
- EXPLAIN

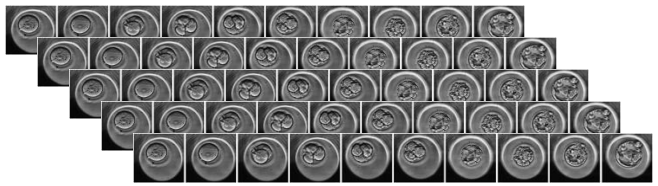
ESHRE Grant
For research in reproductive medicine

Morpheus Embryo Evaluation Pipeline

6047 embryos, time lapse video up to 7 days of culture

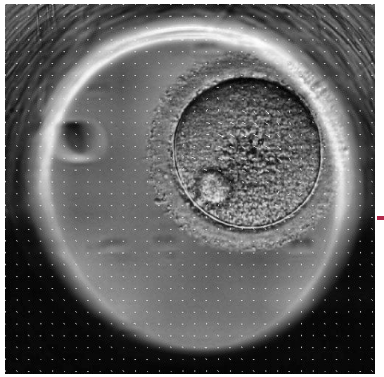
2013

2020

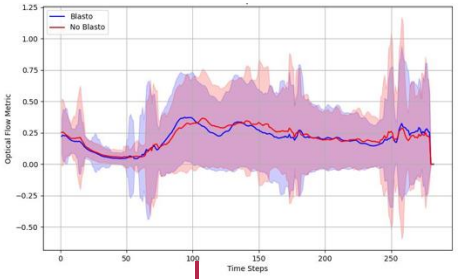


Time Lapse Videos

Optical Flow



Signal extraction and normalization



- **ROCKET**: **R**and**o**m **C**onvolutional **K**ernel **T**ransform
- **KNN**: **K**-**N**earest **N**eighbour

ML

- **LSTM**: **L**ong **S**hort **T**erm **M**emory
- **LSTM-FCN**: **LSTM**-**F**ully **C**onvolutional **N**etwork
- **ConvTran**: **Conv**olutional **Tran**sformer

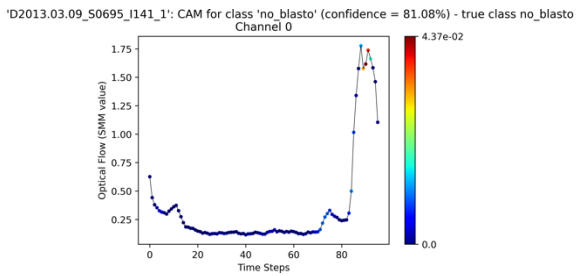
DL

Predicted Class

Class **0** (no_blastocyst)

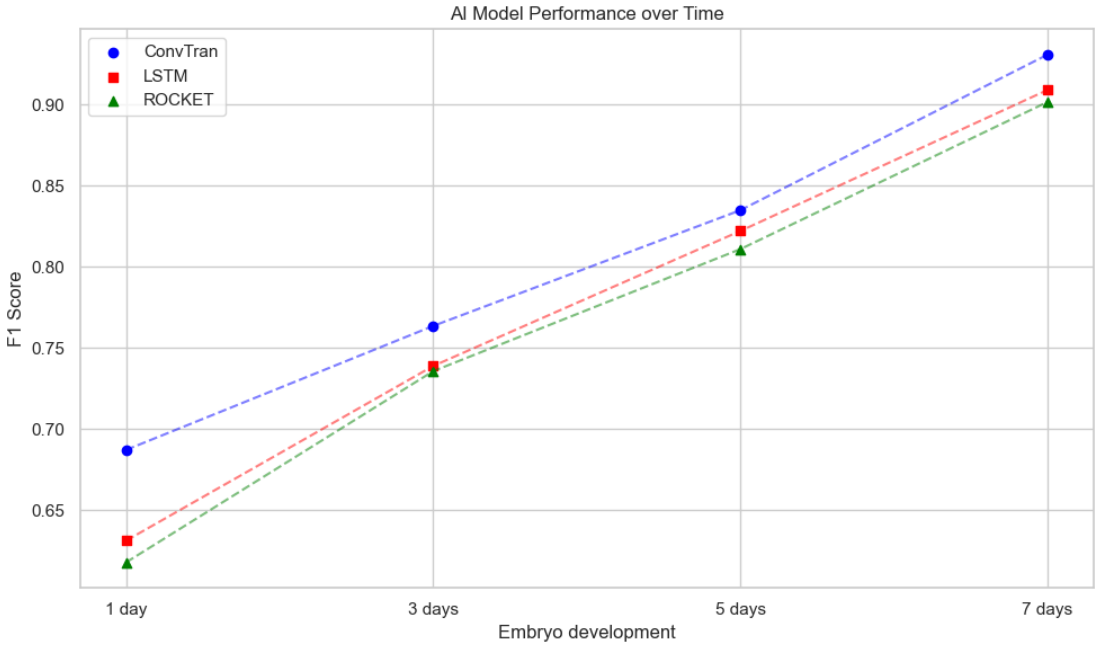
Class **1** (blastostocyst)

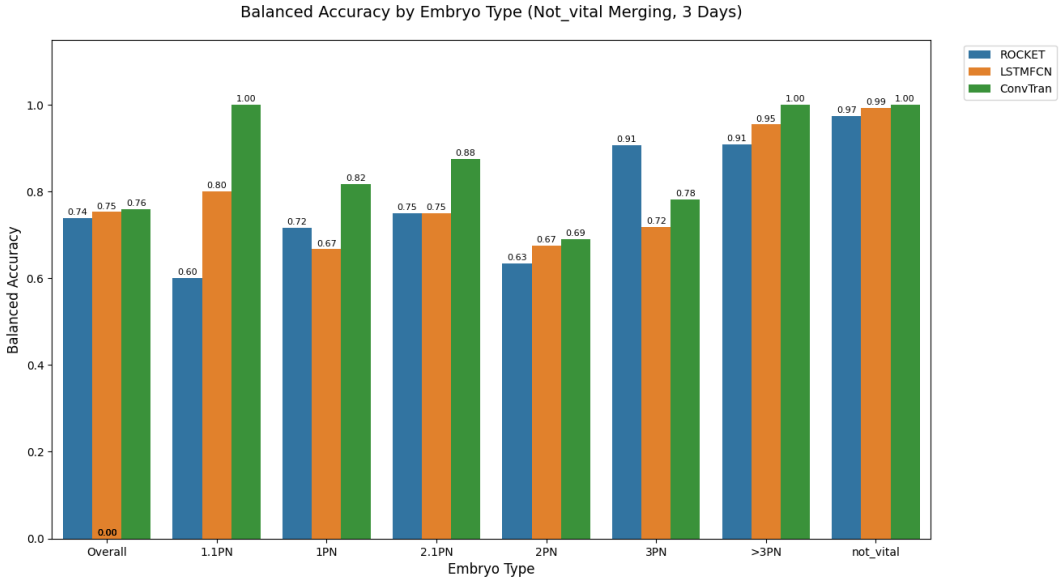
XAI & Results interpretation

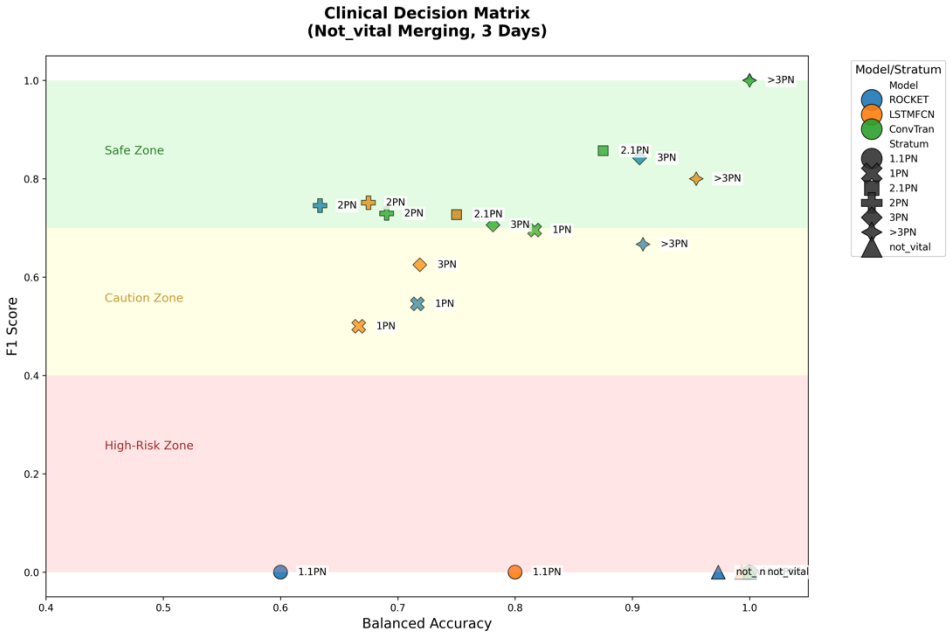


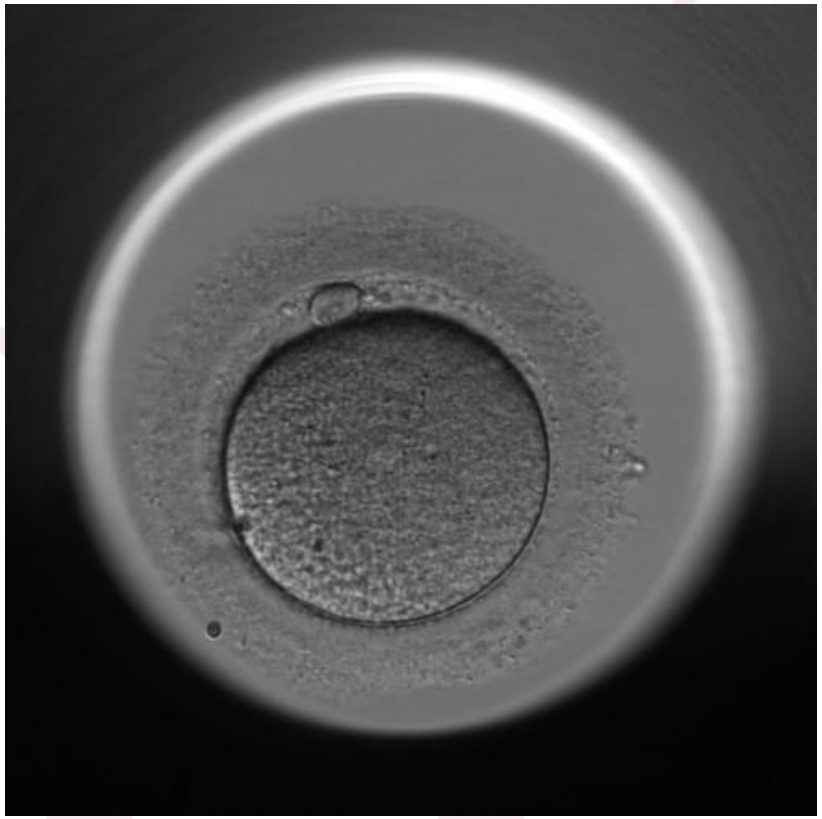
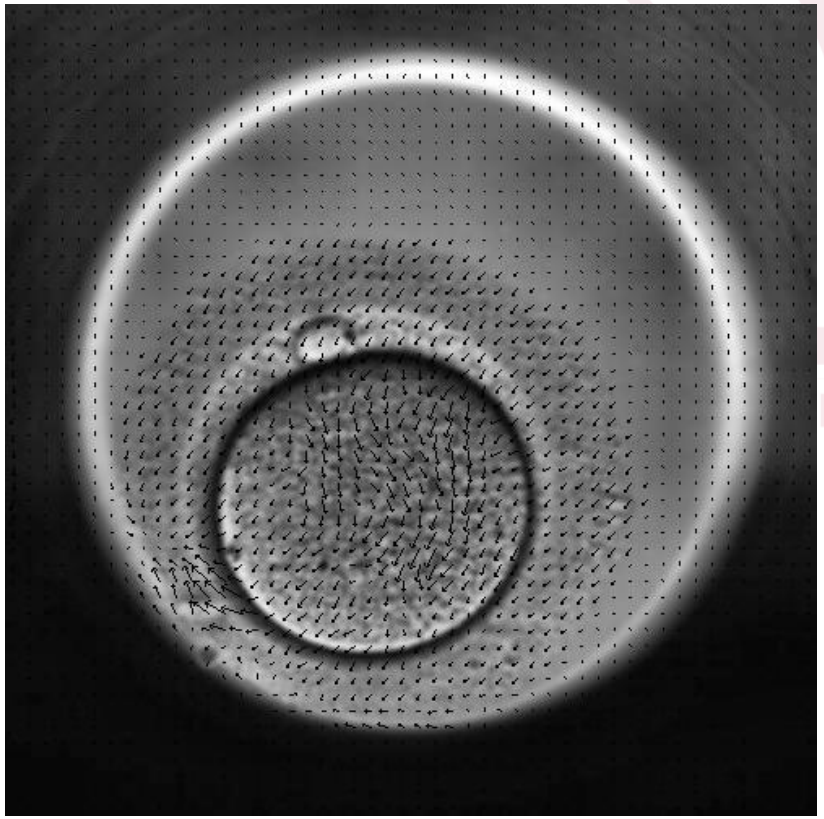
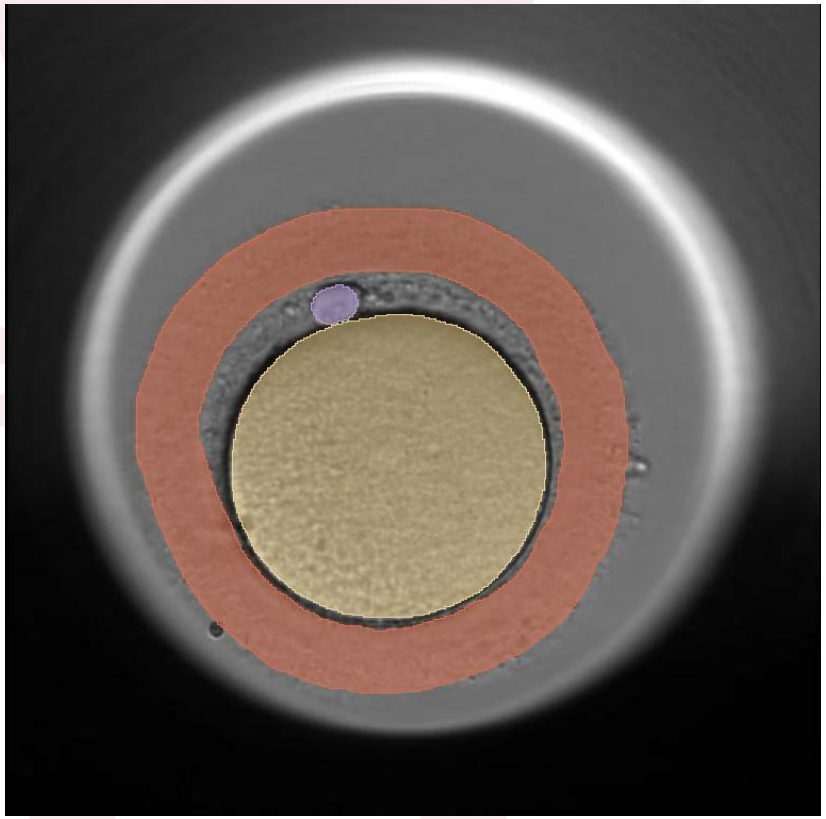
AI predictive ability and confidence at different days

Performance of the 3 AI models at different days during development







UNIVERSITÀ DI PAVIA

Take Home Messages

- La collaborazione tra biologi dello sviluppo e bioingegneri è cruciale per rispondere a **domande irrisolte in merito all'acquisizione e al mantenimento della competenza di gameti ed embrioni**
- Nei laboratori di IVF si producono quotidianamente **grandissime quantità di dati, video e immagini** che richiedono queste collaborazioni per farne fruttrare il **potenziale conoscitivo e scientifico**
- In termini di utilità clinica, la standardizzazione e l'automazione che derivano da questa collaborazione sono fondamentali a **ridurre il workload tecnico per incrementare il workload cognitivo e le capacità di counseling al paziente**

Acknowledgements:

LBBR:
Maurizio Zuccotti
Silvia Garagna
Giulia Fiorentino
Andrea Fantinato

Lab BMI:
Riccardo Bellazzi
Lorenzo Corso
Lucia Sacchi

Genera Roma:
Filippo Maria Ubaldi
Laura Rienzi
Alberto Vaiarelli
Giovanni Coticchio
Federica Innocenti
Marilena Taggi

IVI Valencia:
Marcos Meseguer

UNIVERSITÀ DI PAVIA