Finanziato dall'Unione europea NextGenerationEU
Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
ICSC Centro Nazionale di Ricerca in HPC, Big Data and Quantum Computing

CANDELA

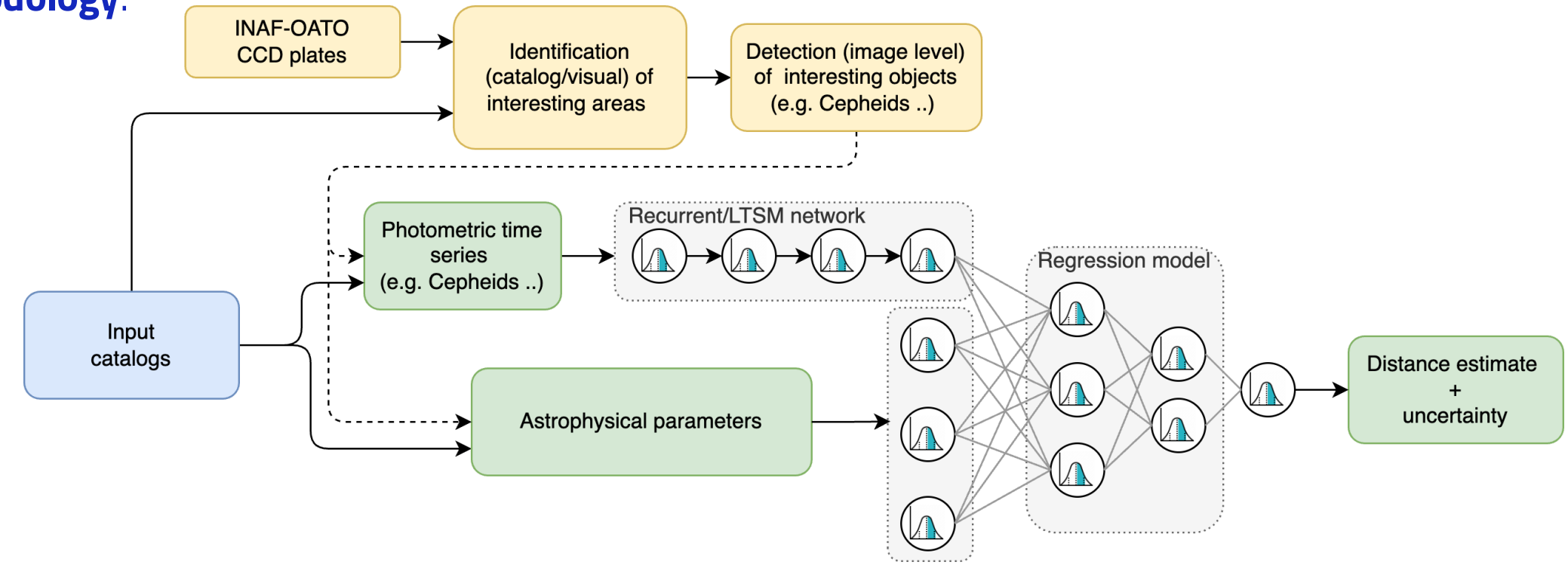
standard **CAN**dle-based **D**istance **E**stimation with **L**earning **A**lgorithms

Vanina Fissore, ITHACA S.r.l

Spoke 3 Progetti Bandi a Cascata, 24/09, 2024

Project Overview

- **Input**: Gaia DR3, OGLE catalog, astronomical plates from INAF-OATO
- **Methodology**:



- **Goal**: Distance Estimation with Learning Algorithms

Technical Objectives, Methodologies and Solutions 1/2

O1	Development of an ML model using analysis of photometric time series and stellar parameters, for inference of distance of Cepheid-type standard candles. Validation on a reference dataset provided by INAF-OATO.
Methodology	Integration of time series based models (e.g. LSTM) with models for tabular data (e.g. MLP) to correlate information from photometric series with astrometric and astrophysical parameters from catalogs (e.g. Gaia DR3) to eventually infer the astrometric distance of standard candles.
O2	Study of the propagation of uncertainties for the class of models (i.e., deep neural networks, recurrent neural networks) of interest, with the aim of providing an accurate estimate of the uncertainty on the predicted distance.
Methodology	Starting from model class identified in **O1**, integration of three source of uncertainty: ML model uncertainty, uncertainty on catalogue paramteres, uncertainty on ground truth distance. A possible strategy could leverage variational networks to incorporate such uncertainties.
O3	Extension, adaptation of the model developed for Cepheids to standard candle type RR Lyrae. Validation with a reference dataset provided by INAF-OATO.
Methodology	Extend model developed in **O1** to different type of standard candles: in pratice adapt and re-train the algoritm to take as input RR Lyrae parameters and photometric time series.

Technical Objectives, Methodologies and Solutions 2/2

O4	Identification of areas of interest using existing catalogs and visual inspection from astronomical plates .**`fits`** images provided by INAF-OATO.
Methodology	Check correspondance of the objects present in the digitalized astronomical plates both by comparison with existing catalogs (e.g. GAIA, OGLE) at coordinate level and by visual inspection with the scientific support of INAF-OATO
O5	Detection of interesting objects (e.g. Cepheids, RR Lyrae) in such areas of interest to futher enrich the standard candles catalogs with complementary information and generalize the developed algorithm on a different input dataset
Methodology	Using existing softwares (e.g. SExtractor, Astrometry.net) or developing ML-based detection algoritm perform detection at the image level of Cepheids and RR Lyrae and interesting objects in astronomical plates images. Include the available sources in training sets for models developed in **O1** and **O3** to enrich the dataset and generalise the model, with the scientific support of INAF-OATO.

Involved Staff and new recruitments

- **Vanina Fissore** (referente progetto, WP1, WP2, WP3,WP4, WP5)
- **Cristina Monaco** (WP1, WP2)
- **Davide Lisi** (WP1, WP2, WP3,WP4, WP5)
- **Andrea Lessio** (WP1, WP2, WP3,WP4, WP5)
- **Alessandro La Rocca** (WP1, WP2, WP3,WP4, WP5)
- **Elena Durando** (WP1, WP2, WP3,WP4, WP5)
- **Luciana Dequal** (referente amministrativa)

- **Referenti scientifiche INAF**: Beatrice Bucciarelli, Deborah Busonero, INAF-OATO

Timescale, Milestones, SAL

	1	2	3	4	5	6	7	8	9	10	11	12
WP1	x	x	x	MS1								
WP2			x	x	x	x	x	MS2				
WP3							x	MS3				
WP4					x	MS4						
WP5								x	x	x	x	MS5

MS1: Validation of output obtained with Cepheid model on existing catalogs;

MS2: Report on the methodology developed for estimation on the propagation of the uncertainties (both on astrophysical parameters and ML/DL model);

MS3: Validation of output obtained with RR Lyrae model on existing catalogs;

MS4: List of areas of interest identified in astronomical plates from INAF-OATO;

MS5: Enriched datasets with available detected objects from astronomical plates and generalised model.