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Deep learning of 87A-like supernovae progenitor characteristics: training the Inception model on synthetic data

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Scientific Rationale

- In the next few years, the number of available supernovaes observations will increase exponentially thanks to the LSST Survey
- Inferring the supernovae's progenitor characteristics is currently performed using several (computationally expensive) methods
- For instance, like Bayesian inference, that is computationally challenging as a Montecarlo search is involved to test the parameters
- Finding the characteristics of all the supernovae' progenitors will be practically unfeasible given the increasing observations

Technical Objectives, Methodologies and Solutions

- In this work, we aim at training a machine to infer the characteristics of the supernovae's progenitor: energy, mass, radius, and nickel content
- Machine Learning is well-suited for the task:
  - Noise and error-tolerance, inference meant as regression of the characteristics, fast computation, trainability on new data, and so on.
- Unfortunately, real-world observations are scarce
  - We train on generated time-series data from synthetic models, that provide bolometric luminosity and photospheric velocity
- This work is also meant as a test-bench for the new HPC capabilities that are under deployment
- We leverage the Inception model for time-series data
  - State-of-the-art for time-series processing is leveraged

Timescale, Milestones and KPIs

- **Submission (12-24 months) of the synthetic models**
- **Submission (12-24 months) of the deep learning approach for 87A-like supernovae**

Accomplished Work, Results

- **Dataset generation**
- **Implementation of the pre-processing pipeline**
- **Training and validation of the models on synthetic data**
- **Both on single-integration and hydrodynamic models, different results**
- **Inference (generalization) to real-world observations**

Next Steps and Expected Results (by next checkpoint: April 2024)

- Generalize from synthetic data to real-world observations during inference phase with lower error
- Dataset improvement
- New and more accurate synthetic model to improve the training data
- Curriculum learning: fine tune on hydrodynamic models (less data available, but more accurate)
- Model explanations to better understand what are the most important phases for the task. This is meant to help researchers spare observational resources that can be employed elsewhere