

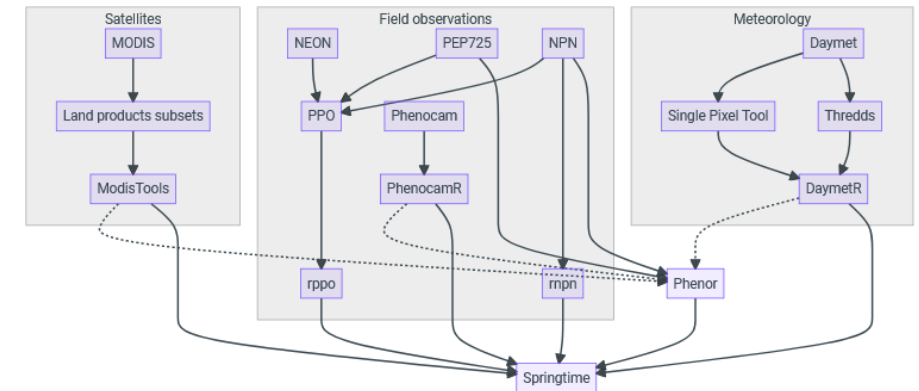
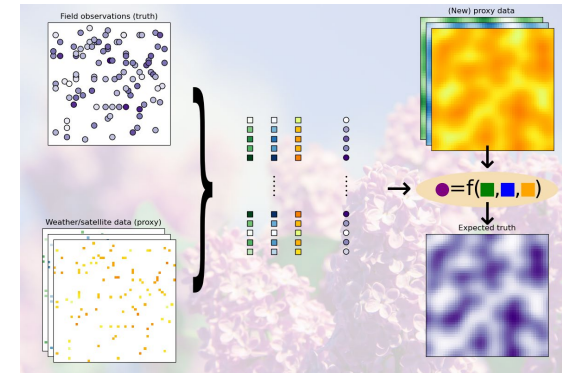
Springtime: An open-source python-based package for plant phenological studies

Mahdi Khodadadzadeh¹, Peter Kalverla², Fakhreh (Sarah) Alidoost², Stefan Verhoeven², and Raúl Zurita-Milla¹

¹ Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, 7522NH Enschede, The Netherlands

² Netherlands eScience Center, Science Park 140, 1098 XG Amsterdam, The Netherlands

- **Phenology** is the scientific discipline that explores the timing of plant life-cycle phases.
- It is a reliable indicator of **climate change**.
- Springtime (Spatiotemporal phenology research with interpretable models) is a **python-based open-source** package that caters to the needs of plant phenological research by focusing on **phenological data and models**.
- It is being developed as a collaborative effort between the **ITC Faculty Geo-Information Science and Earth Observation, the University of Twente**, and the **Netherlands eScience Center** under the framework of an OEC Early Career project titled "Mixed effects explainable boosting machines for spatio-temporal phenological modelling".
- Springtime brings together **datasets from various sources**. Where possible, we use existing tools to retrieve the data.
- It establishes a **shared foundation for phenological modelling**, a standardized workflow specification that encompasses both **numerical and advanced Machine Learning based models**.
- It aims at developing efficient Machine Learning based modelling solutions that capture the **complex correlations across both space and time** present and are **interpretable**.
- It focuses heavily on **streamlining the data and modelling workflows**, such that one can always execute them with a single command.
- It uses standardized locations for storing raw and intermediate data, and a standardized "**recipe**" format to define the steps in the workflows.
- It is being built upon the **FAIR principles** for both software and data management.
- You can run springtime as a **command-line** tool in a terminal or use it as a **python library** e.g. in a Jupyter notebook.



Mixed Effects Random Forest