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

Mahdi Khodadadzadeh¹, Peter Kalverla², Fakhereh (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.

Springtime repository and documentation: [https://github.com/phenology/springtime](https://github.com/phenology/springtime)