Earth System Science Hub Challenge February 2024 PREVIEW

- Challenge 1: **Detection of extreme events**
  - Science case: Heat, Drought, Cold Spell, Rainfall Events, Cevenole episodes,
  - Potential dataset(s): ESDC (one variable of choice), hydrology cube, or other applicable
  - Methods:
    - detect extremes: (e.g. Percentile technique; Ranking method for long time series or other)
    - compare the detected region of both methods
  - Goal: successful detection and visualisation of at least one extreme event using one variable
  - Further experimentation:
    - Use 2 variables (temp/prec/evap)
    - Spatial dimension along time
    - Contouring of the extreme area

- Challenge 2: **Spatio-temporal visualisation of complex satellite data**
  - Science case: Describe the effect of ashfall on plants near a volcanic eruption.
  - Potential dataset(s): ESDC, datasets for volcanic eruption *(remember to provide references to data source!)*
  - Methods:
    - graphical examination of different vegetation indices
    - identify appropriate visualisation region and time frames
  - Goal: spatiotemporal visualisation (video) of impact of ashfall on vegetation
  - Further experiments:
    - Repeat experiments on other volcanic eruptions

- Challenge 3: **Time series interpolation techniques for remote sensing**
  - Science case: generally applicable
  - Potential dataset(s): arbitrary data sources possible *(remember to provide references to data source!)*
  - Methods:
    - Select time series data
    - Introduce temporal gaps of different periods
    - Try to interpolate with different algorithms (i.e.: linear approaches, nonlinear regression, B-Splines, *Bezier splines or other)
 *Special motivation: *Pierre Bézier*
    - Compare interpolations with original time series
  - Goal: Create an evaluation table considering several aspects:
    - Computational cost
    - Interpolation error
    - Generalisation possibility
  - Further experiments:

        - Include additional information from neighbouring pixels

- Challenge 4: **Spatial gap filling in EO data**
    - Science case: generally applicable
    - Potential dataset(s): ESDC cube in chosen region
    - Methods:
        - Introduce spatial gaps of different sizes
        - Train CNN autoencoder (e.g. UNET)
    - Goal: gap filling of data and comparison with original data
    - Further experiments:
        - Evaluate accuracy given different gap sizes
        - Discuss your results with results from the time series interpolation challenge

- Challenge 5: **Dimension reduction with PCA**
    - Science case: generally applicable
    - Potential dataset(s): ESDC and Land Cover Cube in chosen region
    - Methods:
        - Principal Component Analysis (PCA)
    - Goal: compare complexity and compressibility
    - Further experiments:
        - Compare your results to other comparable challenges (autoencoder)
        - Collect ideas to expand from single pixel to a region

- Challenge 6: **Dimension reduction with autoencoder**
    - Science case: generally applicable
    - Potential dataset(s): ESDC and Land Cover Cube in chosen region
    - Methods:
        - simple autoencoder
    - Goal: compare complexity and features of different samples
    - Further experiments:
        - Compare your results to other comparable challenges (PCA)
        - Extend the model architecture (recurrent approach)

- Challenge 7: **Short term forecast**
    - Science case: forecast vegetation variables after heatwave (suggested region: Central Europe in 2018)
    - Potential dataset(s): ESDC, vegetation indices (e.g. kndvi, ndvi, GPP, SIF)
    - Methods:
        - linear trend of regions
        - regression through shallow neural networks
    - Goal: forecast vegetation behaviour and comparison with original measurements, explore forecast horizon: quality of prediction at difference time step sizes
    - Further experiments:

        - Introduce CNN techniques in neural networks

- Challenge 8: **Classification clustering from EO data**
    - Science Case: Classification of Land Cover Types from clustered spectral bands
    - Potential dataset(s): ESDC and Land Cover Cube in chosen region
    - Methods:
        - Cluster spectral bands (nbars) for land cover classification with K-means
        - Verify common classifications with Land Cover Types
    - Goal: create a map with different land cover types
    - Further Experiments:
        - Use additional algorithms: DBSCAN, MeanShift
        - Use different variables or spectral indices

- Challenge 9: **Spatial autocorrelation**
    - Science case: generally applicable
    - Potential dataset(s): ESDC (2m temperature or other local factors)
    - Methods:
        - Correlation metrics
        - Voronoi diagram / Delauney triangulation
    - Goal: Understand and explain spatial autocorrelation and create a biome map for Europe
    - Further experiments:
        - Add a second variable to this approach