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# **sport-activities-features**

***Release 0.4.2***

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# USER DOCUMENTATION

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sport-activities-features is a minimalistic toolbox for extracting features from sports activity files written in Python.

- **Free software:** MIT license
- **Github repository:** <https://github.com/firefly-cpp/sport-activities-features>
- **Python versions:** 3.8.x, 3.9.x, 3.10.x, 3.11.x, 3.12.x



## UNLEASHING THE POWER OF SPORTS ACTIVITY ANALYSIS: A FRAMEWORK BEYOND ORDINARY METRICS ?

Prepare to dive into the thrilling world of sports activity analysis, where hidden geographic, topological, and personalized data await their grand unveiling. In this captivating journey, we embark on a quest to extract the deepest insights from the wealth of information generated by monitoring sports activities. Brace yourself for a framework that transcends the limitations of conventional analysis techniques. ??

Traditional approaches often rely on integral metrics like total duration, total distance, and average heart rate, but they fall victim to the dreaded “overall metrics problem.” These metrics fail to capture the essence of sports activities, omitting crucial components and leading to potentially flawed and misleading conclusions. They lack the ability to recognize distinct stages and phases of the activity, such as the invigorating warm-up, the endurance-testing main event, and the heart-pounding intervals. ??♀?

Fortunately, our sport-activities-framework rises above these limitations, revealing a comprehensive panorama of your sports activity files. This framework combines the power of identification and extraction methods to unlock a treasure trove of valuable data. Picture this ? : effortlessly identifying the number of hills, extracting average altitudes of these remarkable formations, measuring the total distance conquered on those inclines, and even deriving climbing ratios for a true measure of accomplishment (total distance of hills vs. total distance). But that’s just the tip of the iceberg! The framework seamlessly integrates a multitude of extensions, including historical weather parsing, statistical evaluations, and ex-post visualizations that bring your data to life. ???











For those seeking to venture further, we invite you to explore the realms of scientific papers on data mining that delve into these captivating topics. Discover how our framework complements the world of generating and predicting automated sport training sessions, creating a harmonious synergy between theory and practice. ???






## DETAILED INSIGHTS

Prepare to be astounded by the capabilities of the sport-activities-features framework. It effortlessly handles TCX & GPX activity files and harnesses the power of the [Overpass API](#) nodes. Presenting the range of functions at your disposal:

- **Unleash the integral metrics:** From total distance to total duration and even calorie count, witness the extraction of these vital statistics with a single glance.  (Integral Metrics Extraction example)
- **Conquer the peaks:** Ascend to new heights by extracting topographic features like the number of hills, their average altitudes, the total distance covered on these majestic slopes, and the thrilling climbing ratio. Prepare for a breathtaking adventure!  (Hill Data Extraction example)
- **Embark on a visual journey:** Immerse yourself in the beauty of your accomplishments as you plot the identified hills on a mesmerizing map. Witness the landscape come alive before your eyes.  (Draw Map with Identified Hills example)
- **Embrace the rhythm of intervals:** Explore the intervals within your sports activities, uncovering their numbers, durations, distances, and heart rates. Unveil the heartbeat of your performance!  (Draw Map with Identified Intervals example)
- **Calculate the training loads:** Dive deep into the intricate world of training loads and discover the Banister TRIMP and Lucia TRIMP methods. Gain invaluable insights into optimizing your training regimen.  (Calculate Training Load example)
- **Weather the storm:** Unlock the power of historical weather data from external services, adding a fascinating layer of context to your sports activities. 
- **Unveil the secrets within coordinates:** Explore the integral metrics of your activities within specific geographical areas, uncovering valuable data on distance, heart rate, and speed. Peer into the depths of your performance!  (Extract Data Inside Area example)
- **Embrace randomness:** Extract activities from CSV files and indulge in the excitement of randomly selecting a specific number of activities. Embrace the element of surprise!  (Extract Random Activities from CSV example)
- **Conquer the dead ends:** Unravel the mysteries of your sports activities by identifying the dead ends. Prepare to navigate the uncharted territories of your performance!  (Dead End Extraction example)
- **Unlock the format:** Seamlessly convert TCX files to GPX, opening doors to even more possibilities. Adapt and conquer!  (Convert TCX to GPX example)

And that's just the beginning! The sport-activities-framework holds countless other features, awaiting your exploration. Brace yourself for an exhilarating journey of discovery, where the ordinary becomes extraordinary, and your sports activities come alive like never before. 

The framework comes with two (testing) [benchmark datasets](#), which are freely available to download from: [DATASET1](#), [DATASET2](#).



## HISTORICAL WEATHER DATA

Weather data parsed is collected from the [Visual Crossing Weather API](#). Please note that this is an external unaffiliated service, and users must register to use the API. The service has a free tier (1000 Weather reports/day) but is otherwise operating on a pay-as-you-go model. For pricing and terms of use, please read the [official documentation](#) of the API provider.



## **OVERPASS API & OPEN ELEVATION API INTEGRATION**

Without performing activities, we can use the [OpenStreetMap](#) for the identification of hills, total ascent, and descent. This is done using the [Overpass API](#), which is a read-only API that allows querying of OSM map data. In addition to that altitude, data is retrieved by using the [Open-Elevation API](#), which is an open-source and free alternative to the Google Elevation API. Both of the solutions can be used by using free publicly accessible APIs ([Overpass](#), [Open-Elevation Public API](#)) or can be self-hosted on a server or as a Docker container ([Overpass Self-hosting](#), [Open-Elevation Self-hosting](#)).



## DOCUMENTATION

The main documentation is organized into a couple of sections:

- *User Documentation*
- *Developer Documentation*
- *About*

### 5.1 Getting Started

This section is going to show you how to use the sport-activities-features toolbox.

#### 5.1.1 Installation

Firstly, install sport-activities-features package using the following command:

```
pip install sport-activities-features
```

To install sport-activities-features on Fedora, use:

```
dnf install python3-sport-activities-features
```

To install sport-activities-features on Arch Linux, please use an [AUR helper](#):

```
yay -Syyu python-sport-activities-features
```

To install sport-activities-features on Alpine, use:

```
apk add py3-sport-activities-features
```

After the successful installation you are ready to run your first example.

## 5.1.2 Examples

You can find usage examples [here](#).

## 5.2 Installation

### 5.2.1 Setup development environment

#### Requirements

- Poetry: <https://python-poetry.org/docs/>

After installing Poetry and cloning the project from GitHub, you should run the following command from the root of the cloned project:

```
$ poetry install
```

All of the project's dependencies should be installed and the project ready for further development. **Note that Poetry creates a separate virtual environment for your project.**

#### Development dependencies

List of sport-activities-features dependencies:

Package	Version	Platform
matplotlib	^3.3.3	All
geopy	^2.0.0	All
overpy	^0.6	All
geotiler	^0.14.5	All
numpy	*	All
tcxreader	^0.4.4	All
pandas	*	All
niaaml	^1.2.0	All
tcx2gpx	0.1.4	All
gpxpy	1.4.2	All

List of development dependencies:

Package	Version	Platform
ruff	^0.0.292	Any
pytest	^7.2.2	Any
coveralls	^2.2.0	Any
Sphinx	^5.0.0	Any
sphinx-rtd-theme	^1.0.0	Any
sphinxcontrib-bibtex	^2.4.1	Any



## 5.3 Testing

Before making a pull request, if possible provide tests for added features or bug fixes.

In case any of the test cases fails, those should be fixed before we merge your pull request to master branch.

For the purpose of checking if all test are passing locally you can run following command:

```
$ poetry run python -m unittest discover
```

## 5.4 Documentation

To locally generate and preview documentation run the following command in the project root folder:

```
$ poetry run sphinx-build ./docs ./docs/_build
```

If the build of the documentation is successful, you can preview the documentation in the docs/\_build folder by clicking the index.html file.

## 5.5 API

This is the sport-activities-features API documentation, auto generated from the source code.

### 5.5.1 Activity generator

**class** sport\_activities\_features.activity\_generator.**SportyDataGen** (\*\*kwargs)

Bases: object

Class that contains selected and modified SportyDataGen methods for generation of sports activity collections.

#### Parameters

**\*\*kwargs** – various arguments

#### Reference:

Fister Jr., I., Vrbančič, G., Brezočnik, L., Podgorelec, V., & Fister, I. (2018). SportyDataGen: An Online Generator of Endurance

Sports Activity Collections.

In Central European Conference on Information and Intelligent Systems (pp. 171-178). Faculty of Organization and Informatics Varazdin.

#### Reference URL:

<http://www.iztok-jr-fister.eu/static/publications/225.pdf>

---

**Note:** [WIP] This class is still under developement, therefore its methods may not work as expected.

---

**random\_generation\_without\_clustering** (*activities*) → None

Method for the random generation of sport activities (without clustering).

**Parameters**

**activities** –

**Note:**

Select n activities randomly without any special preprocessing tasks.

## 5.5.2 Area Identification

**class** sport\_activities\_features.area\_identification.**AreaIdentification** (*positions:*  
*array,*  
*distances:*  
*array,*  
*times-*  
*tamps:*  
*array,*  
*heart\_rates:*  
*array,*  
*area\_coordinates:*  
*array*)

Bases: object

Area identification based by coordinates.

**Parameters**

- **positions** (*np.array*) – coordinates of positions as an array of latitudes and longitudes
- **distances** (*np.array*) – cummulative distances as an array of floats
- **timestamps** (*np.array*) – information about time as an array of datetimes
- **heart\_rates** (*np.array*) – heart rates as an array of integers
- **area\_coordinates** (*np.array*) – coordinates of the area where data is analysed as an array of latitudes and longitudes

**Reference:**

L. Lukač, “Extraction and Analysis of Sport Activity Data Inside Certain Area”, 7th Student Computer Science Research Conference StuCoSReC, 2021, pp. 47-50, doi: <https://doi.org/10.18690/978-961-286-516-0.9>.

**do\_two\_line\_segments\_intersect** (*p1: array, p2: array, p3: array, p4: array*) → bool

Method for checking whether two line segments have an intersection point.

**Parameters**

- **p1** (*np.array*) – first point of the first line as a pair of coordinates
- **p2** (*np.array*) – second point of the first line as a pair of coordinates
- **p3** (*np.array*) – first point of the second line as a pair of coordinates
- **p4** (*np.array*) – second point of the second line as a pair of coordinates

### Returns

True if the two lines have an intersection point, False otherwise.

### Return type

bool

**static draw\_activities\_inside\_area\_on\_map** (*activities: array, area\_coordinates: array*) → None

Static method for drawing all the activities inside of an area on the map.

### Parameters

- **activities** (*np.array*) – array of AreaIdentification objects
- **area\_coordinates** (*np.array*) – border coordinates of an area as an array of latitudes and longitudes.

**draw\_map** () → None

Method for the visualization of the exercise on the map using Geotiler.

**extract\_data\_in\_area** () → dict

Method for extracting the data of the identified points in area.

**Returns: area\_data:** {

‘distance’: distance, ‘time’: time, ‘average\_speed’: average\_speed, ‘minimum\_heart\_rate’: minimum\_heart\_rate, ‘maximum\_heart\_rate’: maximum\_heart\_rate, ‘average\_heart\_rate’: average\_heart\_rate

}.

**static get\_area\_coordinates\_around\_point** (*point: array, distance: int*) → array

Static method to get area coordinates around the point on Earth according to given distance. Area limits consist of 4 border points.

### Parameters

- **point** (*np.array*) – a pair of Earth coordinates
- **distance** (*int*) – desired distance from given point to area border points

### Returns

an array of area coordinates.

### Return type

np.array

**identify\_points\_in\_area** () → None

Method for identifying the measure points of the activity inside of the specified area.

**is\_equal** (*value\_1: float, value\_2: float*) → bool

Method for checking whether the two float values are equal with certain tolerance (because of round error).

### Parameters

- **value\_1** (*float*) – first value
- **value\_2** (*float*) – second value

### Returns

True if the two values are equal, false otherwise.

### Return type

bool

**static plot\_activities\_inside\_area\_on\_map** (*activities: array, area\_coordinates: array*) → None

Static method for plotting the area borders and the activities (or their parts) inside of an area.

**Parameters**

- **activities** (*np.array*) – array of AreaIdentification objects
- **area\_coordinates** (*np.array*) – border coordinates of an area as an array of latitudes and longitudes.

**plot\_map** () → None

Method for plotting the map using Geotiler according to the object variables.

## 5.5.3 Classes

**class** sport\_activities\_features.classes.**StoredSegments** (*segment, ascent, average\_slope=None*)

Bases: object

Class for stored segments.

**Parameters**

- **()** (*ascent*) –
- **()** –
- **average\_slope** () –

**Note:**

[WIP] This class is still under developement, therefore its methods may not work as expected.

## 5.5.4 Data Analysis

**class** sport\_activities\_features.data\_analysis.**DataAnalysis** (*\*\*kwargs*)

Bases: object

Class for data analysis that uses automated machine learning to analyze extracted sport features.

**Parameters**

**\*\*kwargs** – various arguments.

**analyze\_data** (*src: str, fitness\_name: str, population\_size: uint64, number\_of\_evaluations: uint64, optimization\_algorithm: str, classifiers: Iterable, feature\_selection\_algorithms: Iterable = None, feature\_transform\_algorithms: Iterable = None, imputer: str = None*) → Pipeline

Method for running AutoML process using NiaAML PipelineOptimizer class instance.

**Parameters**

- **src** (*str*) – path to a CSV file
- **fitness\_name** (*str*) – name of the fitness class to use as a function
- **population\_size** (*uint*) – number of individuals in the optimization process
- **number\_of\_evaluations** (*uint*) – number of maximum evaluations

- **optimization\_algorithm** (*str*) – name of the optimization algorithm to use
- **classifiers** (*Iterable[Classifier]*) – array of names of possible classifiers
- **feature\_selection\_algorithms** (*Optional[Iterable[str]]*) – array of names of possible feature selection algorithms
- **feature\_transform\_algorithms** (*Optional[Iterable[str]]*) – array of names of possible feature transform algorithms
- **imputer** (*Optional[str]*) – name of the imputer used for features that contain missing values

**Returns**

instance of Pipeline object from the NiaAML framework

**Return type**

Pipeline

---

**Note:** See NiaAML’s documentation for more details on possible input parameters’ values and further usage of the returned Pipeline object.

---

**static load\_pipeline** (*file\_name: str*) → Pipeline

Method for loading a NiaAML’s pipeline from a binary file.

**Parameters**

**file\_name** (*str*) – path to a binary pipeline file

---

**Note:** See NiaAML’s documentation for more details on the use of the Pipeline class.

---

## 5.5.5 Data Extraction

**class** sport\_activities\_features.data\_extraction.**DataExtraction** (*activities: list*)

Bases: object

Class for storing activities’ analysed data in CSV files.

**Parameters**

**activities** (*list*) – list of activities.

**extract\_data** (*path: str*) → None

This method is used for extracting the data of the activities into separate CSV files.

**Parameters**

**path** (*str*) – absolute path where the CSV files should be saved.

### 5.5.6 Data Extraction from csv files

```
class sport_activities_features.data_extraction_from_csv.DataExtractionFromCSV(activities:  
                                                                           list  
                                                                           =  
                                                                           None)
```

Bases: object

Class for extracting data from CSV files.

**Parameters**

**activities** (*list*) – list of activities.

**from\_all\_files** (*path: str*) → list

Method for extracting data to list of dataframes from all CSV files in the folder.

**Parameters**

**path** (*str*) – absolute path to the folder with CSV files

**Returns**

list of activities.

**Return type**

list

**from\_file** (*path: str*) → list

Method for extracting data from CSV file to dataframe.

**Parameters**

**path** (*str*) – absolute path to the CSV file

**Returns**

list of activities.

**Return type**

list

**select\_random\_activities** (*number: int*) → list

Method for selecting random activities.

**Parameters**

**number** (*int*) – desired number of random activities

**Returns**

list of random activities.

**Return type**

list

### 5.5.7 Dead End Identification

```

class sport_activities_features.dead_end_identification.DeadEndIdentification (positions:
    array,
    distances:
    array,
    tolerance_degrees:
    float
    =
    5.0,
    tolerance_position:
    float
    =
    5.0,
    minimum_distance:
    int
    =
    500,
    U_turn_allowed_distance:
    int
    =
    50)

```

Bases: object

Class for identifying and visualising dead ends in an exercise. Dead end is a part of an exercise, where an athlete suddenly makes a U-turn takes the same path as before the U-turn is conducted in the opposite direction.

#### Parameters

- **positions** (*np.array*) – array of positions as pairs of latitudes and longitudes
- **distances** (*np.array*) – array of cumulative distances
- **tolerance\_degrees** (*float*) – tolerance of driving the same route in the opposite direction given in degrees
- **tolerance\_position** (*float*) – tolerance of positions given in meters
- **minimum\_distance** (*int*) – minimum distance of a dead end
- **U\_turn\_allowed\_distance** (*int*) – maximum distance of a U-turn while turning around and starting a dead end

---

**Note:** [WIP] This class is still under developement, therefore its methods may not work as expected.

---

**draw\_map** () → None

Method for visualisation of the exercise with identified dead ends.

**identify\_dead\_ends** () → None

Method for identifying dead ends of the exercise.

**is\_dead\_end** (*azimuth\_1: float, azimuth\_2: float, tolerance\_azimuth: float*) → bool

Method for checking whether two azimuths represent a part of a dead end allowing the given tolerance.

**Parameters**

- **azimuth\_1** (*float*) – first azimuth
- **azimuth\_2** (*float*) – second azimuth
- **tolerance\_azimuth** (*float*) – difference tolerance of the two azimuths

**Returns**

**True if given azimuths are within the given tolerance,**  
False otherwise.

**Return type**

bool

**long\_enough\_to\_be\_a\_dead\_end** (*start\_distance: float, finish\_distance: float*) → bool

Method for checking whether a dead end is long enough to be a dead end.

**Parameters**

- **start\_distance** (*float*) – cumulative distance at the start of the dead end
- **finish\_distance** (*float*) – cumulative distance at the end of the dead end

**Returns**

True if dead end is long enough, False otherwise.

**Return type**

bool

**really\_is\_dead\_end** (*position1: array, position2: array, tolerance\_coordinates: float*) → bool

Method for checking whether a dead end really is a dead end.

**Parameters**

- **position1** (*np.array*) – position of the first point
- **position2** (*np.array*) – position of the second point
- **tolerance\_coordinates** (*float*) – the tolerance between the two positions in meters

**Returns**

**True if a track segment is a part of dead end,**  
False otherwise.

**Return type**

bool

**reorganize\_exercise\_data** (*positions: array, distances: array, interval\_distance: int = 1*) → None

Method for reorganising the exercise in the way that the trackpoints are organized in a constant interval of distance.

**Parameters**

- **positions** (*np.array*) – array of positions as pairs of latitudes and longitudes
- **distances** (*np.array*) – array of cumulative distances
- **interval\_distance** (*int*) – desired distance between two neighboring points.



**show\_map** () → <module 'matplotlib.pyplot' from '/usr/lib64/python3.12/site-packages/matplotlib/pyplot.py'>

Method for plotting the exercise with dead ends.

**Return type**

plt.

### 5.5.8 File Manipulation

**class** sport\_activities\_features.file\_manipulation.**FileManipulation**

Bases: object

Superclass of GPXFile and TCXFile. Contains common methods of both classes, that have the same implementation. e.g. (filling missing values).

**count\_missing\_values** (*list*)

Counts the number of elements with value Nona.

**Args:**

list (list/ndarray): list to check

**returns**

number of elements with value None in list.

**rtype**

(int)

**linear\_fill\_missing\_values** (*activity*, *key*, *max\_seconds=15*)

Function that lineary fills missing values, if the successive missing values are up to (max\_seconds) apart.

**Args:**

activity: TCXReader read file key (str): dictionary key (e.g. 'heartrates', 'distances', ...)

max\_seconds (int): maximum time between two valid values, to still fill the missing values.

**Returns:**

/ Transforms the sent array / list.

### 5.5.9 GPX Manipulation

**class** sport\_activities\_features.gpx\_manipulation.**GPXFile**

Bases: *FileManipulation*

Class for reading GPX files.

**extract\_integral\_metrics** (*filename*) → dict

Method for parsing one GPX file and extracting integral metrics.

**Returns:** int\_metrics: {

```

        "activity_type": activity_type, "distance": distance, "duration": duration, "calories": calories,
        "hr_avg": hr_avg, "hr_max": hr_max, "hr_min": hr_min, "altitude_avg": altitude_avg, "altitude_max": altitude_max, "altitude_min": altitude_min, "ascent": ascent, "descent": descent,
    }.

```

**read\_directory** (*directory\_name: str*) → list

Method for finding all GPX files in a directory.

**Parameters**

**directory\_name** (*str*) – name of the directory in which to identify GPX files

**Returns**

array of paths to the identified files.

**Return type**

list

**read\_one\_file** (*filename, numpy\_array=False*)

Method for parsing one GPX file.

**Parameters**

- **filename** (*str*) – name of the TCX file to be read
- **numpy\_array** (*bool*) – if set to true dictionary lists are transformed into numpy.arrays

**Returns: activity: {**

```

    'activity_type': activity_type, 'positions': positions, 'altitudes': altitudes, 'distances': distances,
    'total_distance': total_distance, 'timestamps': timestamps, 'heartrates': heartrates, 'speeds':
    speeds

```

```

    }.

```

**Note:**

In the case of missing value in raw data, we assign None.

```

class sport_activities_features.gpx_manipulation.GPXTrackPoint (longitude: float =
                                                                None, latitude: float =
                                                                None, elevation: float
                                                                = None, time=None,
                                                                distance=None,
                                                                hr_value: int = None,
                                                                cadence=None, watts:
                                                                float = None, speed:
                                                                float = None)

```

Bases: object

Class for saving GPX point records.

**Parameters**

- **longitude** (*float*) – longitude in degrees
- **latitude** (*float*) – latitude in degrees
- **elevation** (*float*) – elevation in meters
- **time** (*datetime*) – datetime of time at the given point

- **distance** (*float*) – total distance travelled until this point
- **hr\_value** (*int*) – heart beats per minute at given recording.
- **cadence** (*int*) – cadence
- **watts** (*float*) – watts power rating
- **speed** (*float*) – speed in km/h.

**from\_GPX** (*gpx: GPXTrackPoint, hr\_value: int = None, cadence: int = None, watts: int = None*) → None

Helper method for initialising GPXTrackPoint from the gpxpy.gpx.GpxTrackPoint.

#### Parameters

- **gpx** (*gpxpy.gpx.GPXTrackPoint*) – gpxpy.gpx.GPXTrackPoint not to be confused with class of the same name used in gpx\_manipulation
- **hr\_value** (*int*) – heart beats per minute at given recording
- **cadence** (*int*) – cadence
- **watts** (*int*) – watts power rating.

### 5.5.10 Hills

```
class sport_activities_features.hill_identification.GradeUnit (value, names=<not given>, *values, module=None, qualname=None, type=None, start=1, boundary=None)
```

Bases: Enum

Enum for selecting the type of data we want returned in hill slope calculation (degrees / radians or gradient (%))

```
class sport_activities_features.hill_identification.HillIdentification (altitudes: List[float], distances: List[float] = None, ascent_threshold: float = 30)
```

Bases: object

Class for identification of hills from TCX file.

#### Parameters

- **altitudes** (*list*) – an array of altitude values extracted from TCX file
- **ascent\_threshold** (*float*) – parameter that defines the hill (hill >= ascent\_threshold)
- **distances** (*list*) – optional, allows calculation of hill grades (steepnes)

**identify\_hills** () → None

Method for identifying hills and extracting total ascent and descent from data.

---

**Note:** [WIP] Algorithm is still in its preliminary stage.

---

**return\_hill** (*ascent: float, ascent\_threshold: float = 30*) → bool

Method for identifying whether the hill is steep enough to be identified as a hill.

**Parameters**

- **ascent** (*float*) – actual ascent of the hill
- **ascent\_threshold** (*float*) – threshold of the ascent that is used for identifying hills

**Returns**

True if the hill is recognised, False otherwise

**Return type**

bool

**return\_hills** () → list

Method for returning identified hills.

**Returns**

array of identified hills

**Return type**

list

### 5.5.11 Intervals

**class** sport\_activities\_features.interval\_identification.IntervalIdentificationByHeartRate (

Bases: object

Class for identifying intervals based on heart rate.

**Parameters**

- **distances** (*list*) – list of cumulative distances
- **timestamps** (*list*) – list of timestamps

- **altitudes** (*list*) – list of altitudes
- **heart\_rates** (*list*) – list of heart rates
- **minimum\_time** (*int*) – minimum time of an interval given in seconds

**calculate\_interval\_statistics** () → dict

Method for calculating interval statistics.

**Returns**

```
data = {
    'number_of_intervals': number_of_intervals, 'min_duration_interval':
    min_duration_interval, 'max_duration_interval': max_duration_interval,
    'avg_duration_interval': avg_duration_interval, 'min_distance_interval':
    min_distance_interval, 'max_distance_interval': max_distance_interval,
    'avg_distance_interval': avg_distance_interval, 'min_hearttrate_interval':
    min_hearttrate_interval, 'max_hearttrate_interval': max_hearttrate_interval,
    'avg_hearttrate_interval': avg_hearttrate_interval,
}
```

**identify\_intervals** () → None

Method for identifying intervals from given data.

**return\_intervals** () → list

Method for retrieving identified intervals.

**Returns**

identified intervals

**Return type**

list

```
class sport_activities_features.interval_identification.IntervalIdentificationByPower (distances: list,
times-tamps: list,
al-
ti-
tudes: list,
mass: int,
min-
i-
mum_1 int
=
30)
```

Bases: object

Class for identifying intervals based on power.

**Parameters**

- **distances** (*list*) – list of cummulative distances
- **timestamps** (*list*) – list of timestamps

- **altitudes** (*list*) – list of altitudes
- **mass** (*int*) – total mass of an athlete given in kilograms
- **minimum\_time** (*int*) – minimum time of an interval given in seconds

**calculate\_interval\_statistics** () → dict

Method for calculating interval statistics.

**Returns**

```
data = {
    'number_of_intervals': number_of_intervals, 'min_duration': min_duration_interval,
    'max_duration': max_duration_interval, 'avg_duration': avg_duration_interval,
    'min_distance': min_distance_interval, 'max_distance': max_distance_interval,
    'avg_distance': avg_distance_interval,
}
```

**identify\_intervals** () → None

Method for identifying intervals from given data.

**return\_intervals** () → list

Method for retrieving identified intervals.

**Returns**

identified intervals

**Return type**

list

## 5.5.12 Missing Elevation Identification

```
class sport_activities_features.missing_elevation_identification.ElevationApiType (value,
names=<not
given>,
*val-
ues,
mod-
ule=None,
qual-
name=None,
type=None,
start=1,
bound-
ary=None)
```

Bases: Enum

```
class sport_activities_features.missing_elevation_identification.ElevationIdentification(open_elevation_api: str, positions: list[tuple[float, float]]):
    """
    Class for retrieving elevation data using Elevation Api, Open-Elevation API and OpenTopoData API supported.

    Parameters
    • open_elevation_api (str) – address of the Api, default https://api.open-elevation.com/api/v1/lookup
    • positions (list[tuple(float, float)]) – list of tuples of latitudes and longitudes.

    fetch_elevation_data (payload_formatting: bool = True) → list
    Method for making requests to the Elevation API to retrieve elevation data.

    Parameters
    • payload_formatting (bool) – True -> break into chunks, False -> don't break self.positions into chunks

    Returns
    list of elevations for the given positions.

    Return type
    list[int]
    """
```

Bases: object

Class for retrieving elevation data using Elevation Api, Open-Elevation API and OpenTopoData API supported.

#### Parameters

- **open\_elevation\_api** (*str*) – address of the Api, default <https://api.open-elevation.com/api/v1/lookup>
- **positions** (*list[tuple(float, float)]*) – list of tuples of latitudes and longitudes.

**fetch\_elevation\_data** (*payload\_formatting: bool = True*) → list

Method for making requests to the Elevation API to retrieve elevation data.

#### Parameters

**payload\_formatting** (*bool*) – True -> break into chunks, False -> don't break self.positions into chunks

#### Returns

list of elevations for the given positions.

#### Return type

list[int]

**fetch\_open\_elevation\_data** (*payload\_formatting: bool = True*) → list

Method for making requests to the Open Elevation API to retrieve elevation data.

**Parameters**

**payload\_formatting** (*bool*) – True -> break into chunks, False -> don't break self.positions into chunks

**Returns**

list of elevations for the given positions.

**Return type**

list[int]

**fetch\_open\_topo\_data** (*payload\_formatting: bool = True*) → list

Method for making requests to the Open Topo Data API to retrieve elevation data.

**Parameters**

**payload\_formatting** (*bool*) – True -> break into chunks, False -> don't break self.positions into chunks

**Returns**

list of elevations for the given positions.

**Return type**

list[int]

## 5.5.13 Overpy Node Manipulation

**class** sport\_activities\_features.overpy\_node\_manipulation.**OverpyNodesReader** (*open\_elevation\_api: str = 'https://api.open-elevation.com/api/v1/locations'*)

Bases: object

Class for working with Overpass nodes (Overpy.node). The purpose is to generate a dictionary object similar to those generated by TCXFile and GPXFile classes.

**Parameters**

**open\_elevation\_api** (*str*) – location of the Open Elevation Api.

**read\_nodes** (*nodes: Node, cumulative\_distances: bool = True*) → dict

Method for reading overpy.Node nodes and generating a TCXFile/GPXFile like dictionary of objects.

**Parameters**

- **nodes** (*list*) – list of overpy.Node objects
- **cumulative\_distances** (*bool*) – If set to True, distance equals previous point distance + distance between the nodes, else tells actual distance between two points.

**Returns:** dictionary of nodes.

```
{
    'activity_type': str, 'positions': [...], 'altitudes': [...], 'distances': [...], 'total_distance': float
}
```



### 5.5.14 Plot data

**class** `sport_activities_features.plot_data.PlotData`

Bases: `object`

Class for plotting the extracted data.

**draw\_basic\_map**( ) → `None`

Method for plotting the whole topographic map and rendering the plot.

**draw\_hills\_in\_map**(*altitude: list, distance: list, identified\_hills: list*) → `None`

Method for plotting all hills identified in data on topographic map and rendering the plot.

**Parameters**

- **altitude**(*list*) – list of altitudes
- **distance**(*list*) – list of distances
- **identified\_hills**(*list*) – list of identified hills.

**draw\_intervals\_in\_map**(*timestamp: list, distance: list, identified\_intervals: list*) → `None`

Method for plotting all intervals identified in data on topographic map and rendering the plot.

**Parameters**

- **timestamp**(*datetime*) – list of timestamps
- **distance**(*float*) – list of distances
- **identified\_intervals**(*list*) – list of identified intervals.

**get\_positions\_of\_hills**(*identified\_hills: list*) → `list`

Method for retrieving positions of identified hills.

**Parameters**

- **identified\_hills**(*list*) – list of identified hills

**Returns**

list of hills.

**Return type**

list

**get\_positions\_of\_intervals**(*identified\_intervals: list*) → `list`

Method for retrieving positions of identified intervals.

**Parameters**

- **identified\_intervals**(*list*) – list of identified intervals

**Returns**

list of intervals.

**Return type**

list

**plot\_basic\_map**(*altitude: list, distance: list*) → `<module 'matplotlib.pyplot' from '/usr/lib64/python3.12/site-packages/matplotlib/pyplot.py'>`

Method for plotting the whole topographic map.

**Parameters**

- **altitude**(*list*) – list of altitudes

- **distance** (*list*) – list of distances

**Returns**

plt.

**plot\_hills\_on\_map** (*altitude: list, distance: list, identified\_hills: list*) → <module 'matplotlib.pyplot' from '/usr/lib64/python3.12/site-packages/matplotlib/pyplot.py'>

Method for plotting all hills identified in data on topographic map.

**Parameters**

- **altitude** (*list*) – list of altitudes
- **distance** (*list*) – list of distances
- **identified\_hills** (*list*) – list of identified hills

**Returns**

plt.

**plot\_intervals\_in\_map** (*timestamp: list, identified\_intervals: list*) → <module 'matplotlib.pyplot' from '/usr/lib64/python3.12/site-packages/matplotlib/pyplot.py'>

Method for plotting all intervals identified in data on topographic map.

**Parameters**

- **timestamp** (*list*) – list of timestamps
- **identified\_intervals** (*list*) – list of identified intervals

**Returns**

plt.

## 5.5.15 TCX manipulation

**class** sport\_activities\_features.tcx\_manipulation.TCXFile

Bases: *FileManipulation*

Class for reading TCX files.

**create\_gps\_object** (*path\_to\_the\_file*)

Convert TCX file to GPX file.

**extract\_integral\_metrics** (*filename: str*) → dict

Method for parsing one TCX file and extracting integral metrics.

**Parameters**

**filename** (*str*) – name of the TCX file to be read

**Returns**

```
int_metrics = {
    'activity_type': activity_type, 'distance': distance, 'duration': duration, 'calories': calories,
    'hr_avg': hr_avg, 'hr_max': hr_max, 'hr_min': hr_min, 'altitude_avg': altitude_avg, 'altitude_max': altitude_max, 'altitude_min': altitude_min, 'ascent': ascent, 'descent': descent,
    'steps': steps
}
```

**read\_directory** (*directory\_name: str*) → list

Method for finding all TCX files in a directory.

**Parameters**

**directory\_name** (*str*) – name of the directory in which to identify TCX files

**Returns**

array of paths to the identified files.

**Return type**

str

**read\_one\_file** (*filename: str, numpy\_array=False*) → dict

Method for parsing one TCX file using the TCXReader.

**Parameters**

- **filename** (*str*) – name of the TCX file to be read

- **numpy\_array** (*bool*) –

if set to true dictionary lists are transformed into numpy.arrays

**Returns**

```
activity = {
    'activity_type': activity_type, 'positions': positions, 'altitudes': altitudes, 'distances': distances,
    'total_distance': total_distance, 'timestamps': timestamps, 'heartrates': heartrates, 'speeds': speeds
}
```

**Note:**

In the case of missing value in raw data, we assign None.

**write\_gpx** (*gps\_object, output\_file\_name=None*)

Write GPX object to file. if output\_file\_name is not specified, the output file name will be the same as the input file name, but with .gpx extension.

## 5.5.16 Topographic features

**class** sport\_activities\_features.topographic\_features.**TopographicFeatures** (*identified\_hills: list*)

Bases: object

Class for feature extraction from topographic maps.

**Parameters**

**identified\_hills** (*list*) – identified hills are now passed to this class.

**ascent** (*altitude\_data: list*) → float

Method for ascent calculation.

**Parameters**

**altitude\_data** (*list*) – list of altitudes

**Returns**

total ascent

**Return type**

float

---

**Note:** [WIP] This method should be improved.

---

**avg\_altitude\_of\_hills** (*alts: list*) → float

Method for calculating the average altitude of all identified hills in sport activity.

**Parameters**

**alts** (*list*) – list of altitudes

**Returns**

average altitude.

**Return type**

float

**avg\_ascent\_of\_hills** (*alts: list*) → float

Method for calculating the average ascent of all hills in sport activity.

**Parameters**

**alts** (*list*) – list of altitudes

**Returns**

average ascent.

**Return type**

float

**calculate\_distance** (*latitude\_1: float, latitude\_2: float, longitude\_1: float, longitude\_2: float*) → float

Method for calculating the distance between the two pairs of coordinates.

**Parameters**

- **latitude\_1** (*float*) – first latitude
- **latitude\_2** (*float*) – second latitude
- **longitude\_1** (*float*) – first longitude
- **longitude\_2** (*float*) – second longitude

**Returns**

distance in kilometers.

**Return type**

float

**calculate\_hill\_gradient** (*latitude\_1: float, latitude\_2: float, longitude\_1: float, longitude\_2: float, height\_1: float, height\_2: float*) → float

Method for calculation of the hill gradient in percent.

**Parameters**

- **latitude\_1** (*float*) – first latitude
- **latitude\_2** (*float*) – second latitude
- **longitude\_1** (*float*) – first longitude

- **longitude\_2** (*float*) – second longitude
- **height\_1** (*float*) – first altitude
- **height\_2** (*float*) – second altitude

**Returns**

gradient in degrees.

**Return type**

float

**descent** (*altitude\_data: list*) → float

Method for descent calculation.

**Parameters**

**altitude\_data** (*list*) – list of altitudes

**Returns**

total descent

**Return type**

float

---

**Note:** [WIP] This method should be improved.

---

**distance\_of\_hills** (*positions: list*) → float

Method for calculating the total distance of all identified hills in sport activity.

**Parameters**

**positions** (*list*) – list of positions

**Returns**

distance of hills.

**Return type**

float

**num\_of\_hills** () → int

Method for calculating the number of identified hills in sport activity.

**Returns**

number of hills.

**Return type**

int

**share\_of\_hills** (*hills\_dist: float, total\_dist: float*) → float

Method for calculating the share of hills in sport activity (percentage).

**Parameters**

- **hills\_dict** (*float*) – distance of all hills
- **total\_dist** (*float*) – total distance

**Returns**

share of hills.

**Return type**

float

### 5.5.17 Training loads

This class is used for calculation of training loads.

```
class sport_activities_features.training_loads.BanisterTRIMPv1 (duration: float,  
average_heart_rate:  
float)
```

Bases: object

Class for calculation of simple Banister's TRIMP.

**Reference paper:**

Banister, Eric W. "Modeling elite athletic performance." Physiological testing of elite athletes 347 (1991): 403-422.

**Parameters**

- **duration** (*float*) – total duration in seconds
- **average\_heart\_rate** (*float*) – average heart rate in beats per minute.

**calculate\_TRIMP** () → float

Method for the calculation of the TRIMP.

**Returns**

Banister TRIMP value.

**Return type**

float

```
class sport_activities_features.training_loads.BanisterTRIMPv2 (duration: float,  
average_heart_rate:  
float, min_heart_rate:  
float, max_heart_rate:  
float, gender: Gender  
= Gender.male)
```

Bases: object

Class for calculation of Banister's TRIMP. .

**Reference paper:**

Banister, Eric W. "Modeling elite athletic performance." Physiological testing of elite athletes 347 (1991): 403-422.

**Args:**

**duration (float):**

total duration in seconds

**average\_heart\_rate (float):**

average heart rate in beats per minute

**min\_heart\_rate (float):**

minimum heart rate in beats per minute

**max\_heart\_rate (float):**

maximum heart rate in beats per minute

**gender (Gender):**

gender enum of athlete (default male, female)

**calculate\_TRIMP** () → float

Calculate TRIMP.

**Returns**

float

**Return type**

Banister TRIMP value.

**calculate\_delta\_hr\_ratio** () → float

Calculate the delta heart rate.

The ratio ranges from a low to a high value (i.e., ~ 0.2 — 1.0) for a low or a high raw heart rate, respectively.

**Returns**

float

**Return type**

delta heart rate.

**calculate\_weighting\_factor** (delta\_hr\_ratio: float) → float

Calculate the weighting factor.

**Returns**

float

**Return type**

weighting factor (Y).

```
class sport_activities_features.training_loads.EdwardsTRIMP (heart_rates: list,
                                                            timestamps: list,
                                                            max_heart_rate: int = 200)
```

Bases: object

Class for calculation of Edwards TRIMP.

**Reference paper:**

<https://www.frontiersin.org/articles/10.3389/fphys.2020.00480/full>

**Parameters**

- **heart\_rates** (list[int]) – list of heart rates in beats per minute
- **timestamps** (list[timestamp]) – list of timestamps
- **max\_heart\_rate** (int) – maximum heart rate of an athlete.

**calculate\_TRIMP** () → float

Method for the calculation of the TRIMP.

**Returns**

Edwards TRIMP value.

**Return type**

float

```
class sport_activities_features.training_loads.Gender (value, names=<not given>, *values,
                                                       module=None, qualname=None,
                                                       type=None, start=1,
                                                       boundary=None)
```

Bases: Enum

Gender Enum.

**class** sport\_activities\_features.training\_loads.**LuciaTRIMP** (*heart\_rates: list, timestamps: list, VT1: int = 160, VT2: int = 180*)

Bases: object

Class for calculation of Lucia's TRIMP.

**Reference:**

<https://www.trainingimpulse.com/lucias-trimp-0>

**Parameters**

- **heart\_rates** (*list[int]*) – list of heart rates in beats per minute
- **timestamps** (*list[timestamp]*) – list of timestamps
- **VT1** (*int*) – ventilatory threshold to divide the low and the moderate zone
- **VT2** (*int*) – ventilatory threshold to divide the moderate and the high zone.

**calculate\_TRIMP** () → float

Method for the calculation of the TRIMP.

**Returns**

Lucia's TRIMP value.

**Return type**

float

## 5.5.18 Weather Identification

**class** sport\_activities\_features.weather\_identification.**WeatherIdentification** (*locations: list, timestamps: list, vc\_api\_key: str, unit\_group='metric'*)

Bases: object

A class used for identification of Weather data from TCX file. For identification of weather an external API is used (<https://www.visualcrossing.com/>).

**Parameters**

- **locations** (*list[(float, float)]*) – coordinates of exercise recordings, found in TCXFile/GPXFile generated dictionary under “positions”
- **timestamps** (*list[datetime]*) – timestamps of exercise recordings, found in TCX-File/GPXFile generated dictionary under “timestamps”
- **vc\_api\_key** (*str*) – API key for accessing VisualCrossing weather data



- **unit\_group** (*str*) – Unit group of data recieved. Possible options ‘metric’ (default), ‘us’, ‘uk’, ‘base’.

### Warnings:

vc\_api\_key: api key is required.

**classmethod** **get\_average\_weather\_data** (*timestamps: list, weather: list*) → list

Method generates average weather for each of the timestamps in training by averaging the weather before and after the timestamp, using the `__find_nearest_weathers()` method.

#### Parameters

- **timestamps** (*list[datetime]*) – datetime recordings from the TCXFile parsed data
- **weather** (*list[Weather]*) – list of weather objects retrieved from VisualCrossing API

#### Returns

**list which is an AverageWeather object**  
for each of the given timestamps.

#### Return type

list[AverageWeather]

**get\_weather** (*time\_delta: int = 30*) → list

Method that queries the VisualCrossing weather API for meteorological data at provided (minute) time intervals.

#### Parameters

**time\_delta** (*int*) – time between two measurements, default 30 mins

#### Returns

**list of Weather objects from the nearest**  
meteorological station for every interval (time\_delta minutes) of training.

#### Return type

list[Weather]

## 5.6 Contributing to sport-activities-features

First off, thanks for taking the time to contribute!

### 5.6.1 Code of Conduct

This project and everyone participating in it is governed by the [Contributor Covenant Code of Conduct](#). By participating, you are expected to uphold this code. Please report unacceptable behavior to [iztok.fister1@um.si](mailto:iztok.fister1@um.si).

## **5.6.2 How Can I Contribute?**

### **Reporting Bugs**

Before creating bug reports, please check existing issues list as you might find out that you don't need to create one. When you are creating a bug report, please include as many details as possible in the issue template.

### **Suggesting Enhancements**

Open new issue using the feature request template.

### **Pull requests**

Fill in the pull request template and make sure your code is documented.

## **5.7 Contributor Covenant Code of Conduct**

### **5.7.1 Our Pledge**

We as members, contributors, and leaders pledge to make participation in our community a harassment-free experience for everyone, regardless of age, body size, visible or invisible disability, ethnicity, sex characteristics, gender identity and expression, level of experience, education, socio-economic status, nationality, personal appearance, race, religion, or sexual identity and orientation.

We pledge to act and interact in ways that contribute to an open, welcoming, diverse, inclusive, and healthy community.

### **5.7.2 Our Standards**

Examples of behavior that contributes to a positive environment for our community include:

- Demonstrating empathy and kindness toward other people
- Being respectful of differing opinions, viewpoints, and experiences
- Giving and gracefully accepting constructive feedback
- Accepting responsibility and apologizing to those affected by our mistakes, and learning from the experience
- Focusing on what is best not just for us as individuals, but for the overall community

Examples of unacceptable behavior include:

- The use of sexualized language or imagery, and sexual attention or advances of any kind
- Trolling, insulting or derogatory comments, and personal or political attacks
- Public or private harassment
- Publishing others' private information, such as a physical or email address, without their explicit permission
- Other conduct which could reasonably be considered inappropriate in a professional setting

### 5.7.3 Enforcement Responsibilities

Community leaders are responsible for clarifying and enforcing our standards of acceptable behavior and will take appropriate and fair corrective action in response to any behavior that they deem inappropriate, threatening, offensive, or harmful.

Community leaders have the right and responsibility to remove, edit, or reject comments, commits, code, wiki edits, issues, and other contributions that are not aligned to this Code of Conduct, and will communicate reasons for moderation decisions when appropriate.

### 5.7.4 Scope

This Code of Conduct applies within all community spaces, and also applies when an individual is officially representing the community in public spaces. Examples of representing our community include using an official e-mail address, posting via an official social media account, or acting as an appointed representative at an online or offline event.

### 5.7.5 Enforcement

Instances of abusive, harassing, or otherwise unacceptable behavior may be reported to the community leaders responsible for enforcement at [iztok.fister1@um.si](mailto:iztok.fister1@um.si). All complaints will be reviewed and investigated promptly and fairly.

All community leaders are obligated to respect the privacy and security of the reporter of any incident.

### 5.7.6 Enforcement Guidelines

Community leaders will follow these Community Impact Guidelines in determining the consequences for any action they deem in violation of this Code of Conduct:

#### 1. Correction

**Community Impact:** Use of inappropriate language or other behavior deemed unprofessional or unwelcome in the community.

**Consequence:** A private, written warning from community leaders, providing clarity around the nature of the violation and an explanation of why the behavior was inappropriate. A public apology may be requested.

#### 2. Warning

**Community Impact:** A violation through a single incident or series of actions.

**Consequence:** A warning with consequences for continued behavior. No interaction with the people involved, including unsolicited interaction with those enforcing the Code of Conduct, for a specified period of time. This includes avoiding interactions in community spaces as well as external channels like social media. Violating these terms may lead to a temporary or permanent ban.

### 3. Temporary Ban

**Community Impact:** A serious violation of community standards, including sustained inappropriate behavior.

**Consequence:** A temporary ban from any sort of interaction or public communication with the community for a specified period of time. No public or private interaction with the people involved, including unsolicited interaction with those enforcing the Code of Conduct, is allowed during this period. Violating these terms may lead to a permanent ban.

### 4. Permanent Ban

**Community Impact:** Demonstrating a pattern of violation of community standards, including sustained inappropriate behavior, harassment of an individual, or aggression toward or disparagement of classes of individuals.

**Consequence:** A permanent ban from any sort of public interaction within the community.

## 5.7.7 Attribution

This Code of Conduct is adapted from the Contributor Covenant, version 2.0, available at [https://www.contributor-covenant.org/version/2/0/code\\_of\\_conduct.html](https://www.contributor-covenant.org/version/2/0/code_of_conduct.html).

Community Impact Guidelines were inspired by Mozilla's code of conduct enforcement ladder.

For answers to common questions about this code of conduct, see the FAQ at <https://www.contributor-covenant.org/faq>. Translations are available at <https://www.contributor-covenant.org/translations>.

## 5.8 Contributors

### 5.8.1 Credits

#### Maintainers

- Iztok Fister, Jr.

#### Contributors (alphabetically)

- Dušan Fister
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- Zala Lahovnik
- Luka Lukač
- Luka Pečnik
- Špela Pečnik
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## 5.9 License

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