Project Group:
Machine Learning for Predictive Maintenance
(Weekly Status Report)

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Summary of main contributions

Introduction to PdM

1. Created the latex minutes of meeting (MOM) template with @Vinay.
2. Created the latex weekly status report template with @Saghar.
3. Organized doodle to check the availability of all team members to decide the day and timing for the weekly meeting.
4. Organized doodle to check the availability of all team members to decide day for Presence day.

Topic Study & Requirement Analysis

1. Wrote different approaches of PdM part in Introduction chapter.
2. Wrote Motivation for Time Series Feature extraction (TSFE) chapter.
3. Wrote the Time Domain (statistical features, BOP, Shapelet Transform, ROCKET, RNN Autoencoder) and Windowing approaches in TSFE chapter.
4. Reviewed the Introduction, Conclusion, Health State Classification and RUL chapter and added comments and feedback in document.

System Design

1. Created the sequence diagram for TSFreshWrapper, MovingWeightedAverage, RNNAutoencoder, and WindowingApproach approach and wrote explanation for them in design document.
2. Wrote Git Strategy chapter in system design document.
3. Was part of the general class diagrams and sequence diagrams design @Team.
4. Discussed and created the class diagram for Fixed size feature extractor and Timeseries Transformer With @Paul.

Implementation

1. Implemented the DatasetSummary, MovingWeightedAverage, TSFreshWrapper, TimeSeriesTransformer, Transformer, EvaluatorConfigParser, and EvaluatorConfig class and also wrote test cases to independently test the functionality of each class.

2. Created the Anaconda environment setup file for our library and created a README.md file in the GitLab repository to explain how to set up the Anaconda environment on a local machine.

3. Created Merge request template in GitLab repository.

4. Reviewed the implementation of RNNAutoencoder class which is implemented by @Christopher.

5. Added OS path separator while mentioning the file paths in code to avoid OS path separator issues.

6. Did the code review of Merge request 44, 43, 29, 27, 25, 20, 19, 17, 15.

Final Presentation

1. Meeting with @Team to discuss and plan presentation contents.

2. Created the Predictive Maintenance File Format (PdMFF), Feature Engineering(FE), and Abstract Pipeline structure slides and gave presentation on that.

3. Created API package structure, Authors, License, and Changelog pages in our documentation.

4. Updated the logo and acknowledgments section in documentation and readme file.

5. Did review of the Merge request 49.

6. Did research on different types of licenses are available for Open Source Project and suggested BSD 3-clause license for ML4PdM library. Also summarize the license used by dependent package in pdf document.

Calendar Week: 38 24 September, 2021

Completed Tasks

1. Created the first draft of slides to explain *PdMFF* data format.
2. Created the first draft of slides for Feature Engineering chapter to explain *Timeseries* to *Timeseries* and *Timeseries* to *Fixedsize* transformer.
3. Discussed few new suggestions for slides and planned few meeting to discussed the new changes.

Tasks in-progress

1. Updating contents of Feature Engineering slide after @Team feedback.
2. Create abstract pipeline options slides.
3. Add *C-MAPSS* dataset introduction slide in presentation.

Calendar Week: 37 17 September, 2021

Completed Tasks

1. Completed the *ML4PdM* library structure (hierarchy) display in documentation and also got approval from @Team after demo.
2. Updated the Authors page in documentation with @Tanja as contact person for future queries related to *ML4PdM* library.
3. Did research on different types of licenses are available for Open Source Project and suggested suitable license for *ML4PdM* library.
4. Added BSD 3-clause license to *ML4PdM* library.
5. Removed contributors section from Authors page in documentation.
6. Discussed few suggestions and ideas for presentation slides and divided the task between @Team.

Tasks in-progress

1. Create powerpoint slides for Feature engineering, pdmff data format, few abstract pipeline options.

Calendar Week: 36 10 September, 2021

Completed Tasks

1. I was responsible for taking the minutes notes for the week 36 meeting, and wrote the MOM document for the same.
2. Wrote the Changelogs and Authors page in documentation.
3. Wrote notebooks examples on How to use *TSFreshWrapper* class of ML4PdM library. So that we can include this examples in documentation.

Tasks in-progress

1. Working on to display proper tree structure of ML4PdM library in documentation.
2. Working on the final presentation contents.

Calendar Week: 35 03 September, 2021

Completed Tasks

1. Wrote changelog for merge request [GEN] Release of version 0.1.0.

Tasks in-progress

1. Writing and describing examples for the documentation on how to use *TSFreshWrapper* and *MovingWeightedAverage* class.

Calendar Week: 34 27 August, 2021

Completed Tasks

1. Fixed the transform method output representations issues for *MovingWeightedAverage* class.
2. Implementation of summary print for Dataset class (ML4PDM-222).
3. Did code review of the Merge requests [RUL] Fixes code smell of SVREstimator and [RUL] Implements CNN Rul approach.
4. Reviewed the implementation of *RNNAutoencoder* class in feature engineering module.

Tasks in-progress

1. Working on documentation part for the final project presentation.

Calendar Week: 33 20 August, 2021

Completed Tasks

1. Tested the code thoroughly.
2. Fixed the multiple dataset passing issue in transform method of *TSFreshWrapper* class which was giving error while executing in Pipeline.
3. Fixed the *TSFreshWrapper* class constructor to assign values to its object.
4. Refactor the *TSFreshWrapper* and *MovingWeightedAverage* class test code to match with latest code changes.
5. Updated the docs string of *TSFreshWrapper* and *MovingWeightedAverage* class and its methods.

Tasks in-progress

1. Fixing the moving weighted average class issue while executing in Pipeline.
2. Implementation of summary print in Dataset class.

Calendar Week: 32 13 August, 2021

Completed Tasks

1. I was responsible for taking the minutes notes for the week 32 meeting, and wrote the MOM document for the same.
2. Added OS path separator while mentioning the file paths in code to avoid OS path separator issues.
3. Passing the Dataset object as input and returning Dataset object as output to transform method of *TSFreshWrapper* class.
4. Implementation of Moving Weighted Average class in Fixed size feature transformation.
5. Wrote test code to test the Moving Weighted Average class and it's method.
6. Did code review of the Merge request [GEN] Added Integration Test and AttributeFilter and [RUL] Add multiple classifier approach.

Tasks in-progress

1. Reviewing the implementation of *RNNAutoencoder* class in feature engineering module.
2. Testing the code thoroughly.

Calendar Week: 31 06 August, 2021

Completed Tasks

1. Completed the passing of list of features as Enum in *TSFreshWrapper* constructor and filtering out feature keys which is not required.
2. Updated the testing code to test the *TSFreshWrapper* class after latest code changes.
3. Refactor the *_pandas_dataframe_wrapper* function of *TSFreshWrapper* class to reduce its Cognitive Complexity code smell.

Tasks in-progress

1. Working on output representations issue of transform method in *TSFreshWrapper* class.
2. Working on to use OS path separator in code while mentioning the file paths.
3. Reviewing the implementation of *RNNAutoencoder* class in feature engineering module.
4. Will start working on my part of pylint code issues.

Calendar Week: 30 30 July, 2021

Tasks in-progress

1. Working on to refactor the code of *TSFreshWrapper* class in Feature engineering module based on feedback from @Team.
2. Working on to use OS path separator in code while mentioning the file paths.
3. Reviewing the implementation of *RNNAutoencoder* class in feature engineering module.

Calendar Week: 29 23 July, 2021

Completed Tasks

1. Fixed the two code smells of the *TSFreshWrapper* class in feature engineering module.
   (a) Updated the parameters of *init* method to fix the cognitive complexity code smell.
   (b) Created *TSFreshFeatureCalculatorsAttributes* class with all 72 features as Enum.
   (c) Updated the *TSFreshFeatureCalculators* class with new method which perform the deleting of key from feature calculators dictionary of tsfresh library and also removed *init* method to fix the cognitive complexity code smell.

Tasks in-progress

1. Working on to fix the code smell of transform function which is part of *TSFreshWrapper* class in Feature engineering module.
2. Started reviewing the implementation of *RNNAutoencoder* class in feature engineering module.

Calendar Week: 28 16 July, 2021

Completed Tasks

1. I was responsible for taking the minutes notes for the week 28 meeting, and wrote the MOM document for the same.
2. Did code review of the Merge request Added emd signal wrapper and listify function.
3. Completed the implementation of *TSFreshWrapper* class and its method in feature engineering module.
   (a) Added method to convert list of dataset to pandas dataFrame which is required input format for tsfresh library.
   (b) Added and updated DocString to TSFreshWrapper class and its methods.
   (c) Added FD001_train pdmff dataset file in test folder to calculate features from tsfresh.
   (d) Added test code to test the implementation of TSFreshWrapper class and its methods.
   (e) Created Merge request in GitLab to review the code from @Paul before mergeing to develop branch.

Tasks in-progress

1. Working on the implementation of *RNNAutoencoder* class in feature engineering module.

Calendar Week: 27 09 July, 2021

Completed Tasks

1. Implementation of *TSFreshWrapper* class in feature engineering module.
   (a) Added all statistical features (64) from *tsfresh* for extraction.
   (b) Added fit and transform method to calculate the features.
   (c) Fixed the circular redundancy issue.

Tasks in-progress

1. Writing test module to test the implementation of *TSFreshWrapper* class.
2. Will start working on the implementation of *RNNAutoencoder* class in feature engineering module.

Calendar Week: 26 02 July, 2021

Completed Tasks

1. Implementation of *EvaluatorConfigParser* class.
   (a) Moved the *parse* method contents to *parse_from_file* method instead of *parse_from_string* because it was doing the same task.
   (b) Update the code to use *jsonpickle* instead of *json* library to maintain code consistency.
   (c) Removed the *_list _data & list_of_* prefix from variable name to reduce the length.
   (d) Moved the iteration of Pipeline paths and strings code to separate static *_get_pipelines* method.
   (e) Moved the iteration of Dataset paths code to separate static *_get_datasets* method.
   (f) Removed the unwanted code.
   (g) Fixed the code smells.
   (h) Updated the testing code according new changes.

Tasks in-progress

1. Implementation of *TSFreshWrapper* class in feature engineering module.
   (a) Working on to add *enum* for all features from *tsfresh* library.

Calendar Week: 25 25 June, 2021

Completed Tasks

1. Added *parse* method in *EvaluatorConfigParser* class.
   (a) Added iteration of Pipeline paths and string.
   (b) Added iteration of Dataset paths.
   (c) Method return Evaluator object.
   (d) Added Doc string.
2. Added test functionality to test the *parse* method of *EvaluatorConfigParser* class.
3. Updated the *EvaluatorConfig* class parameters with *dataset_paths & pipeline_paths* and its doc string.
4. Added *EvaluatorConfiguration* and *PipelineConfiguration* json file in test folder so that we can test the *parse* method easily.

Tasks in-progress

1. Working on the *TSFreshWrapper* class implementation in feature engineering module.

Calendar Week: 24 18 June, 2021

Tasks in-progress

1. Working on adding the *parse()* method to the *EvaluatorConfigParser* class, as well as the test functionality which I missed due to my misunderstanding and confusion about the sequence diagram of the predefined approach and evaluation.

2. Fixing few bugs of *EvaluatorConfig* test. i.e.- Instead of passing the database file path, I passed the actual data for testing.

3. Parallel I'm also working on the *TSFreshWrapper* class's implementation.

Calendar Week: 23 11 June, 2021

Tasks in-progress

1. Working on to specify a file path to a pipeline in the config file for an evaluator and it should be automatically loaded functionality in *EvaluatorConfigParser* class.

2. Implementation of *TSFreshWrapper* class.

Calendar Week: 22 04 June, 2021

Tasks in-progress

1. Working on to specify a file path to a pipeline in the config file for an evaluator and it should be automatically loaded functionality in *EvaluatorConfigParser* class.

2. Implementation of *TSFreshWrapper* class.

Calendar Week: 21 28 May, 2021

Completed Tasks

1. I was responsible for taking the minutes notes for the week 21 meeting, and wrote the MOM document for the same.

2. Created the *feature/ts-fresh-wrapper* branch which is derived from *develop* branch in GitLab.

Tasks in-progress

1. Working on to specify a file path to a pipeline in the config file for an evaluator and it should be automatically loaded functionality in *EvaluatorConfigParser* class.

2. Implementation of *TSFreshWrapper* class.

Calendar Week: 20 21 May, 2021

Completed Tasks

1. Fixed the code smells of *Transformer & TimeSeriesTransformer* abstract class.
2. Took review for the code changes of *Transformer & TimeSeriesTransformer* abstract class from @Christopher and @Paul respectively.
3. Merged the *Transformer & TimeSeriesTransformer* branch to *develop* branch in GitLab.

Tasks in-progress

1. Working on to specify a file path to a pipeline in the config file for an evaluator and it should be automatically loaded functionality in *EvaluatorConfigParser* class.

Calendar Week: 19 14 May, 2021

Completed Tasks

1. Updated the documentation of *EvaluatorConfig, EvaluatorConfigParser, Transformer & TimeSeriesTransformer* class to avoid webpage breakdown.

2. Added the *__init__.py* file in data and parsing folder and adopted to define class name in *__all__* to make importing of class easy in other class or methods.

3. Updated the *Transformer & TimeSeriesTransformer* abstract class with python Abstract Base Classes.

4. Refactor the code to test the *EvaluatorConfig & EvaluatorConfigParser* class and it's methods based on code reviewers (@Christopher) comments.

Tasks in-progress

1. Fixing the code smells of *Transformer & TimeSeriesTransformer* abstract class.

Calendar Week: 18 07 May, 2021

Completed Tasks

1. Added the *parse_from_string* method in *EvaluatorConfigParser* class and also added the document string in code.
2. Fixed the recursive call issue of fix and transform methods in *Transformer* abstract class.
3. Updated the *TimeSeriesTransformer* abstract class and it's methods.

Tasks in-progress

1. Fixing the code smells of *Transformer & TimeSeriesTransformer* abstract class.

Calendar Week: 17 30 April, 2021

Completed Tasks

1. Implemented the *Transformer* abstract class & it's methods and also added the class reference to Sphinx documentation for code description rendering on *html* page.

2. Implemented the *TimeSeriesTransformer* abstract class and also added the class reference to Sphinx documentation for code description rendering on *html* page.

Tasks in-progress

1. Working on fixing the *EvaluatorConfigParser* class changes as mentioned by @Christopher in merge request review issue.

Calendar Week: 16 23 April, 2021

Completed Tasks

1. Created a test module for the *EvaluatorConfigParser* class and tested it with dummy data.
2. Created a test module for the *EvaluatorConfig* class and tested it with dummy data.
3. Added the *EvaluatorConfig* class reference to Sphinx documentation for code description rendering on *html* page.

Tasks in-progress

1. Will start working on implementation of *Transformer* abstract class ML4PDM-196.

Calendar Week: 15 16 April, 2021

Completed Tasks

1. I was responsible for taking the minutes notes for the week 15 meeting, and I wrote the MOM document for the same.

2. Created and implemented the *EvaluatorConfigParser* class and its attributes and methods in *parsing* folder directory of ML4PdM project.

3. Created and implemented the *EvaluatorConfig* class and its attributes in *data* folder of ML4PdM project.

Tasks in-progress

1. Implementing and testing the *EvaluatorConfigParser* and *EvaluatorConfig* class and its attributes & methods.

Calendar Week: 14 09 April, 2021

Completed Tasks

1. Updated the *tensorflow* library version from 2.4 to 2.3 in conda environment to resolved the dependencies of *Scipy, tsfresh* libraries.
2. Set up Visual Studio Code for our project on local machine.
3. Created *feature/evaluator-config-parser* branch from *develop* branch in GitLab code repository.

Tasks in-progress

1. Adding and implementing the basic parameters and functions to the EvaluatorConfigParser class. ML4PDM-192

Calendar Week: 13 02 April, 2021

Completed Tasks

1. *Python, matplotlib, pandas, scikit-learn, pytest, pywavelets, numpy, scipy, pyts,* and *Keras* libraries installed in the newly created Anaconda environment for the project.

2. Resolved the *tensorflow* and *tsfresh* library dependencies and added the correct versions to our environment.

3. Push the final version of the environment.yml file to the GitLab repository so that other members of the team can create and use it.

4. Created a README.md file in the GitLab repository to explain how to set up the Anaconda environment on a local machine and how to use it.

Tasks in-progress

1. Adding and implementing the basic parameters and functions to the EvaluatorConfigParser class. ML4PDM-192

2. Set up Visual Studio Code for our project on local machine.

Calendar Week: 12 26 March, 2021

Completed Tasks

1. Removed the DataSet reference from bibliography section of System design document.
2. Updated the *PytsTransformWrapper, TSFreshWrapper, RNNAutoencoder, and WindowingApproach* approach sequence diagram and their description.
3. Added footnotes with links in TFE chapter of external libraries which we are going to use in our approach for implementation.
4. With team decided on Git Strategy and wrote same in Quality Assurance chapter for System Design document.

Tasks in-progress

1. Working on Anaconda environment setup. ML4PDM-187

Calendar Week: 11 19 March, 2021

Completed Tasks

1. Updated the Feature Extraction class diagram boxes alignment & shape and same added in System design document.
2. Added Actor element and updated the sequence diagram as per @Tanja comments.
3. Merge BOP, ROCKET and Shapelet Transform sequence diagrams to one sequence diagram.
4. Discussed Quality assurance part with team and distributed the work to complete the document.

Tasks in-progress

1. Updating the System design document for Feature Extraction sequence diagrams.
2. Working on Git Strategy and it's documentation. ML4PDM-183

Calendar Week: 10 12 March, 2021

Completed Tasks

1. Added tsfresh, windowing approach, and moving weighted average class in Feature Extraction class diagram.
2. Created TswreshWrapper, Shapelet Transform, ROCKET, Bag Of Patterns, RNNAutoencoder and Windowing Approach sequence diagrams and wrote in system design document.
3. With team, updated the general class and sequence diagram.

Tasks in-progress

1. Updating the Feature extraction class and sequence diagram as per comments given by @Tanja.
2. Updating the System design document for Feature Extraction class and sequence diagram.

Calendar Week: 09 05 March, 2021

Completed Tasks

1. I was responsible for taking the minutes notes for the week 09 meeting, and I wrote the MOM document for the same.
2. Meeting with @Christopher, @Paul, @Selami, and @Vinay to refactor the general class diagram, including:
    - Adding the sklearn library classes to the class diagram and extending to the Pipeline element.
    - Deciding on the naming convention of class, approaches, and Pipeline.
    - Deciding on parser and configuration parser and their data members.
    - Deciding on the Evaluation class and its data members and approaches.
    - Decide on which approach to adopt for implementation as @Tanja introduced two types of the method definition.

Tasks in-progress

1. Extending the Feature Extraction part of the class diagram to include all the approaches of the Feature Extraction chapter and determine their data members and functions.

Calendar Week: 08 26 February, 2021

Completed Tasks

1. Created the class diagram for Feature Extraction chapter on diagrams.net. (ML4PDM-164)

2. Created the first draft of the system architecture class diagram on diagrams.net with @Anurose, @Christopher, and @Gourav. (ML4PDM-164)

3. Created the first draft of the system architecture sequence diagram on diagrams.net with @Anurose, @Christopher, and @Gourav. (ML4PDM-165)

Tasks in-progress

1. Working with @Christopher to create refine class and sequence diagrams for the System design of the system. (ML4PDM-164) (ML4PDM-165)

Calendar Week: 07 19 February, 2021

Completed Tasks

1. Reviewed the RUL chapter of Topic study document.
2. Implemented the changes in the TSFE chapter based on the comments of the 2nd review, including:
    - Fixed sentence, spelling mistakes denoted by the reviewers on my part.
    - Updated figure font to make it bright.

Tasks in-progress

1. Working with the interface team, e.g. @Anurose, @Christopher, and Gourav, to create class diagrams for the system design milestone.

Calendar Week: 06 12 February, 2021

Completed Tasks

1. Implemented changes to the PdM approach in the Introduction chapter based on the first review comments, including:
    - Removed the unwanted headings and name which was kept as it is.
    - Make provision to add a name to each part of the document section structure so that each team can name it.
    - Fixed sentence, spelling mistakes denoted by the reviewers on my part.
2. Implemented the changes in the TSFE chapter based on the comments of the first review, including:
    - Adjust the text of the approach part to fix the image.
    - Updated the images to a grid-free background and created a new image to avoid copyright issues.
    - Changed the textbf to subsubsection* tag.
    - Fixed sentence, spelling mistakes denoted by the reviewers on my part.
    - Updated the table and figure latex properties to match the standard decided by the team.

Tasks in-progress

1. Doing the 2nd review of RUL chapter.

Calendar Week: 05 05 February, 2021

Completed Tasks

1. Reviewed the Health State Classification chapter and added comments, suggestions in the topic study document.
2. Updated the spelling mistakes, date and added the author's name on the Title page of the topic study document. (ML4PDM-160)

Tasks in-progress

1. Implementing review provided by reviewers on PdM approaches, time domains, and windowing techniques.

Calendar Week: 04 29 January, 2021

Completed Tasks

1. Created a template for a Merge request in Gitlab that is reviewed by @Christopher. (ML4PDM-141)

2. Reviewed the Introduction, Conclusion chapter and added comments, suggestions in the topic study document.

Tasks in-progress

1. Review of the contents of the Health State chapter written by @Saghar.

Calendar Week: 03 22 January, 2021

Completed Tasks

1. Wrote RNN Autoencoder method for Time-domain approach in the TSFE chapter.
2. Wrote Window Sliding Method for Windowing Techniques in the TSFE chapter.
3. Wrote the Motivation part for the TSFE chapter.
4. Together with @Christopher, @Paul, and @Vinay, we discussed and decided on Git Branch, merge requests, commit messages, versioning tags, and CI Pipeline for the project.
5. Cross-checked and wrote, PdM Approaches References in the Introduction chapter reference section.
6. Cross checked and wrote, Time domain and windowing techniques references in the TSFE chapter reference section.

Tasks in-progress

1. Reviewing the contents which I wrote in the Topic study document.

Calendar Week: 02 15 January, 2021

Completed Tasks

1. Added a description to each of the basic mathematical features of the time domain as per @Tanja feedback.
2. Updated the Overview of fault diagnosis and Bags of Patterns images as per @Tanja feedback.
3. With @Vinay, discuss the windowing techniques required by the RUL team to be included in the TSFE chapter.
4. Wrote ROCKET method for Time domain approach in TSFE chapter.

Tasks in-progress

1. Writing Autoencoder method for Time domain approach in TSFE chapter.

Calendar Week: 01 08 January, 2021

Completed Tasks

1. Wrote basic mathematical features for Time domain approach in TSFE chapter.
2. Wrote Bags-of-patterns method for Time domain approach in TSFE chapter.
3. Wrote Shapelet Transform method for Time domain approach in TSFE chapter.

Tasks in-progress

1. Writing ROCKET method for Time domain approach in TSFE chapter.

Calendar Week: 52-53 30 December, 2020

Completed Tasks

1. With @Paul, discussed the new structure and added few topics to our Times series feture extraction (TSFE) chapter.
2. Wrote the different PdM approaches in the topic study document under Introduction chapter.
3. Wrote a brief explanation for the TSFE approach section.

Challenges

1. Writing mathematical equations and representations in LaTex.

Tasks in-progress

1. Writing time domain feature extraction methods in TSFE chapter.

Calendar Week: 51 18 December, 2020

Completed Tasks

1. Responsible for taking the notes and writing of the Minutes of meeting report for week 51.
2. Worked with the team to refine the formal definition of time series.
3. Finished reading of the seed papers [1], [2] of Time Series Feature Extraction.
4. With @Tanja and @Paul, the contents of the Time Series Feature Extraction chapter are discussed.
5. Updated the Milestone 2 work plan for our topic with @Paul and sent the work plan to @Vinay to create the Gantt chart and represent to @Tanja.

Tasks in-progress

1. Writing the different Approaches of PdM in Introduction chapter of topic study document.

References

[1] Maximilian Christ et al. "Time Series FeatuRe Extraction on basis of Scalable Hypothesis tests (tsfresh - A Python package)". In: *Neurocomputing* 307 (2018), pp. 72–77. DOI: 10.1016/j.neucom.2018.03.067. URL: https://doi.org/10.1016/j.neucom.2018.03.067.

[2] Anthony J. Bagnall et al. "The Great Time Series Classification Bake Off: An Experimental Evaluation of Recently Proposed Algorithms. Extended Version". In: *CoRR* abs/1602.01711 (2016). arXiv: 1602.01711. URL: http://arxiv.org/abs/1602.01711.

Calendar Week: 50 11 December, 2020

Completed Tasks

1. Worked with the team to decide on Introduction chapter for the topic study.
2. Finished reading the seed paper [1] of Time Series Feature Extraction. (ML4PDM-81)
3. With @Paul, discussed about seed papers [2], [3], [1] and dissertation [4] contents related to time series and their methods for PdM.
4. With @Paul, planned Times Series Feature Extraction chapter outlines, who is going to work on which sub sections and deadline to finished that part.

Tasks in-progress

1. Reading the seed papers [2], [3] of Time Series Feature Extraction.
2. Writing and research on the Different Approaches of PdM in Introduction chapter of topic study document.

References

[1] Narendhar Gugulothu et al. "Predicting Remaining Useful Life using Time Series Embeddings based on Recurrent Neural Networks". In: *CoRR* abs/1709.01073 (2017). arXiv: 1709.01073. URL: http://arxiv.org/abs/1709.01073.

[2] Maximilian Christ et al. "Time Series FeatuRe Extraction on basis of Scalable Hypothesis tests (tsfresh - A Python package)". In: *Neurocomputing* 307 (2018), pp. 72–77. DOI: 10.1016/j.neucom.2018.03.067. URL: https://doi.org/10.1016/j.neucom.2018.03.067.

[3] Anthony J. Bagnall et al. "The Great Time Series Classification Bake Off: An Experimental Evaluation of Recently Proposed Algorithms. Extended Version". In: *CoRR* abs/1602.01711 (2016). arXiv: 1602.01711. URL: http://arxiv.org/abs/1602.01711.

[4] James Kuria Kimotho. "Development and performance evaluation of prognostic approaches for technical systems". PhD thesis. University of Paderborn, Germany, 2016. URL: https://nbn-resolving.org/urn:nbn:de:hbz:466:2-27129.

Calendar Week: 49 04 December, 2020

Completed Tasks

1. Worked with the team to decide on a template and its structure for the topic study.

2. With @Paul, planned how we're going to work on the topic "Times Series Feature Extraction" (TSFE).

Challenges

1. Understand how we need to modify the TSFE chapter outline, as this topic will also be used for reference by all other team members in the future.

2. Trying to understand different types of feature extraction methods and their purposes.

Tasks in-progress

1. Reading the dissertation [1] and the third paper [2] listed on the "Milestone 2: Topics" document for our topic Times Series Feature Extraction.

References

[1] James Kuria Kimotho. "Development and performance evaluation of prognostic approaches for technical systems". PhD thesis. University of Paderborn, Germany, 2016. URL: https://nbn-resolving.org/urn:nbn:de:hbz:466:2-27129.

[2] Narendhar Gugulothu et al. "Predicting Remaining Useful Life using Time Series Embeddings based on Recurrent Neural Networks". In: *CoRR* abs/1709.01073 (2017). arXiv: 1709.01073. URL: http://arxiv.org/abs/1709.01073.

Calendar Week: 48 27 November, 2020

Completed Tasks

1. Finished the reading of survey paper [1]. (ML4PDM-30)

   In this paper, the authors systematically reviewed the literature on PdM and its technique. In the first section, the types of maintenance strategies used in industry are introduced. Subsequently, in section two different publications and journals are considered for analysis and selection of the most related PdM papers.In addition, the Citation Analysis Platform is also introduced to help researchers check the number of citations for selected papers.In the final review of the literature, Machine Learning and Deep Learning Techniques are discussed briefly.

Tasks in-progress

1. Reading the dissertation [2].

References

[1] Thyago Peres Carvalho et al. "A systematic literature review of machine learning methods applied to predictive maintenance". In: *Comput. Ind. Eng.* 137 (2019). DOI: 10.1016/j.cie.2019.106024. URL: https://doi.org/10.1016/j.cie.2019.106024.

[2] James Kuria Kimotho. "Development and performance evaluation of prognostic approaches for technical systems". PhD thesis. University of Paderborn, Germany, 2016. URL: https://nbn-resolving.org/urn:nbn:de:hbz:466:2-27129.

Calendar Week: 47 20 November, 2020

Completed Tasks

1. Finished the reading of survey paper [1]. (ML4PDM-14)

   The authors of this paper provided a comprehensive analysis of past and current literature on the design, purposes and methods of the PdM. The three different machine architecture of PdM is explained in detail in the first section. Then the objectives of PdM in cost minimization, availability and realiablilty are determined in the next section. Various ML and DL techniques describe the achievement of the PdM in detail in the last section.

2. Finished the reading of survey paper [2]. (ML4PDM-33)

   Compared to the research survey paper [1], survey paper [2] is more inclined towards industrial equipment. It began with a brief introduction to the PdM, the intent of the PdM, and data-driven methods. In this paper, the authors examine the industrial applications of the last five years and how the industry is trying to use PdM in an accurate and efficient manner. The challenges, advantages, and disadvantages of the different ML and DL application scenarios are also described in detail.

Tasks in-progress

1. Reading the survey paper [3]. (ML4PDM-30)

References

[1] Yongyi Ran et al. "A Survey of Predictive Maintenance: Systems, Purposes and Approaches". In: *CoRR* abs/1912.07383 (2019). arXiv: 1912.07383. URL: http://arxiv.org/abs/1912.07383.

[2] Weiting Zhang, Dong Yang, and Hongchao Wang. "Data-Driven Methods for Predictive Maintenance of Industrial Equipment: A Survey". In: *IEEE Syst. J.* 13.3 (2019), pp. 2213–2227. DOI: 10.1109/JSYST.2019.2905565. URL: https://doi.org/10.1109/JSYST.2019.2905565.

[3] Thyago Peres Carvalho et al. "A systematic literature review of machine learning methods applied to predictive maintenance". In: *Comput. Ind. Eng.* 137 (2019). DOI: 10.1016/j.cie.2019.106024. URL: https://doi.org/10.1016/j.cie.2019.106024.

Calendar Week: 46 13 November, 2020

Completed Tasks

1. Added Minutes-Taker section and person responsible to take the minutes of the next meeting in the Overleaf minutes of meeting template. After that, I uploaded the template to GitLab so that other members of the team could use it as a reference. (ML4PDM-38)

2. A reference section has been added to each week page so that each week has its own reference section in the weekly status report and the 'References.bib' file has been deleted. After that, I uploaded the template to GitLab so that other members of the team could use it as a reference. (ML4PDM-37)

3. Completed the reading and understanding of abstract, Introduction, Categories of Maintenance Techniques, and System architecture of PdM section of survey paper [1].

4. Set up the GitLab environment on the local machine.

Tasks in-progress

1. Started reading the Purposes of PdM section of survey paper [1].

References

[1] Yongyi Ran et al. "A Survey of Predictive Maintenance: Systems, Purposes and Approaches". In: *CoRR* abs/1912.07383 (2019). arXiv: 1912.07383. URL: http://arxiv.org/abs/1912.07383.

Calendar Week: 45 06 November, 2020

Completed Tasks

1. Organize the Doodle Poll to check the availability of all team members to decide the day & the timing for weekly meeting with the supervisors. (ML4PdM - Weekly Meeting)

2. Organize the Doodle Poll to check the availability of all team members to decide on the day of the Presence Day. (ML4PdM - Presence Day)

3. Along with Saghar Heidari, we created the Weekly status report template in Overleaf as decided by supervisors and team. After that, I uploaded the template to GitLab so that other team members could use it as a reference. (ML4PDM-37)

4. Along with Vinay Kaundinya, we created the Minutes of meeting template in Overleaf as decided by supervisors and team. After that, I uploaded the template to GitLab so that other team members could use it as a reference. (ML4PDM-38)

Tasks in-progress

1. Started reading the survey paper [1] to expand my knowledge of Machine Learning for Predictive Maintenance.

References

[1] Yongyi Ran et al. "A Survey of Predictive Maintenance: Systems, Purposes and Approaches". In: *CoRR* abs/1912.07383 (2019). arXiv: 1912.07383. URL: http://arxiv.org/abs/1912.07383.