



SOFTWARE ENGINEERING

Exercises

Summary

This document contains the exercises that support the lecture Software Engineering.

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1 Exercise 1: Good preparation is everything!

*“In a mature software development organization, much of a software engineer's life is spent in meetings, discussing **requirements**, planning, evaluating software products [...], **documenting** and **reporting**.”*
[Conn, R. in IEEE Software, No. 5, 2002]

1.1 Task 1: Software? Processes?

By now you have learned a bit about process models.

- a) In which phases of the software life cycle is software created?
- b) Discuss the three basic models “Sequential/Waterfall,” “Sashimi,” and “Incremental” regarding the required competences of the development team, the scope of projects and the requirements for projects. What do they have in common, how do they differ?

1.2 Task 2: Tools check

In addition to your head, paper and pencil, you will also need and use a few tools for the following exercises, namely:

- Word processing: MS Word, alternatively: LibreOffice Writer, Google Docs
 - Flow charts: MS Visio, alternatively: MS PowerPoint, Google Slides, LibreOffice Impress, **Miro**, Collaboard, **draw.io**, or any other drawing program
 - List creation, diagrams: MS-Excel, alternatively: LibreOffice Calc, Google Sheets
 - Process models: V-model project assistant 1.5.8¹
 - Web Browser, Email: Mozilla Firefox, Google Chrome, MS Edge, Outlook, Thunderbird, or any other browser and email client
 - Configuration Management Client: TortoiseGIT, alternatively: SourceTree, **GitHub Desktop**
 - Mind Maps: Freeplane (FreeMind), alternative: MS Visio, **Miro**, Collaboard
 - UML diagrams: MS-Visio, alternatively: ArgoUML, UMLet, plantuml in GitLab, Enterprise Architect, **draw.io**, ...
 - Creation of presentations and drawings: MS PowerPoint, alternatively: LibreOffice Impress, Google Slides
- a) Check on your computer whether the software mentioned is installed and whether you can run it.²
 - b) Preferably use your own computer. If necessary, install the specified software there.

¹ Portable version available e.g., at https://www.cio.bund.de/Web/DE/Architekturen-und-Standards/V-Modell-XT/vmodell_xt_node.html.

² On the laboratory computers: virtual desktop via <https://inf-view.fh-rosenheim.de/>.

1.3 Task 3: Word template

In the project business and in your studies, a word processor is one of your most elementary tools. Using a Word template as an example, you should learn how to use the most important functions of MS Word:

- Structured work with a word processor (Word)
 - Creating a Word document template
 - Creation of / working with format templates (e.g., chapter, section, ...)
 - Indexes: Generate table of contents, outline view, ...
 - Manage links: Number figures, code fragments
 - Essential tools: Ctrl-C, Ctrl-V, Ctrl-X, Ctrl-Z
- a) Create a Word document as a template – for example – for a report. The document should have the following properties:
- Cover sheet (title, student)
 - Table of contents (chapters with page numbers)
 - Numbered pages in the footer (no numbering on the cover sheet!)³
 - The following numbered main chapters:
 - 1. Summary**
 - 2. Tools**
 - 3. Remarks**
- b) Working with the template
- What do you think, what is software and what does software engineering mean? To do this, write a few sentences under Chapter **1. Summary** and insert any image (gif, jpg, png, ...) there. Create a caption for this figure, including a figure number.
- Describe the figure with a short text, in which you refer to the caption. The referencing should be done in such a way that the reference is automatically adjusted if something changes in the figure (number, caption).
- c) Extension of the template
- On the cover sheet of your report, add a line that indicates where the document is located in the directory structure. The field should be updated automatically.
- In addition, add the current date to the footer, this should also be updated automatically.
- d) *Optional (try it!): Advanced extension of the template*
- In addition, on all pages – except for the cover sheet – add a field with the title that is on the cover sheet in the header.*
- The field should be automatically updated if the title on the cover sheet changes.⁴*

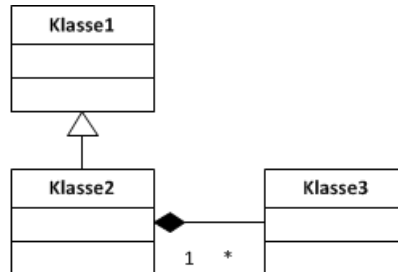
³ Note: see also “Different first page” or “Section breaks”.

⁴ Note: see Create “Bookmark” (on cover page) and “Cross-reference →bookmark” (for header).

1.4 Task 4: Try it out and interact

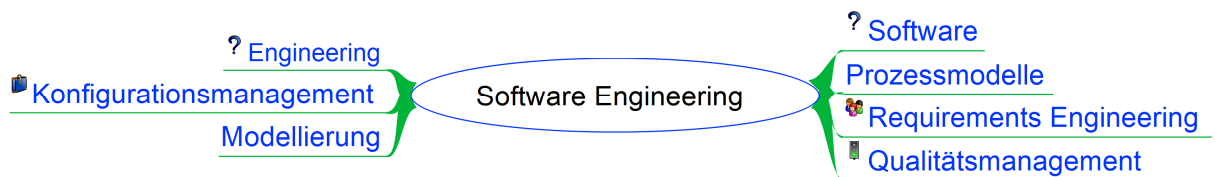
Use the Word template you created in Task 2 and create a sub-chapter under Chapter 2. **Tools for each of the following sub-tasks.**

- a) Create the following class diagram with **draw.io** or MS Visio⁵



and paste it into the Word document.

- b) Start the V-model project assistant and insert a screenshot of the initial dialog window into the Word document.
- c) Take a screenshot of TortoiseGIT's (or SourceTree's, **GitHub Desktop**'s) About dialog and paste it into the Word document.
- d) Finally, create the following mind map with Freeplane, **Miro**, or Collaboard.



and paste it into the Word document.

⁵ Template Category = "Software and Database," Template = "UML Class"

2 Exercise 2: Procedure in software projects

The aim of this exercise is for you to use a small example to understand the steps involved in software development projects. You should be able to think of a simple procedure yourself and model it as a flowchart. And you know how to represent roles, products/results, and activities.

Finally, you will get to know the main factors influencing projects and examine them using the following example.

Story

Congratulations! You have just founded a new Rosenheim software and consulting company (RoSCoF) and are now producing web applications for your customers.

Your first customers are Silvio Bocaccio⁶ and Umberto Rossi, both owners of the pizzeria “Il Papagallo.” Your two customers want you to build a web application that can be used to order pizza and other foods over the Internet; so, they want a delivery service software. Both customers are available to you on site for a few hours a day to tell you the requirements for the web application.

You decide not to write a full specification (you don't know what that is yet)! Your customers should write the requirements for the functions/features of the web application on **index cards**. A file card contains no more than three sentences of what a required function should look like.

Example of an index card:

Customer Story and Task Card BLW Development / COLA

DATE: 3/19/98 TYPE OF ACTIVITY: NEW: ☒ FIX: ☐ ENHANCE: ☐ FUNC. TEST: ☐

STORY NUMBER: ~~1275~~ 1275 PRIORITY: USER: ☐ TECH: ☐

PRIOR REFERENCE: ☐ RISK: ☐ TECH ESTIMATE: ☐

TASK DESCRIPTION:
SPLIT COLA: When the COLA rate chgs. in the middle of the BIW Pay Period, we will want to pay the 1st week of the pay period at the OLD COLA rate and the 2nd week of the pay period at the NEW COLA rate. Should occur automatically based on system design.

NOTES: on system design
For the OT, we will run a m/frame program that will pay or calc the COLA on the 2nd week of OT. The plant currently retransmits the hours data for the 2nd week exclusively so that we can calc COLA. This will come into the Model as a "2144" COLA

TASK TRACKING: Gross Pay Adjustment. Create RM Boundary and Place in DEEnt Express COLA

Date	Status	To Do	Comments	BIN:

⁶ Names of the customers and the pizzeria are fictitious. Matches with living persons and/or premises would be purely coincidental.

2.1 Task 1: Creation of a process model

Your task as the manager of RoSCoF is now to think of a *process (model) for your five ambitious employees* with which the web application can be programmed.

- a) Think about how the requirements on index cards are implemented in a delivered partial web application.

The following aspects must be considered in your approach:

- Programming the requirements of index cards, of course only if feasible.
- Developer test the requirements of flashcards, and develop a unit test per requirement (preferably even before implementation → “Test First”)
- Delivery of the software to Silvio and Umberto.
- Acceptance test of the requirements of individual index cards by the customer.
- In order to be able to work in a focused manner, only the project manager is allowed to have customer contact.

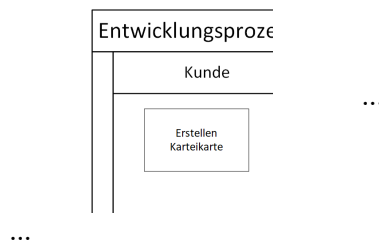
- b) Requirements for the procedure.

Define:

- **Roles** for the five employees (not Mr. Müller, but: “Developer”, ...), the role “Customer” is also included.
- **Activities** in development (e.g., writing source code, testing software, ...).
- **Intermediate results** (e.g., source text).
- A **flow** that shows the order in which activities are performed, what intermediate result they contribute to, and who is responsible for the activities.

- c) Finally, document your process, i.e., also roles, activities, and intermediate results, as a flow chart using MS Visio, **draw.io**, by hand or with any other tool you prefer 😊.

For example, start like this:



In the appendix you will find flow chart symbols (according to DIN 66001) and an example with so-called “swim lanes” to help you.

2.2 Task 2: Factors influencing projects

As the manager of RoSCoF, you also want to be able to specify a suitable strategy. It helps to classify your development project for the delivery service software.

Boehm and Turner, in their book “Balancing Agility and Discipline” proposed a classification scheme for projects. The scheme has five criteria:

Criteria	Description
Personnel	How well qualified are the people in the project? What is the proportion of IT professionals (Cockburn Level 2 and 3) ⁷ ? Possible levels here are 35%, 30%, 25%, 20%, 15%
Dynamism	What is the proportion of requirements that change monthly? Possible levels here are 50%, 30%, 10%, 5%, 1%
Culture	How large is the proportion of people who want as much freedom as possible when designing their projects? Possible levels are here: 90%, 70%, 50%, 30%, 10%
Size	How many people work on the project? Possible levels are: 5, 10, 50, 100, 500, ...
Criticality	How (safety) critical is the project? Possible levels here are: Loss of comfort, loss of (disposable) funds, loss of essential funds (=company bankrupt), loss of a life, loss of many lives

- a) For the project outlined in Task 1, draw a Kiviati diagram.

(Find out what a Kiviati diagram is first!)

If necessary, make suitable assumptions as to which stages might be suitable for your project and document them.

- b) (For advanced)

Create an **Excel sheet** in which you can specify the 5 criteria for any project – preferably using a drop-down list⁸ – and a corresponding Kiviati diagram will be displayed automatically!

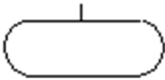

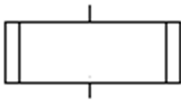

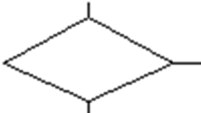



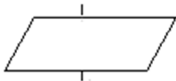
⁷ Cockburn means by level 2 and 3:

Levels	Characteristics
3	Able to revise a method (break its rules) to fit an unprecedented new situation.
2	Able to tailor a method to fit a precededented new situation.
1A	With training, able to perform discretionary method steps (e.g., sizing stories to fit increments, composing patterns, compound refactoring, complex COTS integration). With experience can become Level 2.
1B	With training, able to perform procedural method steps (e.g., coding a simple method, simple refactoring, following coding standards and CM procedures, running tests). With experience can master some Level 1A skills.
-1	May have technical skills, but unable or unwilling to collaborate or follow shared methods.

⁸ In Excel: Data → Data Tools → Data Validation... → Allow: List

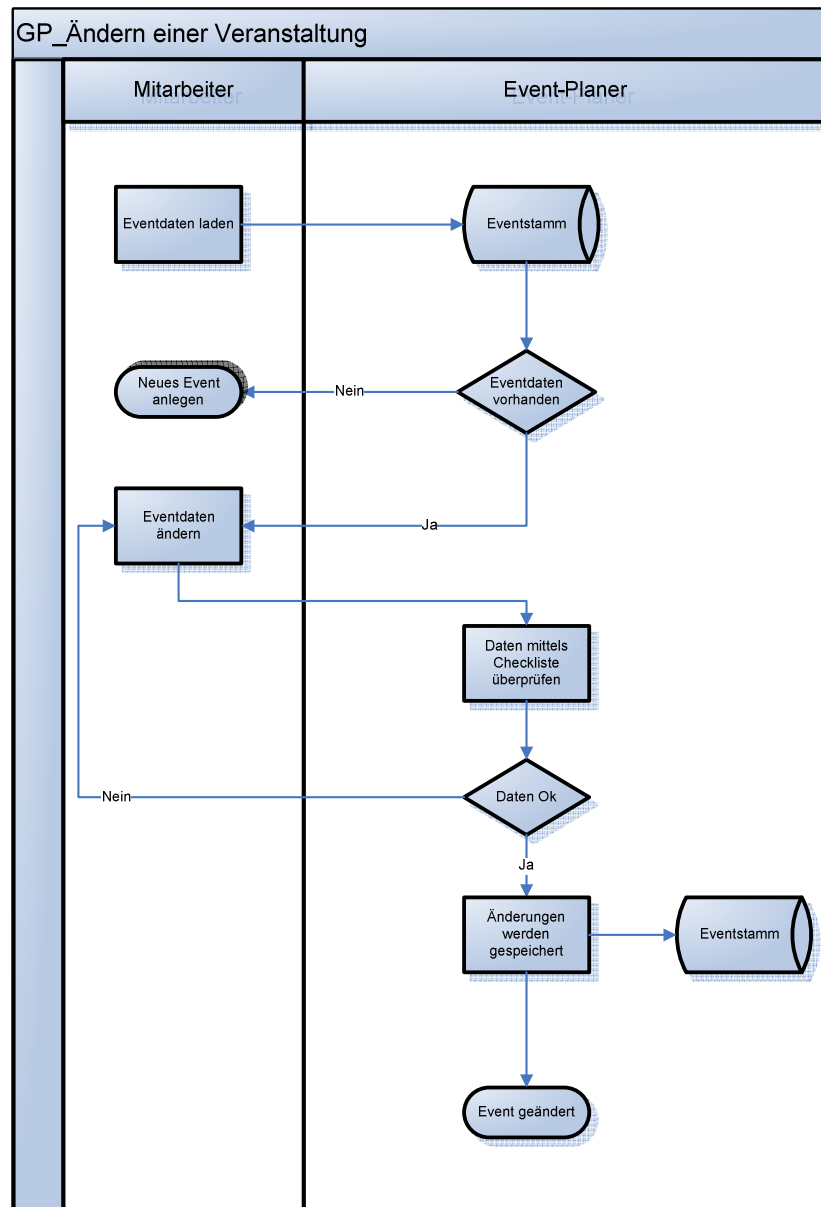
Appendix (flow chart symbols according to DIN 66001)

Flowcharts are widely used in computer science. They are used, for example, to document program sequences and algorithms (program flow charts). They can also be used to model the procedure in software development projects or business processes and other processes in general.

Symbol	Meaning according to DIN 66001	Meaning in SE
	Border post (terminator)	A terminator is the start and stop symbol of a process model. This is where the process ends: e.g., software delivered, project canceled, ...
	Processing in general (process)	With the "Process" symbol, activities are modeled , e.g., program class, test class ...
	Subprogram call (predefined processes); Reference to documentation elsewhere in the form of clear internal labeling	Using "predefined process" large flowcharts are structured. The symbol indicates the call of a sub-process (sub-procedure) .
	Flow lines	The control flow / sequence from processing step to processing step is shown with the aid of the flow lines.
	Branch (decision)	The branch symbol represents decisions where the control flow can branch in different directions, e.g., found a bug? Yes / No, build successful? Yes / No, ...
	Connection point (connector)	Various possibly parallel control flows are brought together again or parallel control flows are generated via a connector.
	Data on Document	Results / products / artefacts are displayed with the "Data on Document" symbol: e.g., specification document, a Java class, ...
	Data on memory also with direct access	This symbol represents access to stored data . This can be the messages in the bug tracker, the source code in the repository, and others.
	Input/output; also: data, general (data)	

The symbols from DIN 66001 cannot represent who is carrying out an activity or who is responsible for a result (role). For this we use the “Swimlane” notation, which you will also get to know in the context of the UML activity diagrams. For example, MS-Visio offers “**Cross-Functional Flowchart Shapes**”.

Example of a flowchart with swimlanes⁹



⁹ Source: SE-2 project “Event Planner”, S. Keller et al.

3 Exercise 3: Process models

Assessing the suitability of a process model, but also being able to implement a given process model in a specific project, characterizes a good software engineer. In today's exercise, you will learn about both.

3.1 Task 1: Selection of a process model

Which basic model would you choose for the development of the following software systems?

- a) A software system that controls an anti-lock braking system in a car.
- b) An accounting system that replaces the existing system in a company.
- c) An interactive system for train passengers to find train departure times at train stations.
- d) A virtual reality system for power plants. The 3D software to be developed should show what happens inside power plants.

(With its help, it should be possible to simulate the processes inside a power plant and to display them as a three-dimensional graphic. In the future, it should be easier to construct and operate power generation plants.)

Think of plausible criteria for each of these software systems that could apply to their development, and use them to justify your choice!

3.2 Task 2: V-Modell XT project assistant

The management of the company RoSCoF (cf. Exercise 2) introduced the V-Modell XT as a standard process model. As a project manager, you are now supposed to be in charge of a software development project. As expected, it is about the development of the said pizza delivery service software.

The following framework conditions are given:

- The project is scheduled to start on **April 5, 2022** and be completed before Christmas (**December 22, 2022**).
- As part of the development, you will first create **two prototypes**: One prototype should implement the user interface and thus facilitate coordination with your customer (duration approx. 3 weeks). The second prototype will be a technical breakthrough (duration approx. 2 weeks).
- After completion of the prototype development, the development should be carried out incrementally. There should be **two increments**, with the 1st increment being delivered at the beginning of September and the 2nd increment being delivered in the second week of December.
- Since the resources are already planned, you don't need to schedule more than 1-2 days for project definition and project completion. Your team includes you as project manager and 4 software developers.
- You have been instructed to use off-the-shelf products (third-party software, frameworks, etc.) in the project, provided they are available and economically viable.
- To create a project plan, you build on your experience from other projects. You need about 1 week to prepare an offer, and it usually takes about 3 weeks until the order is placed. You plan about **10 weeks for each increment** (creation of specifications about 3 weeks, rough and fine draft about 3 weeks, implementation about 4 weeks).¹⁰
- No milestone (decision point) falls on a Saturday, Sunday, or public holiday.

Since you have the project order, you must now set up the project using V-Modell XT and its tools:

- Start a new project and initialize it using the V-Modell XT project assistant¹¹.
- Complete the tailoring with the project assistant.
Briefly explain each case if you do not select certain modules.
- Create a milestone plan based on the data you have.¹²



- Export the project plan in Microsoft Project (XML) format and view the corresponding Gantt chart.¹³

¹⁰ The decision points for specifications, rough draft and detailed draft are identified in the V-Modell XT documentation (see also: **Reference processes**) with:

- **“Overall system designed”** (Requirement specification = functional specification is available)
- **“System designed”** (System architecture = rough design = logical architecture is available)
- **“Unit(s) designed”** (SW or HW architecture = detailed design = technical architecture is available).

¹¹ Depending on the installation, a **source directory for the V-Modell XT may first have** to be specified (.xsd files), e.g., C:\...\Release-2.3\V-Modell XT\Modell.

¹² Insert so-called “free milestones” for the creation of the two prototypes.

¹³ It should also work with ProjectLibre or Planner.

4 Exercise 4: Configuration management

Efficient provision of essential and always up-to-date project information as well as configuration management are decisive factors for successful development projects – right from the start!

Configuration management is one of the central tasks in software engineering. Only then is sensible software development in a team possible. Two of the best-known free tools are **Git** and **SVN** (Subversion). With these tools it is possible to manage code (i.e., ASCII texts) and binary files (e.g., Word documents) professionally. As part of this exercise, we now deal with basic *Git* commands.

Wiki pages are a simple and effective means of displaying current project information. Again, there are a wide variety of integrated variants (*Redmine*, *GitLab*, *trac*, etc.). In this exercise, we'll look at *GitHub*.

However, a project first needs a so-called repository...

4.1 Task 1 – preliminary work: teams and project repositories

- a) Form teams of no more than **five** people and designate a team administrator for the project repository.
- b) The team administrator creates a project on GitHub¹⁴.
 - Create a user account on GitHub and login.
 - On the main page, click the **New** button (Create blank project) and enter a “**Repository name**” for the team as follows.

Repository name: **thro-se**

- Enter an appropriate description for the project and select **Private** as **the Visibility Level**. The project created in this way is displayed on the overview page.

4.2 Task 2 – Team Administration

After creating the project, the project owner (team admin) now needs to add the team members. In order for this to be possible, they **must have registered at GitHub**.

When this is done, in the project under **Settings** → **Collaborators** (left side menu) Team members are added with **Add people**.

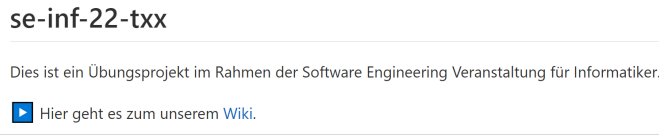
Check (every team member!) if you have access to your project. Your email inbox should also contain a notification regarding your project affiliation.

¹⁴ <https://github.com/>

4.3 Task 3 – Creation of a project homepage (wiki)

Create your project appearance together in your team. All relevant project information is typically stored there in order to make it easy to find for those involved in the project. To do this, a README file and a wiki are created in a GitHub project.

- a) Create a README.md for your project, something like this:



Notes on syntax can be found [here](#)¹⁵.

- b) Now create the wiki page for your project (**Wiki**). Briefly repeat the content of your README here and add a description of your team to the page. Present your team there in the form of a table, with pictures if you like, but at least with the rows (or columns):

- Name
- Role (project manager, developer, ...), and
- Contact (= email address).

- c) Now add the heading “**Our domain**” to the page in such a way that clicking on it takes you to a separate wiki page.

4.4 Task 4 – Cloning the repository

Everyone on your team works with a complete project repository, meaning they have all versions of all files in the project in a local directory. The content of the local directory is compared with the central (remote) repository via Git. Now you'll learn some basic configuration management concepts and apply them with Git.

- a) When the project was created, a repository was automatically created on the Git server. In order to now synchronize your data with the repository, you need a suitable tool.

In the following, the use with **GitHub Desktop** is described, but the use of other tools such as *TortoiseGit*, *SourceTree*, or the command line is possible without further ado (a list of alternatives can be found here¹⁶, a tutorial for using the command line tool can be found here¹⁷).

GitHub Desktop can be downloaded from the following website: <https://desktop.github.com>

¹⁵ <https://inf-git.fh-rosenheim.de/help/user/markdown.md>

¹⁶ <https://git-scm.com/downloads/guis>

¹⁷ <https://try.github.io>

- b) Any action with the Git server requires you to be authenticated. The fastest way is authentication via username and password. To do this, select in *GitHub Desktop* “**Clone a repository from the Internet**” and add the “**https:**” URL specified in the GitHub project, for example:

`https://github.com/kef59000/thro-se.git`

You can now create files in the directory you have selected (destination path) and save them in the central repository.

Note: *Difference between **Clone** and **Pull***

- Cloning is used to initialize your workspace / local repository.
- Pull only fetches changes from the remote repository.

(*Not within the scope of this exercise, but...*) In order to avoid the tedious task of entering user names and passwords, you could also authenticate using an SSH key if you are interested.¹⁸

With the Git Clone dialog, you would then have to enter the “SSH” URL, for example
`git@github.com:kef59000/thro-se.git`.

4.5 Task 5 – Make files available to the team

- a) A team member now creates a subdirectory `source` in the project directory and a file in it, named `.gitkeep`¹⁹.

Caution: *The Gitkeep file is only required to create folder structures and can be removed again as soon as the folders are filled with data.*

- b) A `HelloWorld.txt` file should be created in the root directory. Once created, this file can be made available to other team members. To do this, select “**Commit to main**” in *GitHub Desktop*. Before, check the checkboxes next to the directory and the file and write a comment (Commit Message / Summary).

*It's good form to include a **meaningful comment** with each commit—here, for example, “Initial build.”*

With Commit the changes are transferred to the local repository.

- c) In order to transfer these changes to the remote repository and thus enable the team members to access them, a **push** must be carried out (“**Push...**”).
- d) All team members now clone the project, if they have not already done so (task 4b), or carry out a **pull** (“**Pull...**”).

The `HelloWorld.txt` file should appear along with the `source` folder and the `.gitkeep` file to be visible to all other team members.

¹⁸ Instructions, for example, at <https://help.itc.rwth-aachen.de/service/ubrf9cmzd17m/article/54a96b4470644bf9a015da5b197da489>

¹⁹ <http://stackoverflow.com/questions/7229885/what-are-the-differences-between-gitignore-and-gitkeep/7229996#7229996>

4.6 Task 6 – Familiarization with how Git works

Next to the `.gitkeep` you can store `.gitignore` files in the repository. This is how Git is told which files to ignore²⁰. This can be specified separately for each directory.

- a) In the `source` folder, create a `.gitignore` file with the content `*.tmp`. Now add a file with the extension `.tmp` and watch *GitHub Desktop* behave on your next commit.
- b) Try as you like! Complete the process
 1. Adding not indexed files
 2. Commit
 3. Push

using the [cheat sheet](#)²¹ (alternative [source](#)²²).

4.7 Task 7 – View version history and changes

- a) Make multiple changes to a file in a row. The routine in everyday project work is usually as follows:
 1. A **Commit** follows after logically completed units – with a suitable comment! (This can be repeated until a “ticket” has been processed.)
 2. Then a **Pull** is performed to get any changes made by team members. (This can lead to conflicts and may have to be merged at this point – “**merge**”, see Task 8)
 3. Finally, a **Push** occurs to propagate the local changes to the remote repository.
- b) View the version history, comments, and changes (**History**) and have the differences for two versions of this file displayed (**GitHub.com**).
- c) Rename the `HelloWorld.txt` file to `readme.txt`, check in this file (**Commit**) and then look at the version history of the renamed file.

4.8 Task 8 – Conflicts and Merging (merge)

Two team members now modify the new file in parallel (first **Pull** then **Push**) and try to transfer it one after the other.

What happens to the second team member?

- a) Investigate the following cases:
 1. Both team members modify different lines of the file.
 2. Both team members modify the same line of the file.

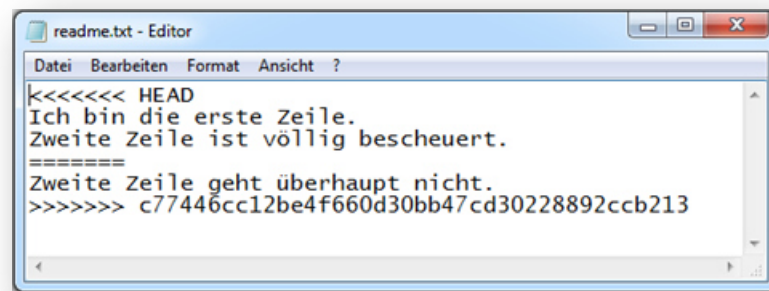
Either case leads to a conflict that cannot be easily resolved:

Both when opening the `readme.txt` file and in *GitHub Desktop*, the conflict is represented by reflecting both team members’ changes in the text. The text file might look something like this because of the same changed line:

²⁰ <https://git-scm.com/docs/gitignore>

²¹ <http://ndpsoftware.com/git-cheatsheet.html>

²² <https://git-scm.com/book/en/v1/Getting-Started>



Now edit the file appropriately and mark the conflict as resolved.²³

(Don't forget to commit afterwards!)

- b) Provoke a conflict again! However, when reporting the conflict, do not execute a Pull or correct it manually, but call up the log instead.


(Don't forget to commit afterwards!)

What happens and how is a conflict represented as it progresses?

4.9 Task 9 - GitLab tools and interaction with Git

GitLab offers a variety of options for project management and project presentation. Let's just try a few more useful things...

- Set your project using the **New milestone** button (Menu on the left **Issues** → **Milestones**) the two milestones "**M1 – Setup**" and "**M2 – Development**" to which tasks (**Issues**) can be assigned later.
- Use the **New label** button to create two labels "**1st sprint**" and "**2nd sprint**" with different colors for your project so that you can later mark tasks (**Issues**) accordingly.
- Issues can be easily presented and tracked on issue boards.
 - Click on **Boards** and create a new board "**Setup**" pull down menu → **Create new board**), with the two lists "**Open**" and "**Closed**".
 - Edit the new setup board (→ **Edit board**) and select "**M1 – Setup**" for Milestone so that only issues that are assigned to this milestone are displayed there.
- Here is another simple way to display Product Backlog and Sprint Backlogs: Select the **Development** board (should already be created by default). Configure it in such a way that you insert two more lists (**Create list**) between the two lists "**Open**" and "**Closed**", namely with the two labels "**1st Sprint**" and "**2nd Sprint**".
- It is often desirable to be able to access relevant file versions directly from the project wiki. This is also possible with GitLab. Try the `readme.txt` file
 - with the current status
 - an older version of the file

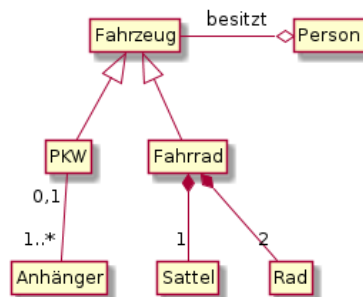
to include in your project wiki and to link to Git²⁴. To do this, formulate an issue with 2 tasks (**in Write** → ) for the **M1** milestone and assign it to one of your team members (→ **Assignee**).

²³ An external conflict resolution tool could also be used for this.

- f) Observe the automatically logged activities on this issue, especially when a task has been marked as complete. When both tasks are done, it should be closed (→ **Close issue**). Watch your **setup** board.
- g) With GitLab / Git it is conveniently possible to mark tasks as done with a commit. Close such an assigned task without using GitLab's graphical interface, but solely with the help of a commit message (see [notes](#)²⁵ in the GitLab Docs).

4.10 Task 10 - Cool features ... (only if you have the time and are interested 😊)

- a) Draw models. Try drawing the following simple domain model as a class diagram using **plantuml** directly in your wiki under **Our domain** (Task 3c).



Hints:

- See <https://plantuml.com/de/class-diagram>, instead of the tags given there **@startuml** and **@enduml**, use the **```` plantuml** and **````** tags in our Gitlab Wiki
- Work with **Preview** before you save.

- b) Parallel development with branches.
- In your repository, create a new development branch called “**dev**” via **Branches** → **New branch**.
 - Switch to the **dev** branch (pull down menu → **dev**) and change, for example, the `readme.txt` so that you add a test line below and then confirm the change with **Commit changes**.
 - Now the changed file should be transferred back to the **main** branch. To do this, create a **Merge request** in the **dev** branch with an assignee and a team member as a reviewer. In addition, specify the milestone “**M2 – Development**” and the label “**1st Sprint**” before you click **Create merge request**.
 - For the merge to complete, the **Merge request** must first be confirmed (**Approve**) and then triggered with **Merge**.
 - Finally, review the process under **Repository** → **Graph**.
- c) Continuous integration and deployment (CI/CD).
- You could also use GitLab to trigger automatic actions, such as builds or tests, on every Commit. Basically, this is only done via a file `.gitlab-ci.yml` with an even simpler markup language “**YAML A in't M arkup L** language”. This would actually go beyond the scope here. Therefore, it is only mentioned here for further study... see, for example, “**Hello world**” with **GitLab CI** (integrated)

²⁴ Tip: In the GitLab project under **Repository** → **Files** it is possible to browse through the repository.

²⁵ https://docs.gitlab.com/ee/user/project/issues/managing_issues.html#closing-issues-automatically

4.11 Parallel development with branches (Branching strategies, Gitflow)

There are different branching strategies to support parallel development:²⁶

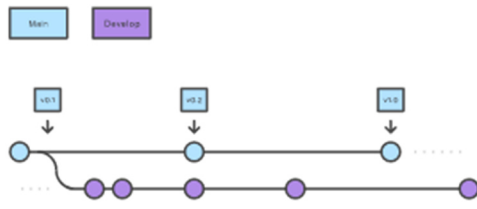


Figure 1. GitFlow: Main & Dev Branches

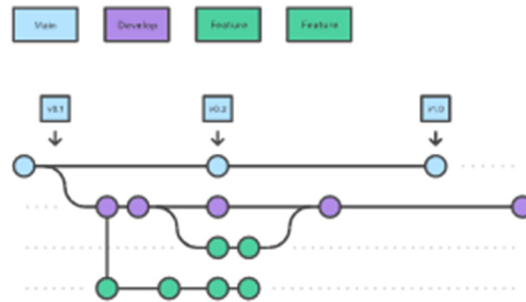


Figure 2. GitFlow: Main, Dev & Features Branches

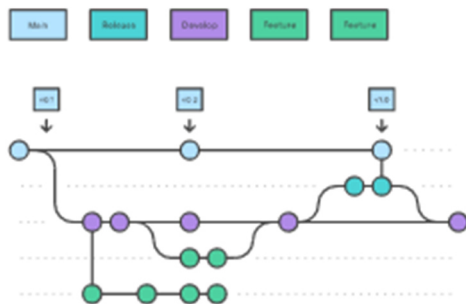


Figure 3. GitFlow: Main, Dev, Feature and Release Branches

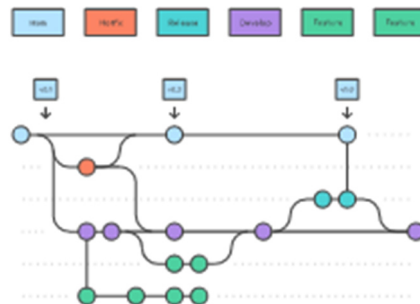
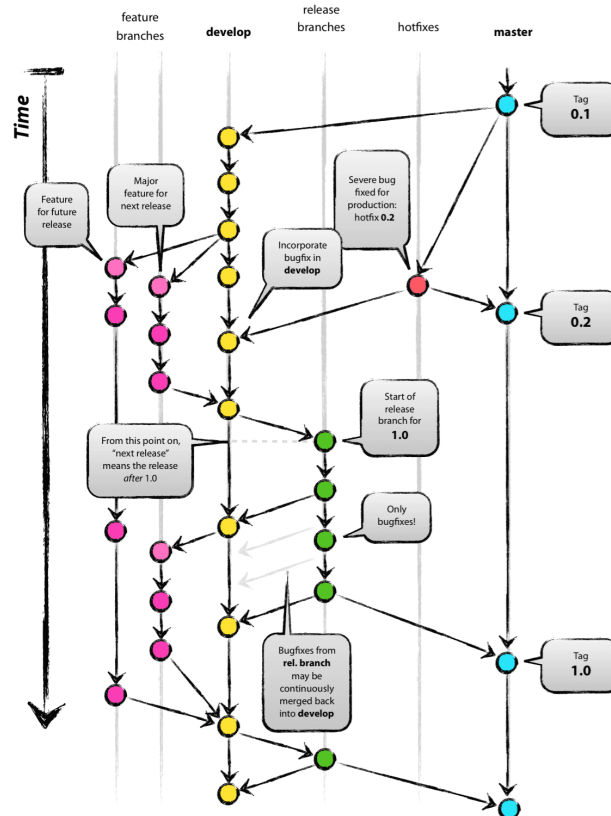


Figure 4. GitFlow: Main, Dev, Feature, Release & HotFix Branches



²⁶ <https://www.atlassian.com/de/git/tutorials/comparing-workflows/gitflow-workflow>,
<https://nvie.com/posts/a-successful-git-branching-model/>

- a) In *github.com* or in *GitHub Desktop*, create a new development branch called “dev”.
- b) Switch to the dev branch and change, for example, the *readme.txt* so that you add a test line below and then confirm the change with Commit changes.
- c) Now the changed file should be transferred back to the main branch. To do this, create a **Pull request** in the dev branch with an assignee and a team member as a reviewer.
- d) Finally, delete the dev branch

4.12 Continuous integration and deployment (CI/CD)

You can also use GitHub to trigger automatic actions, such as builds or tests, on every Commit. Basically, this is done via a yml files with an even simpler markup language "YAML A in't Markup Language". This would actually go beyond the scope here. Therefore, it is only mentioned here for further study... see, for example, <https://github.com/features/actions>

PS: You can delete your project again via the *Settings* → **Delete this repository**.