Hochschule
Bonn-Rhein-Sieg
University of Applied Sciences

Bonn-Aachen
International Center for
Information Technology

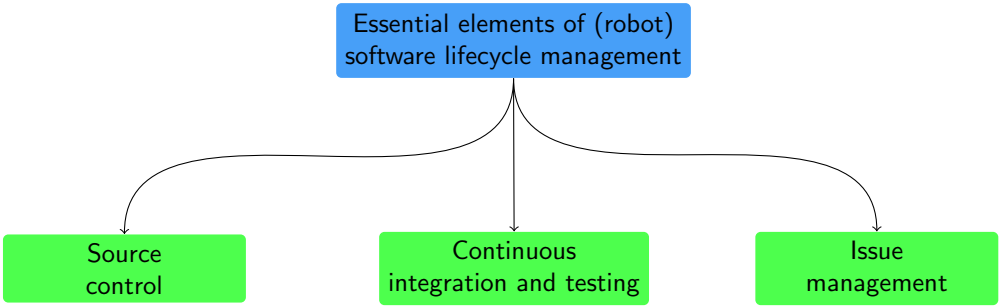
Institute for AI and
Autonomous Systems

Robot Software Development Lifecycle

Dr. Alex Mitrevski
Master of Autonomous Systems

Structure

- Source control
- Continuous integration
- Issue management


Essential elements of (robot) software lifecycle management
Source control
Continuous integration and testing
Issue management

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  - **Upstream version**: The version of a repository that is **hosted centrally** (e.g. on an external server) and that **everyone can access**
  - **Local clone**: A local copy of a repository, whose changes **may be made available** in the upstream version at a later point

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Code sharing and reusability

The way in which **free and open source software is accessed and can be contributed to** is also simplified through source control

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Pushing

Records any local changes in the repository's history tree **to the central repository**

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- Due to its decentralised nature, Git **enables offline working**
  - In principle, Git can be used without a central repository — useful for maintaining local backups

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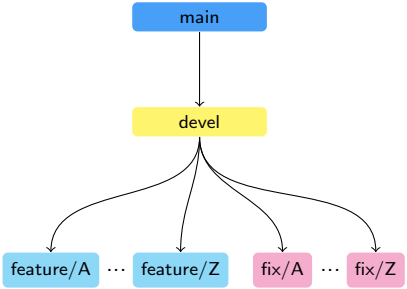

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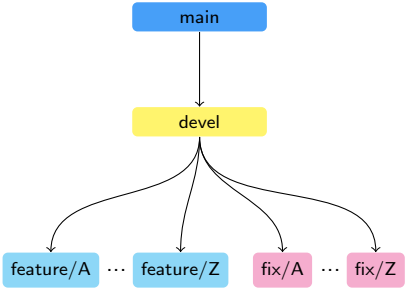

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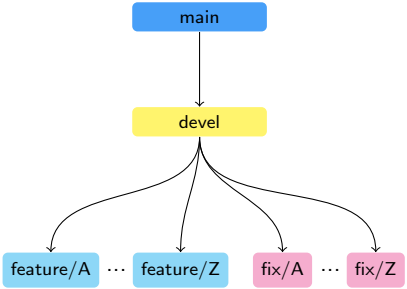

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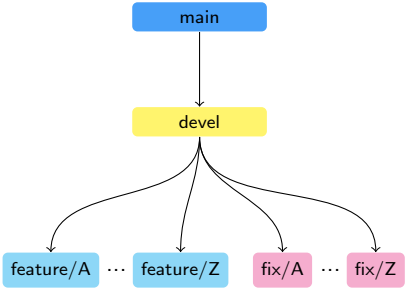

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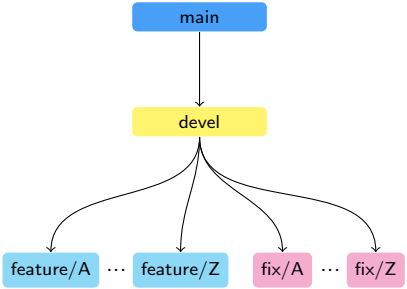

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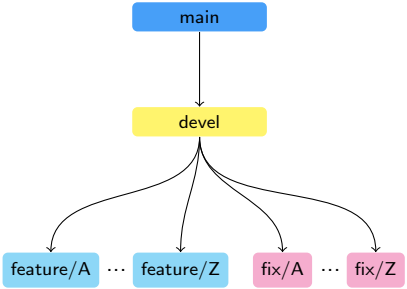

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- Code from a child branch is integrated into a parent branch via a **merge (aka pull) request**

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  - But pull requests can also be made to the upstream repository
- Forks **simplify repository access management for large, very distributed teams**
  - Instead of giving every contributor access to the main repository, everyone maintains their own fork and makes a pull request later
  - For this reason, forks are essential for large open-source projects, where anyone can contribute

Typical Collaborative Development Workflow

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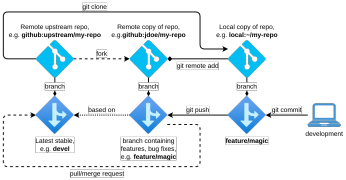

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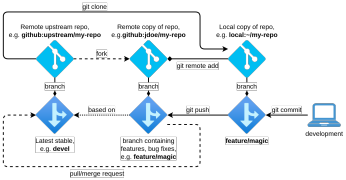

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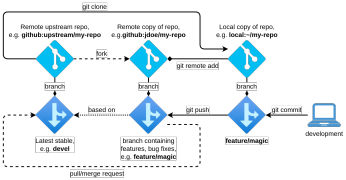

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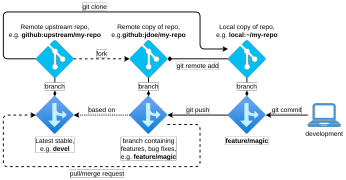

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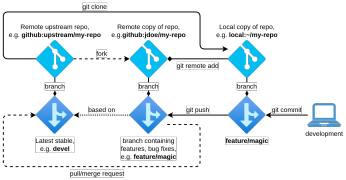

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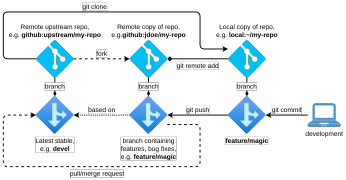

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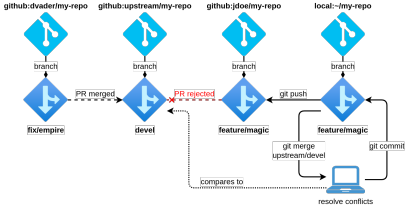

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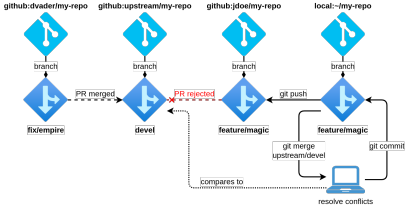

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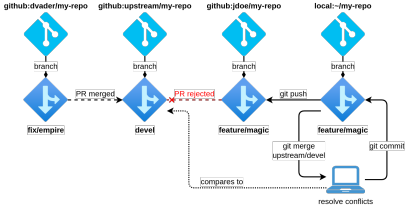

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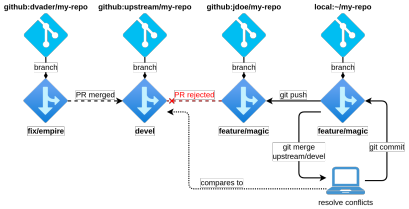

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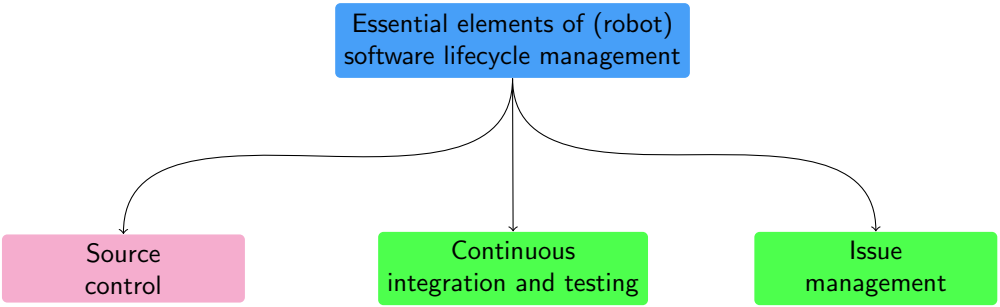
- Conflict resolution is a **manual process** that requires **careful consideration of the conflicting file lines** so that important changes are not lost
- The best strategy to avoid merge conflicts is to **pull from the parent branch / repository frequently** so that new file edits are integrated before a pull request is even created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Example of a Python-based unit test for a library that interacts with data in a database. Taken from https://github.com/ropod-project/black-box-tools

```python
class TestDataUtils(unittest.TestCase):
    @classmethod
    def setUpClass(cls):
        cls.test_db_name = "bb_tools_test_data"
        test_dir = os.path.abspath(os.path.dirname(__file__))
        cls.test_db_dir = os.path.join(test_dir, cls.test_db_name)
        cls.collection_name = 'ros_ropod_cmd_vel'

        host, port = cls._get_db_host_and_port()
        cls.client = pm.MongoClient(host=host, port=port)
        success = cls._restore_test_db()
        assert(success)

    @classmethod
    def tearDownClass(cls):
        cls._drop_test_db()

    def test_get_all_measurement(self):
        database = self.client[self.test_db_name]
        collection = database[self.collection_name]
        doc_cursor = collection.find({})
        docs = [doc for doc in doc_cursor]
        measurements = DataUtils.get_all_measurements(docs, 'linear/x')
        self.assertEqual(measurements.shape, (149,))
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An example of a continuous integration pipeline on GitHub. Taken from https://github.com/ropod-project/black-box-tools

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image: "mongo"
before_script:
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    - apt-get install -y git-all
    - apt-get install -y python3-pip
    - pip3 install --upgrade pip
    - cat requirements.txt | xargs -n 1 -L 1 pip3 install
variables:
  DB_HOST: mongo
services:
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test:
    script:
        - python3 -m unittest discover -s 'test' -p 'test_*.py'
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- **Continuous integration pipelines are typically automated** and are associated with **automated tests** — the code changes are integrated into the target branch **only if all tests pass**

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        - python3 -m unittest discover -s 'test' -p 'test_*.py'
```

- **Continuous integration** is one such automated process, based on which changes are merged into a target branch at a frequent rate — in principle, multiple times a day
- **Continuous integration pipelines are typically automated** and are associated with **automated tests** — the code changes are integrated into the target branch **only if all tests pass**
- Additional steps, such as **static code analysis** tools, are often included in continuous integration pipelines as well — this **prevents low-quality code from being merged**

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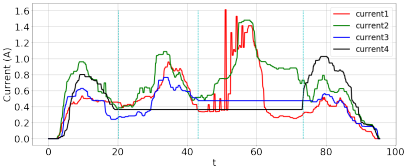
- **The quality of HIL testing depends on the used simulation though** — a high-fidelity simulation is needed so that meaningful evaluation results are obtained
- **Testing with the real system under real conditions is eventually unavoidable**, but it is best if this is only performed after software-based and HIL testing are both satisfactory

Fault Injection



Current measurements of a Robile-like platform with injected wheel faults. Taken from A. Mitrevski and P. G. Plöger, "Data-Driven Robot Fault Detection and Diagnosis Using Generative Models: A Modified SFDD Algorithm," in *30th Int. Workshop Principles of Diagnosis (DX)*, 2019.

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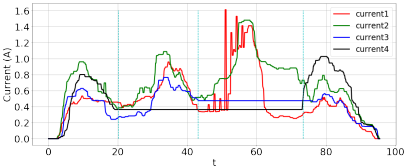

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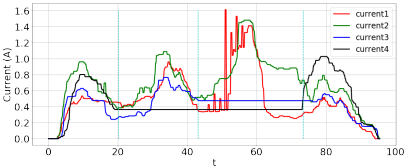

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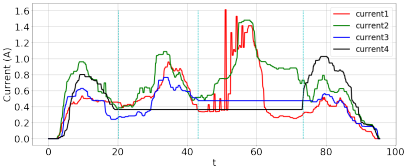

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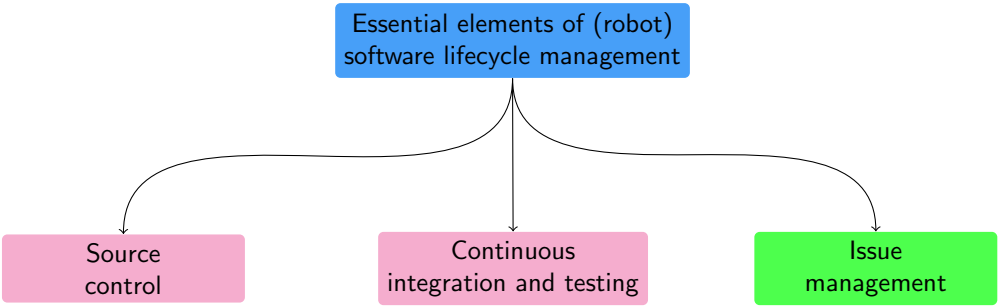
- Fault injection can also be used to **verify the correctness of fault management strategies**, namely fault detection, identification, and diagnosis


Essential elements of (robot) software lifecycle management
Source control
Continuous integration and testing
Issue management

Task Management Through Issues

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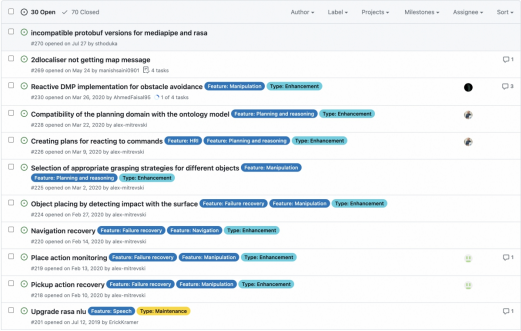

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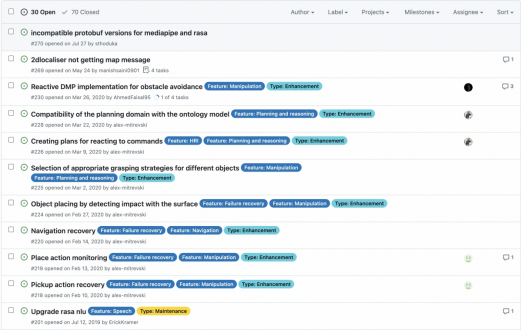

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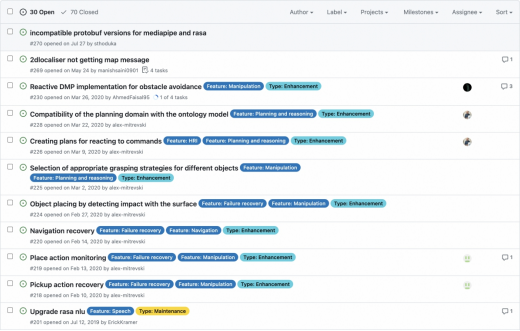

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- Issues are typically **associated with individual repositories**, but can also be managed for a complete project — this depends on the development style that is followed by a team

Issue Best Practices

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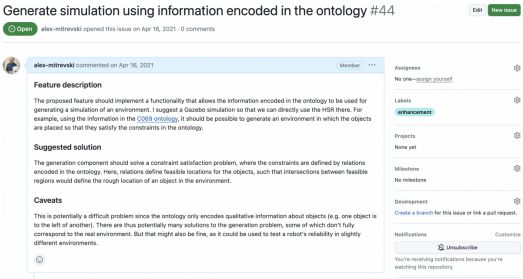

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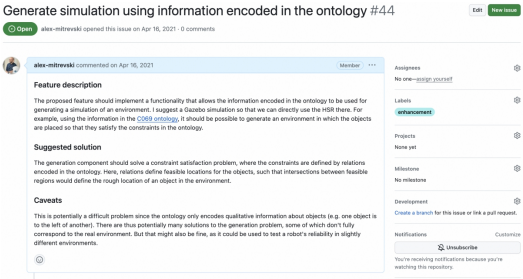

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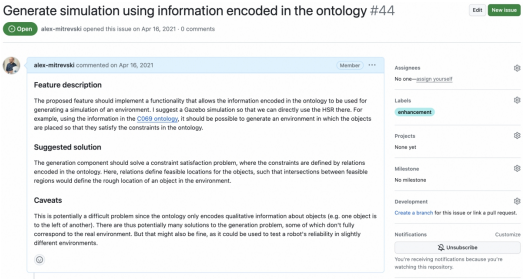

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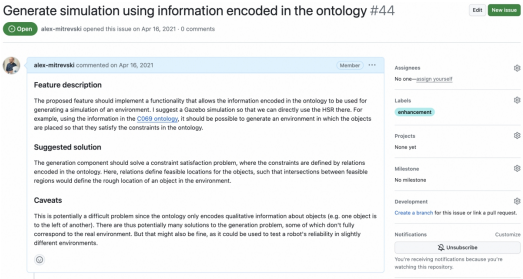

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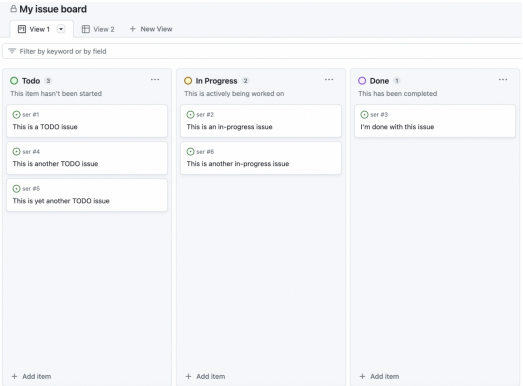
- Many open-source repositories have **issue description templates** — the details expected in the template should all be filled out for the issue to be considered by the developers

Issue Boards



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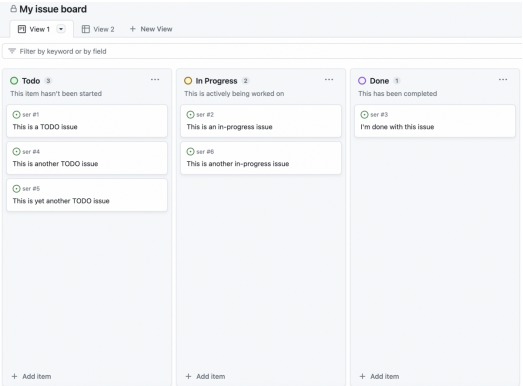

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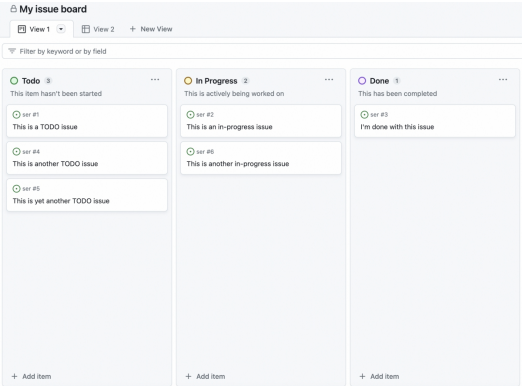

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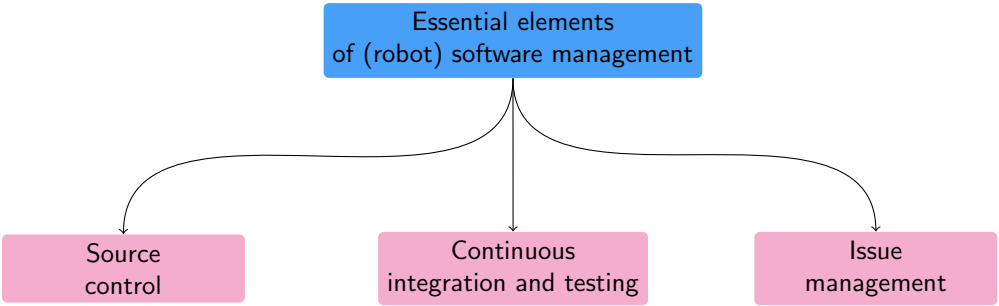
- Most major software management platforms, such as GitHub and GitLab, provide an integrated facility for creating issue boards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