



Hochschule
Bonn-Rhein-Sieg
University of Applied Sciences



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

```
graph TD; A[Essential elements of (robot) software lifecycle management] --> B[Source control]; A --> C[Continuous integration and testing]; A --> D[Issue management];
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Continuous
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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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- ▶ Due to its decentralised nature, Git **enables offline working**
 - ▶ In principle, Git can be used without a central repository — useful for maintaining local backups

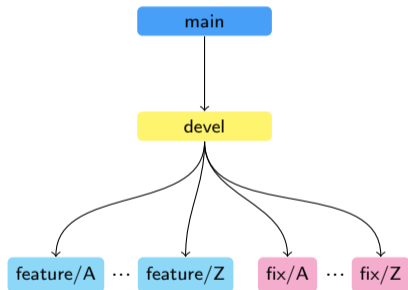
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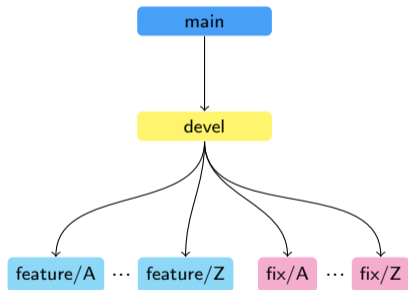
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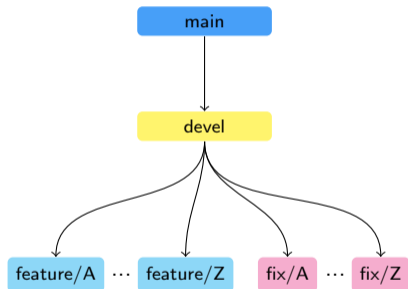
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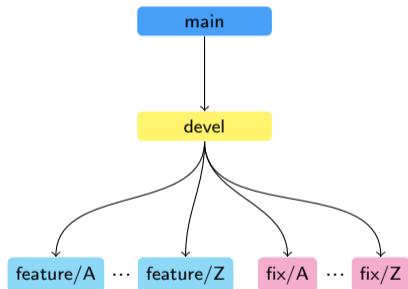
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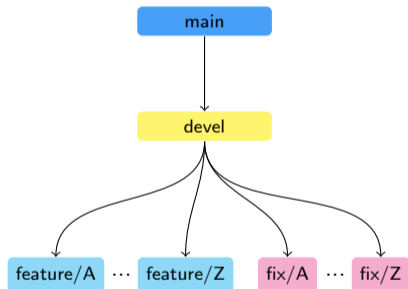
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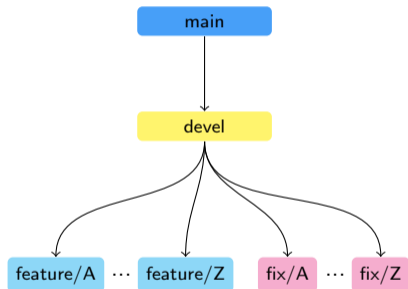
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- ▶ Code from a child branch is integrated into a parent branch via a **merge (aka pull) request**

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- ▶ 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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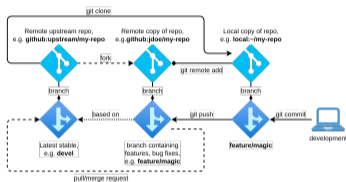


Illustration of a typical collaborative development workflow. Courtesy of Minh Nguyen.

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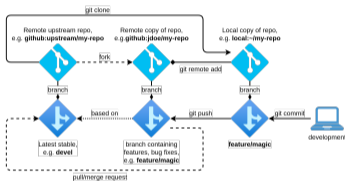


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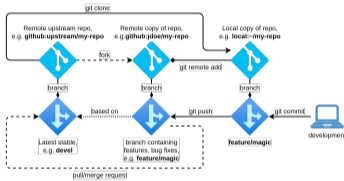


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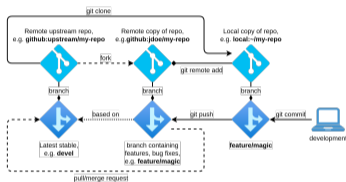


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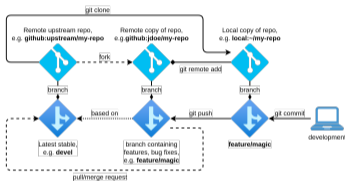


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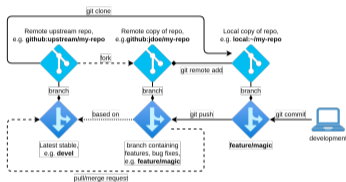


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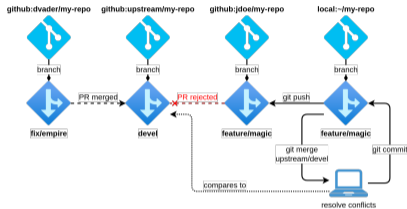


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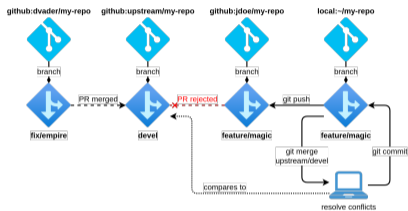


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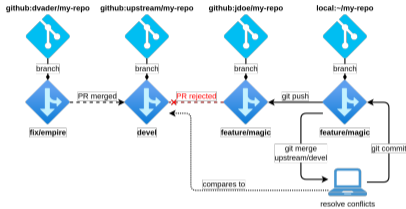


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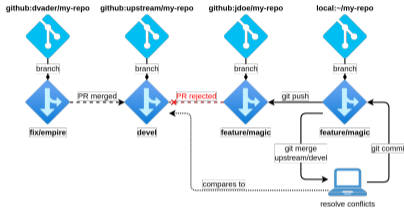


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- ▶ Conflict resolution is a **manual process** that requires **careful consideration of the conflicting file lines** so that important changes are not lost
- ▶ The best strategy to avoid merge conflicts is to **pull from the parent branch / repository frequently** so that new file edits are integrated before a pull request is even created

Essential elements of (robot) software lifecycle management

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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>

```
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:
  - apt-get update
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  - pip3 install --upgrade pip
  - cat requirements.txt | xargs -n 1 -L 1 pip3 install
variables:
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- ▶ 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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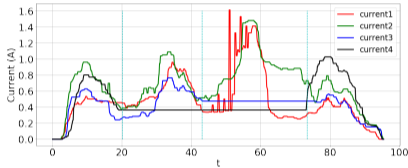
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- ▶ **The quality of HIL testing depends on the used simulation though** — a high-fidelity simulation is needed so that meaningful evaluation results are obtained

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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

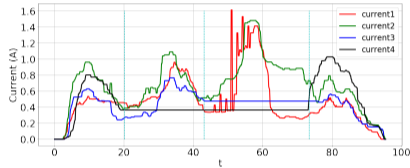
Fault Injection

- ▶ Robots process complex sensor data to eventually produce actuator output, but **sensors, actuators, as well as algorithms are all susceptible to faults**
 - ▶ Faults can be either **intermittent**, which appear sporadically, or **permanent**, which persist for a prolonged period of time



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.

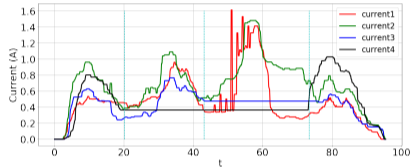
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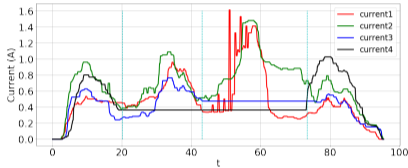
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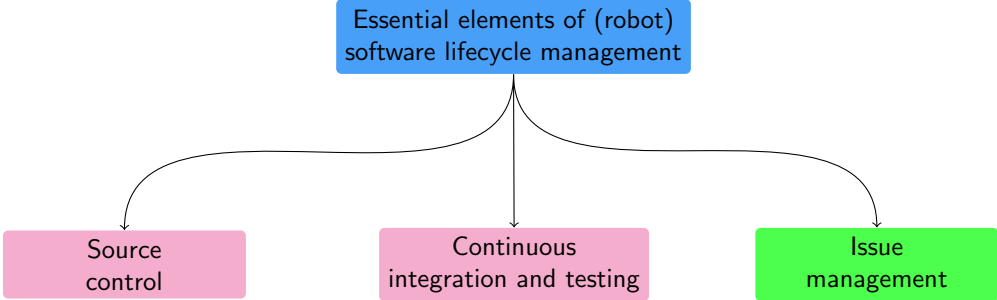
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Essential elements of (robot) software lifecycle management



```
graph TD; A[Essential elements of (robot) software lifecycle management] --> B[Source control]; A --> C[Continuous integration and testing]; A --> D[Issue management];
```

Source
control

Continuous
integration and testing

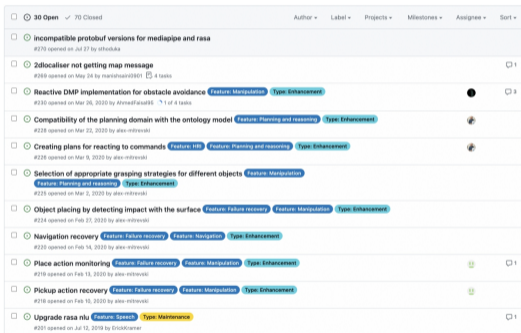
Issue
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Task Management Through Issues

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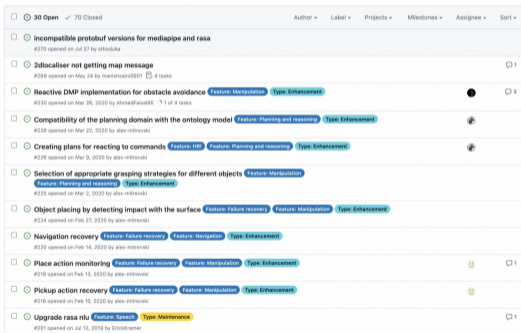
Issue Title	Author	Label	Projects	Milestones	Assignee	Sort
Incompatible protobuf versions for mediapipe and rasa #270 opened on Jul 27 by ottobocka						
2dlocaliser not getting map message #269 opened on May 24 by marishvair03001 4 tasks						1
Reactive DMP implementation for obstacle avoidance (Feature: Manipulation) (Type: Enhancement) #230 opened on Mar 26, 2020 by AhmedHassan96 1 of 4 tasks						3
Compatibility of the planning domain with the ontology model (Feature: Planning and reasoning) (Type: Enhancement) #228 opened on Mar 22, 2020 by alex-mitrevski						
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Navigation recovery (Feature: Failure recovery) (Feature: Navigation) (Type: Enhancement) #220 opened on Feb 14, 2020 by alex-mitrevski						
Place action monitoring (Feature: Failure recovery) (Feature: Manipulation) (Type: Enhancement) #219 opened on Feb 13, 2020 by alex-mitrevski						1
Pickup action recovery (Feature: Failure recovery) (Feature: Manipulation) (Type: Enhancement) #218 opened on Feb 10, 2020 by alex-mitrevski						
Upgrade rasa nlu (Feature: Speech) (Type: Maintenance) #201 opened on Jul 12, 2019 by ErickKramer						1

A list of open issues from https://github.com/b-it-bots/mas_domestic_robotics/issues

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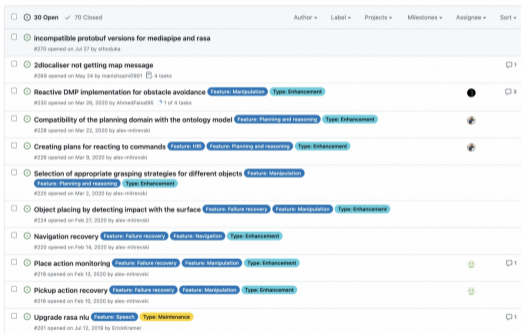
Issue ID	Title	Author	Label	Project	Milestone	Assignee	Sort
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#269	2dlocaliser not getting map message	marishvair0301					1
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#228	Compatibility of the planning domain with the ontology model	alex-mitrevski	Feature: Planning and reasoning	Type: Enhancement			
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#220	Navigation recovery	alex-mitrevski	Feature: Failure recovery	Feature: Navigation	Type: Enhancement		
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The screenshot shows a list of 10 open issues. Each issue entry includes a title, a description, the date it was opened, the author, and tags for features and types. The issues are:

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- ▶ An issue is a **description of a concrete task** that can be **assigned to a developer**, potentially with **associated tags** that help identify the type of issue
- ▶ 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

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Generate simulation using information encoded in the ontology #44

alex-mitrevski opened this issue on Apr 16, 2021 · 0 comments

alex-mitrevski commented on Apr 16, 2021

Feature description

The proposed feature should implement a functionality that allows the information encoded in the ontology to be used for generating a simulation of an environment. I suggest a Gazebo simulation so that we can directly use the HSR there. For example, using the information in the [COB9 ontology](#), it should be possible to generate an environment in which the objects are placed so that they satisfy the constraints in the ontology.

Suggested solution

The generation component should solve a constraint satisfaction problem, where the constraints are defined by relations encoded in the ontology. Here, relations define feasible locations for the objects, such that intersections between feasible regions would define the rough location of an object in the environment.

Caveats

This is potentially a difficult problem since the ontology only encodes qualitative information about objects (e.g. one object is to the left of another). There are thus potentially many solutions to the generation problem, some of which don't fully correspond to the real environment. But that might also be fine, as it could be used to test a robot's reliability in slightly different environments.

Assignees: No one—assign yourself

Labels: enhancement

Projects: None yet

Milestone: No milestone

Development: Create a branch for this issue or link a pull request.

Notifications: Unsubscribe

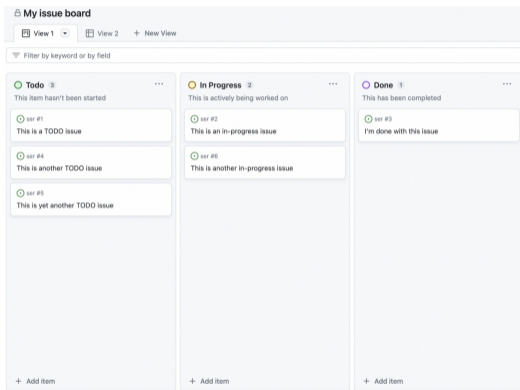
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- ▶ Many open-source repositories have **issue description templates** — the details expected in the template should all be filled out for the issue to be considered by the developers

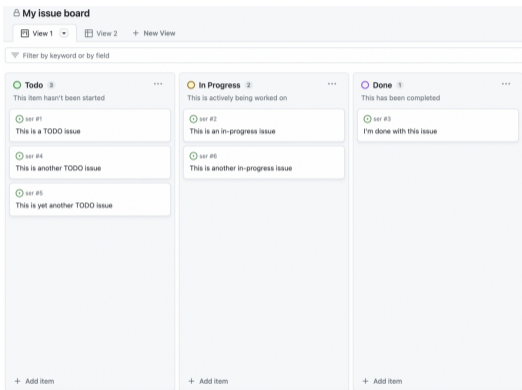
Issue Boards

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An example of an issue board on GitHub

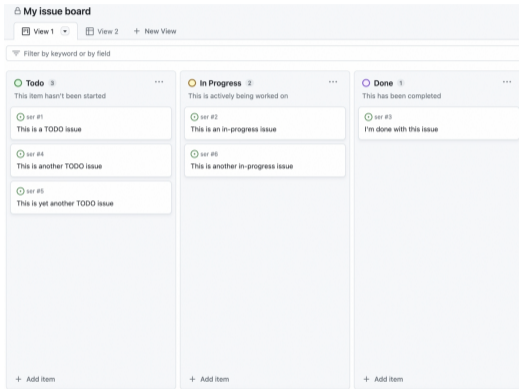
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- ▶ Most major software management platforms, such as GitHub and GitLab, provide an integrated facility for creating issue boards

Essential elements of (robot) software management

