Lab 8 – Visual SLAM

First: The project

The student project

- Develop a functioning computer vision system that does something interesting
  - Large: More than a month
  - Mandatory: 60% of the grade

- Students propose their own projects
- Preferably groups of 2-3 students

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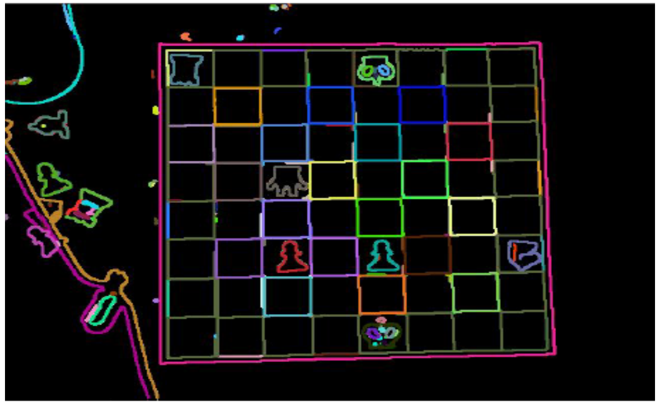
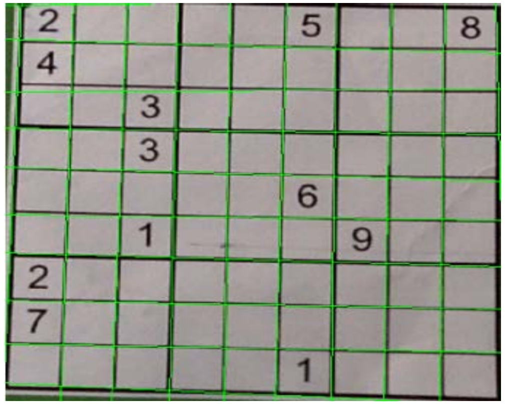




The student project

- Freedom of choice
  - Platform, programing language, tools,…
- Important dates
  - **Thursday April 12th**: Hand in written project proposal
  - **Thursday April 19th**: Verbal feedback on the project proposals
  - **Sunday May 27th** : Hand in project report
  - **Thursday May 31st** : Project presentations
- In the project period we will be available for project support here at Kjeller on Thursdays 09:15-12:00
- The lab will in general be available to you (at least within office hours)

The student project

- The project proposal
  - Describes what you want to do
  - Briefly describes how you plan to do it
  - Preferably not more than one page

- The feedback
  - Verbal (here in the lab)
  - Our thoughts regarding difficulty, workload and relevance

- The project report
  - We expect a proper written report
  - Project code

- The project presentation
  - Typically a powerpoint presentation + LIVE demonstration

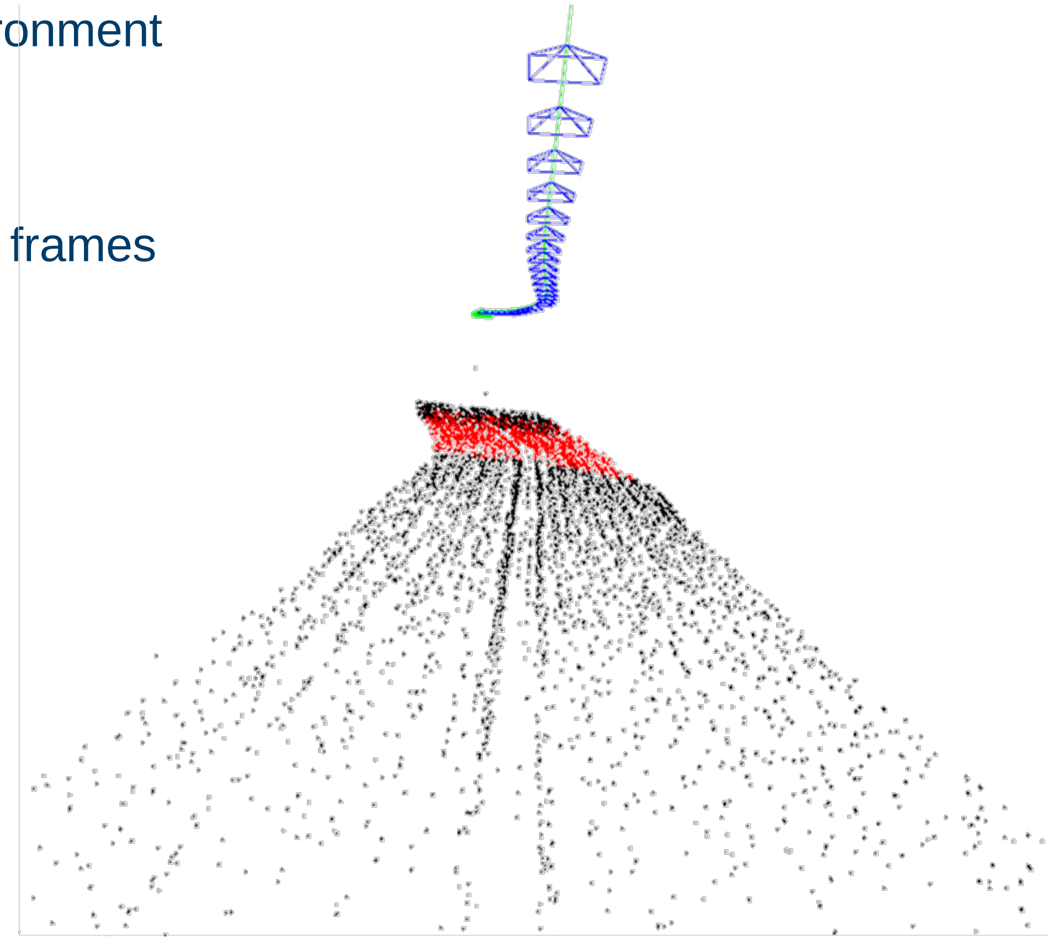
Visual SLAM

Visual simultaneous localization and mapping

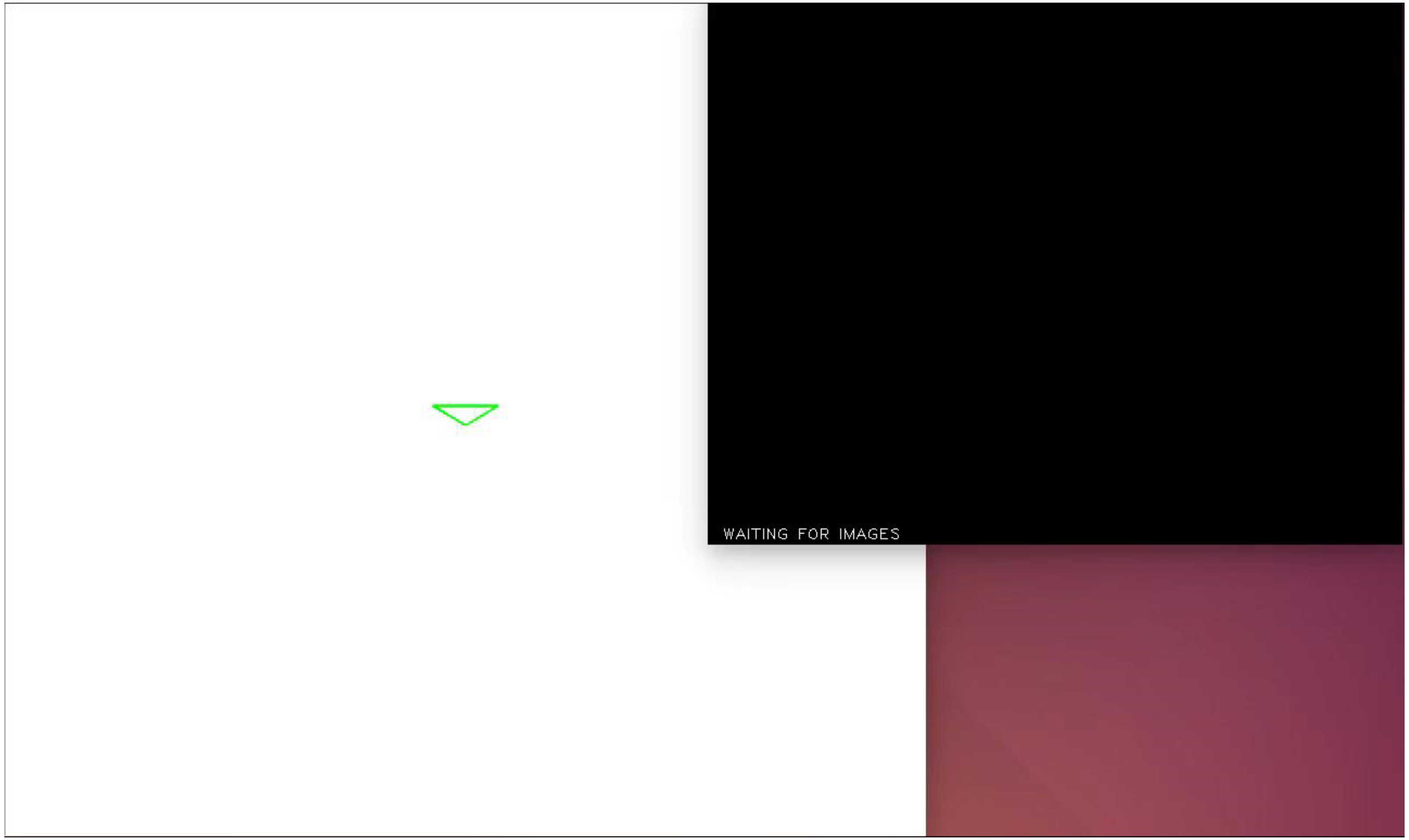
- Mapping
  - Continuously expanding a map while exploring the environment
- Localization (tracking)
  - Localization within the map = tracking the map in image frames
- Loop closure
  - Recognizing areas you have visited before
  - Added as constraints in the map

    ⇒ More consistent map topology

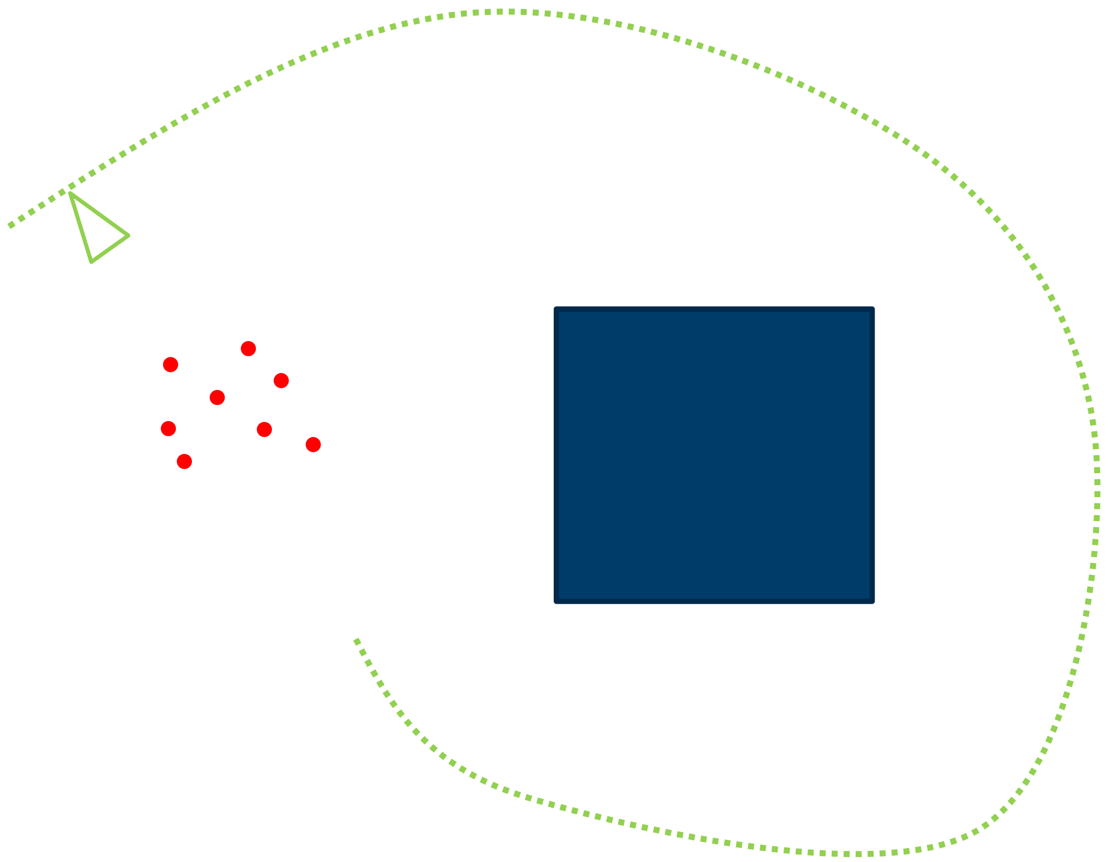
    ⇒ Less drift
- Visual SLAM ≈ “Real-time SfM”
- Visual SLAM ≈ Visual odometry + loop closure



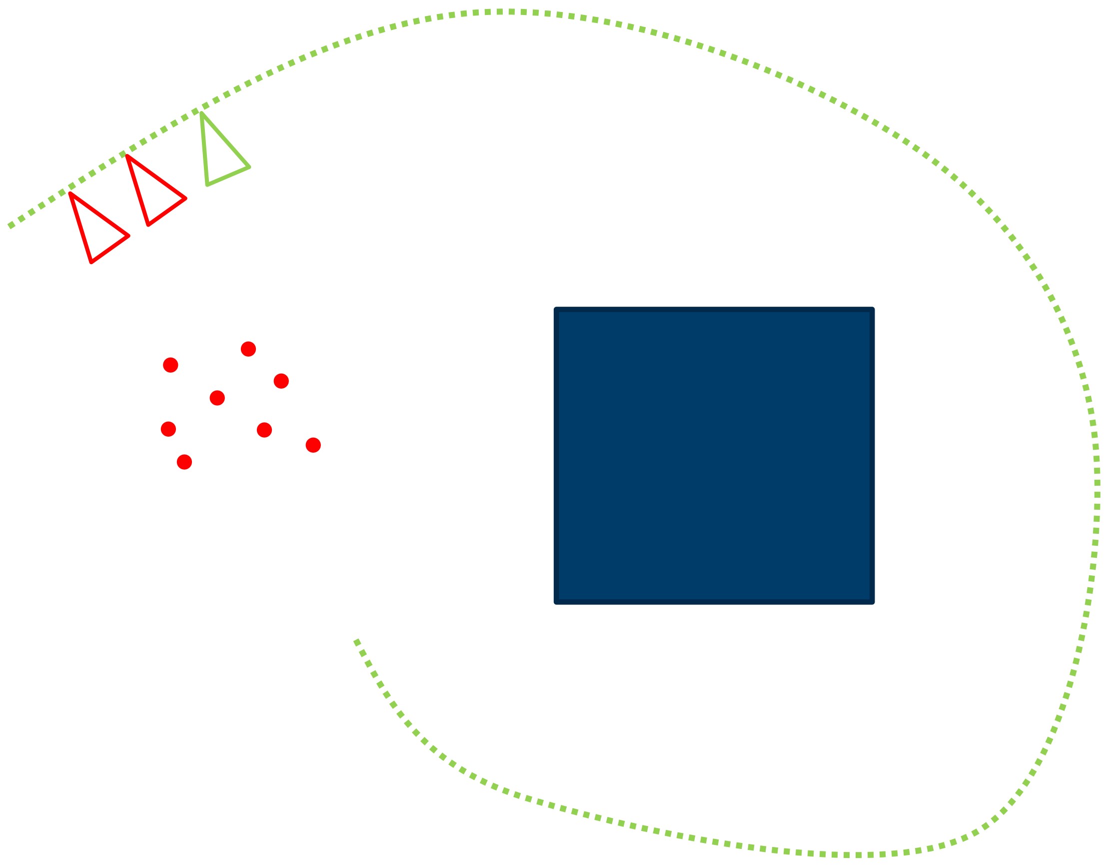
Visual simultaneous localization and mapping



Pose estimation with known 3D points (single-view geometry – lab 5)



Map initialization and visual odometry (two-view geometry – lab 7)



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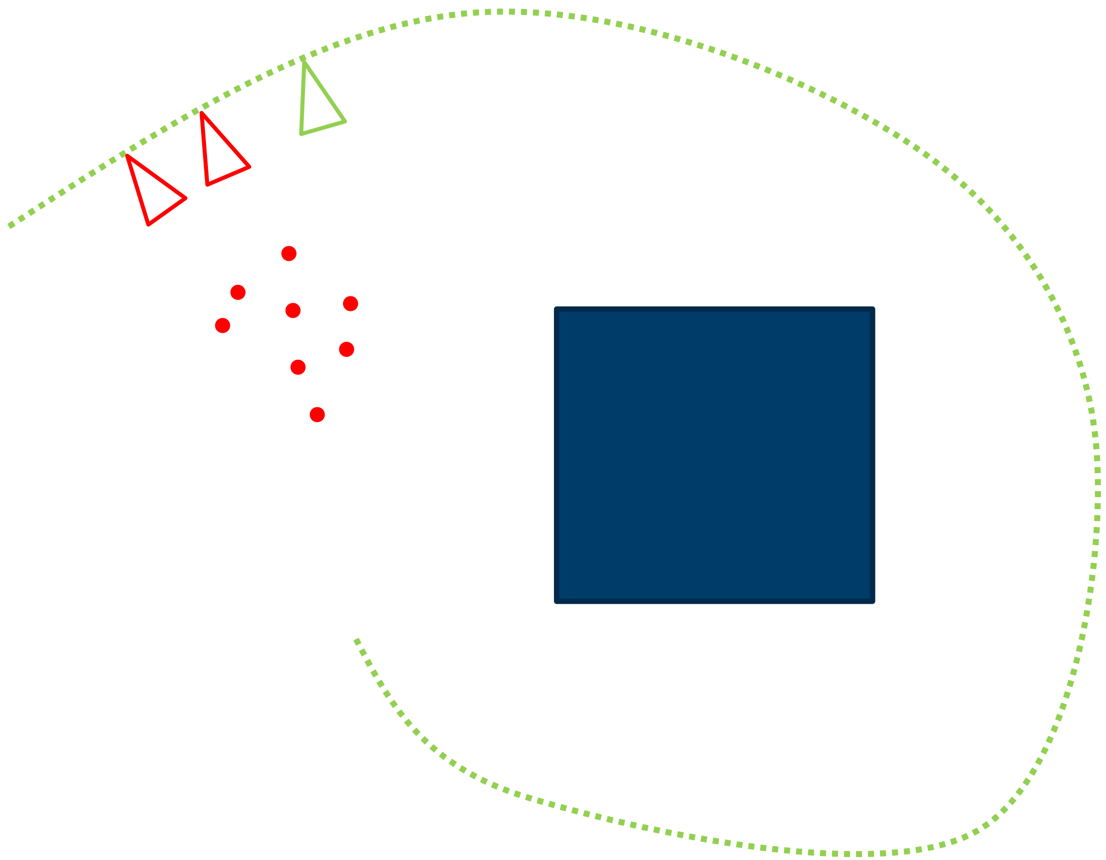

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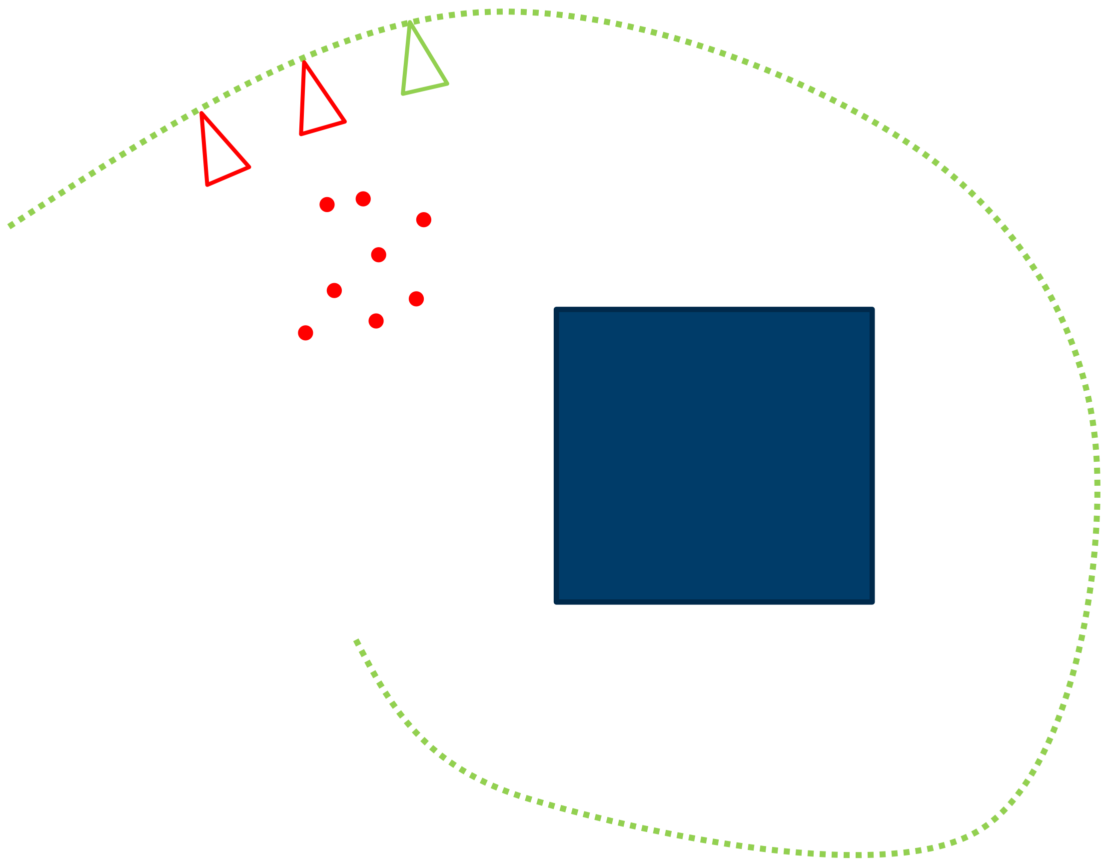

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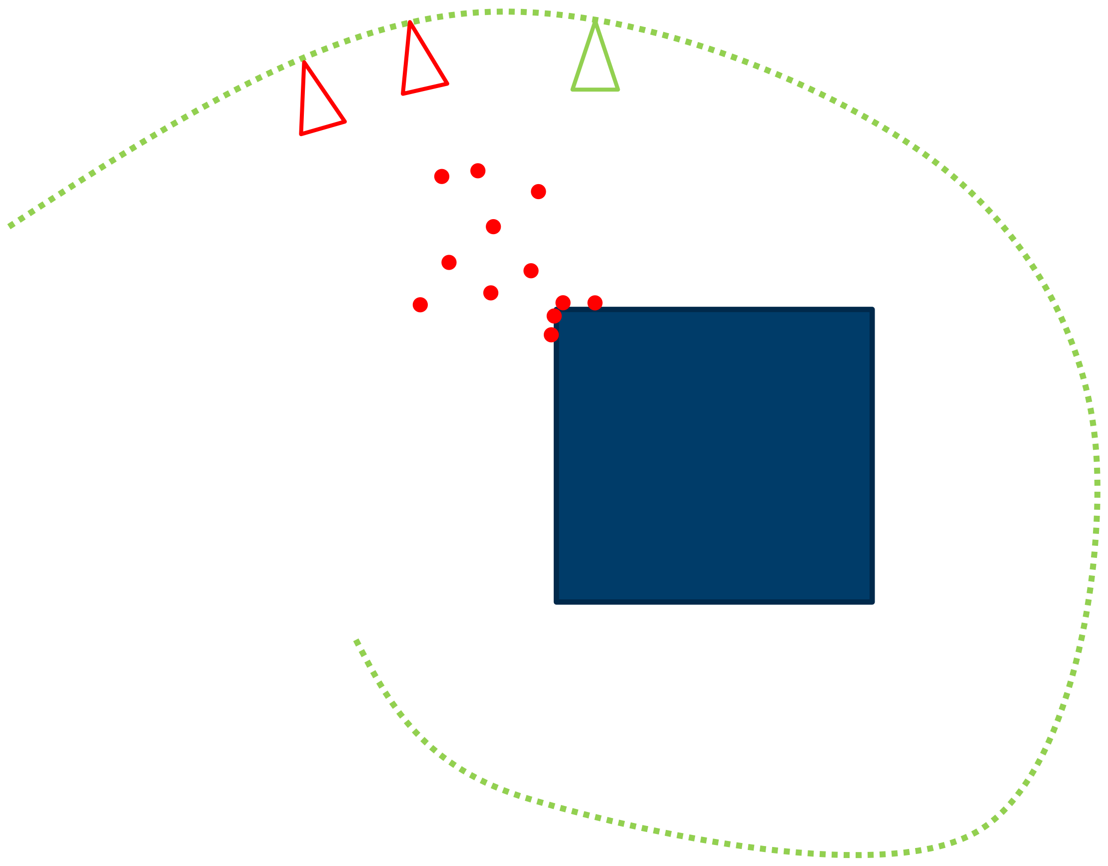

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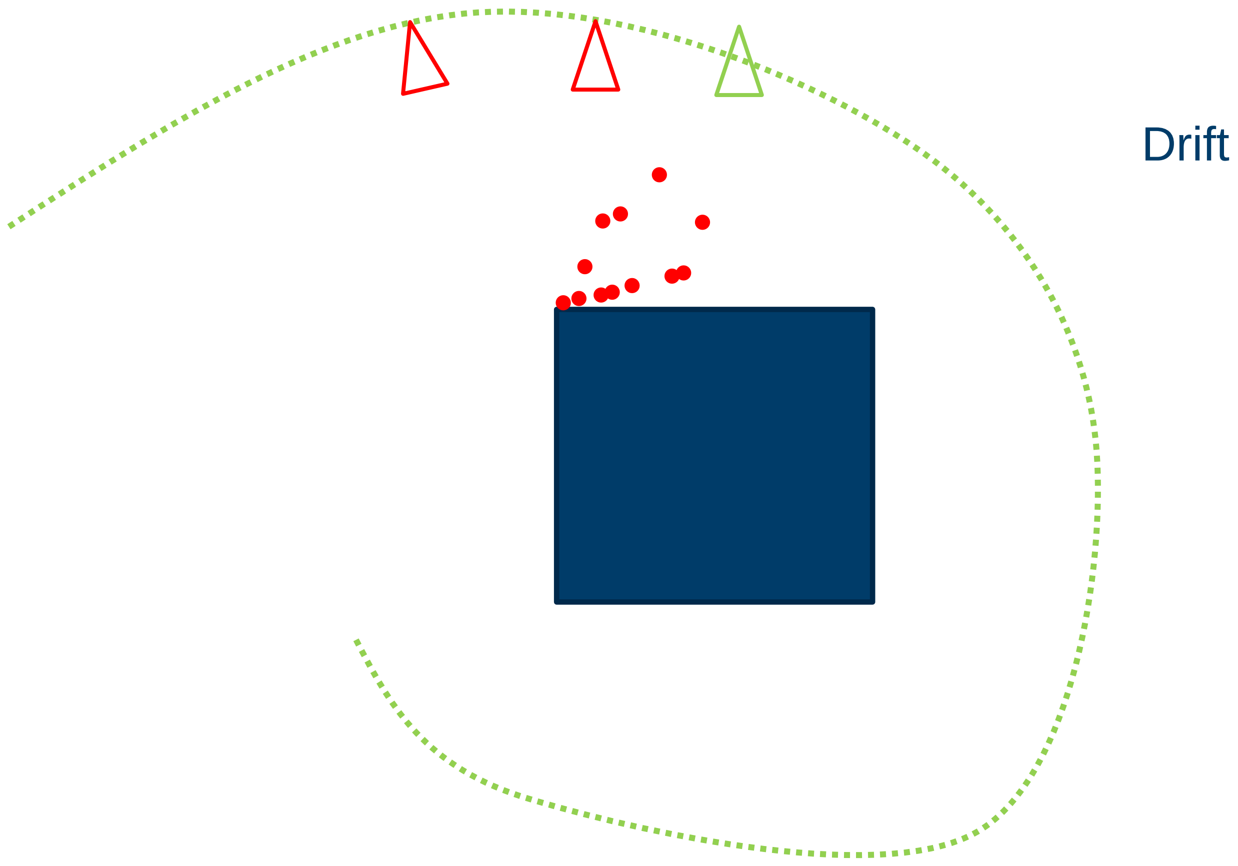

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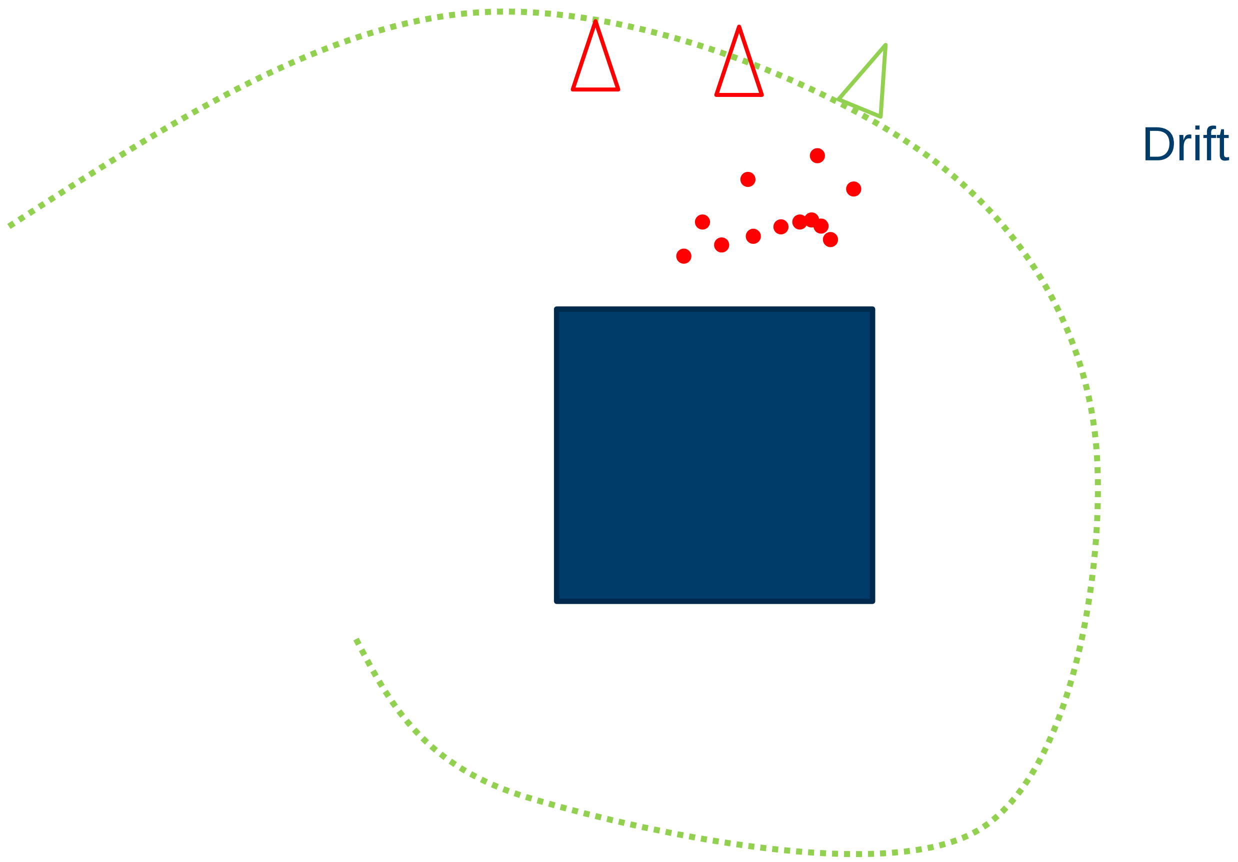
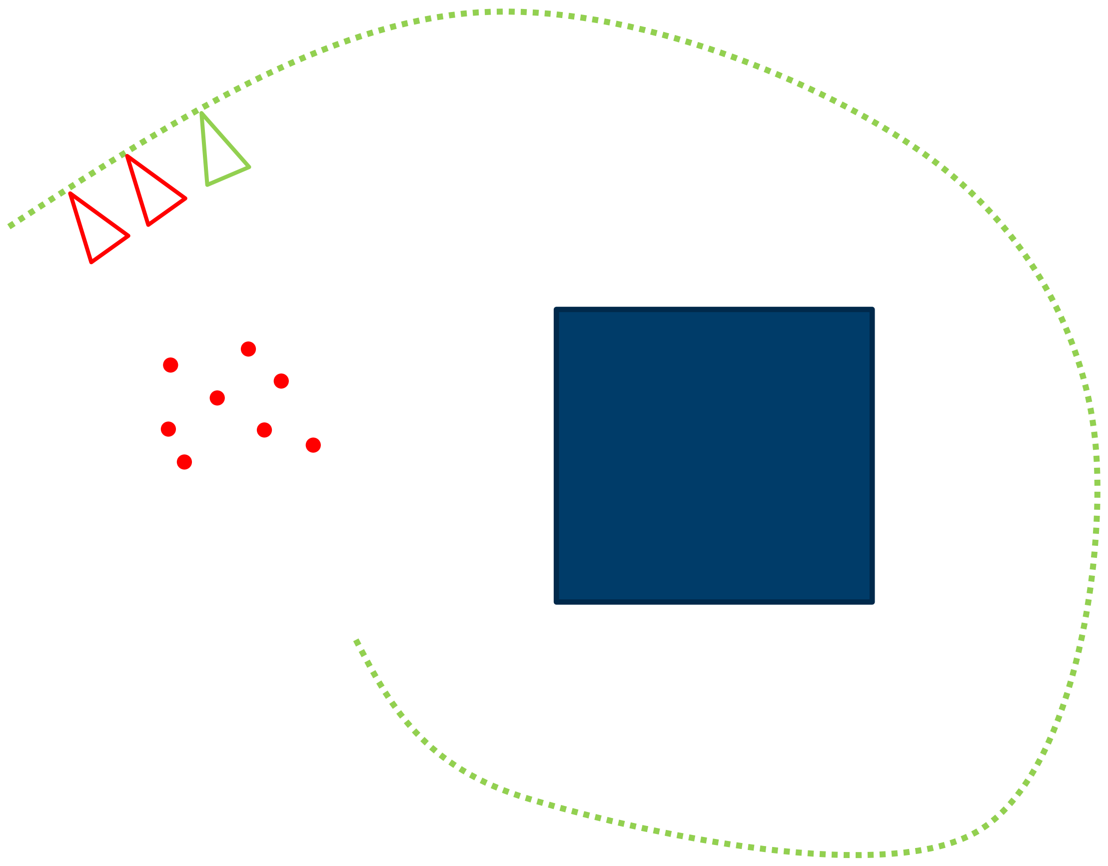


Monocular visual SLAM



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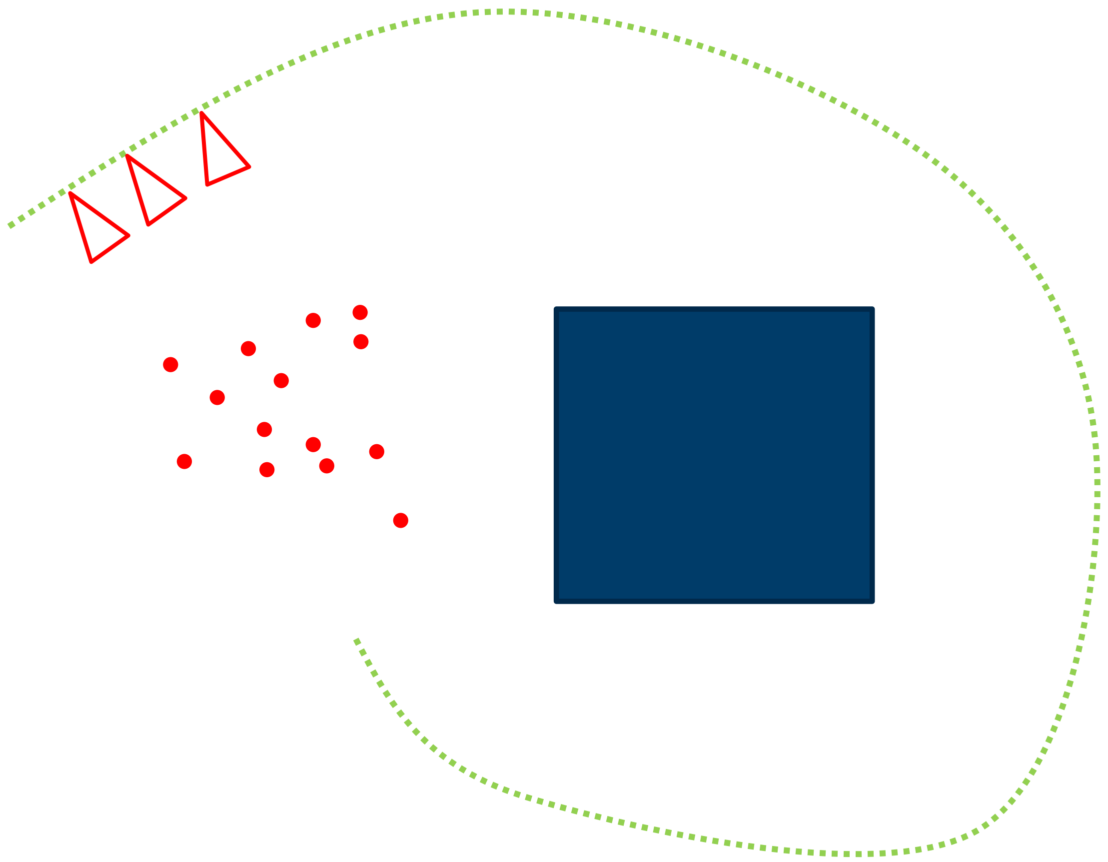

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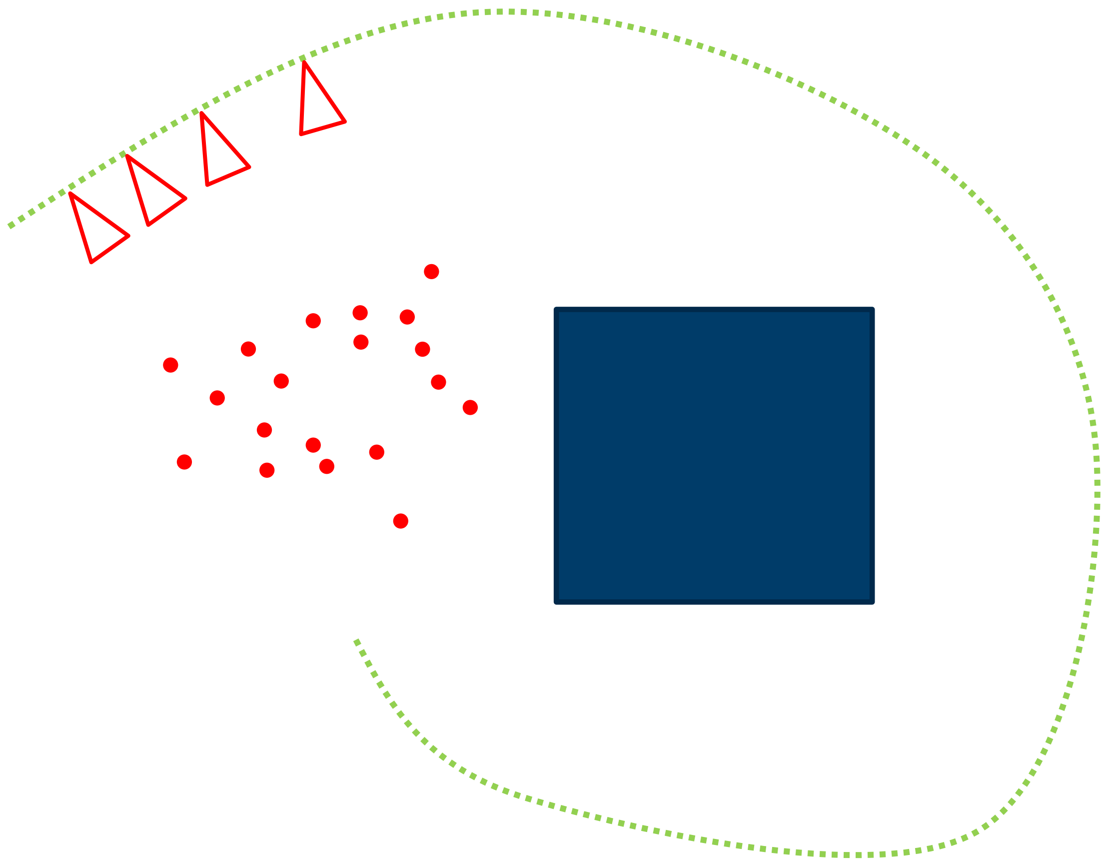

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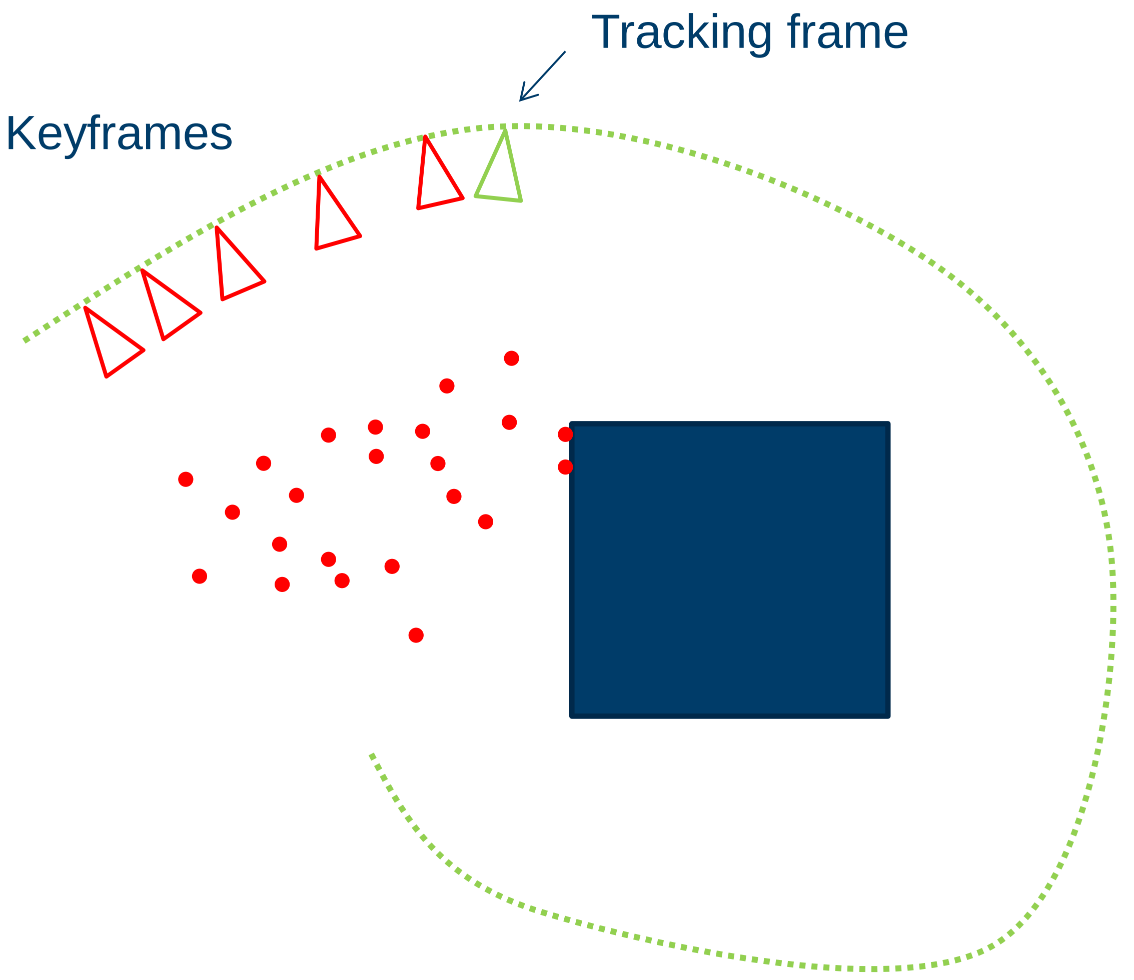

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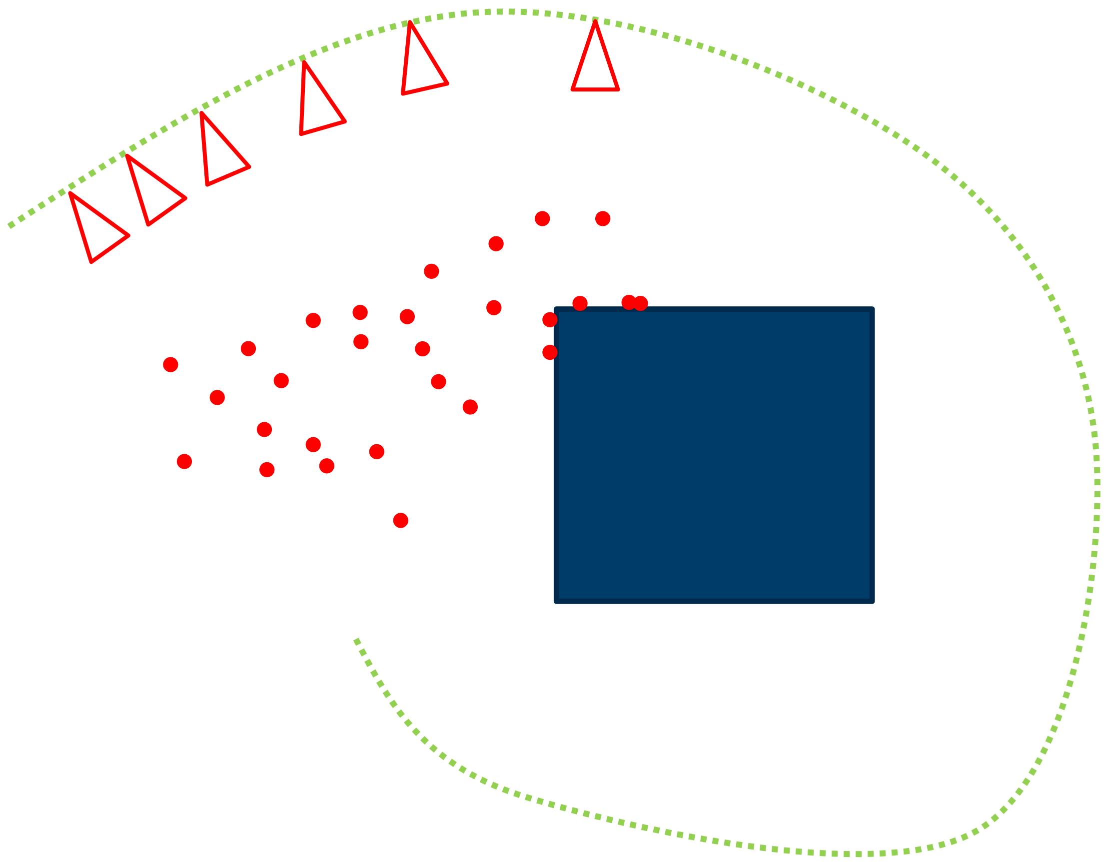

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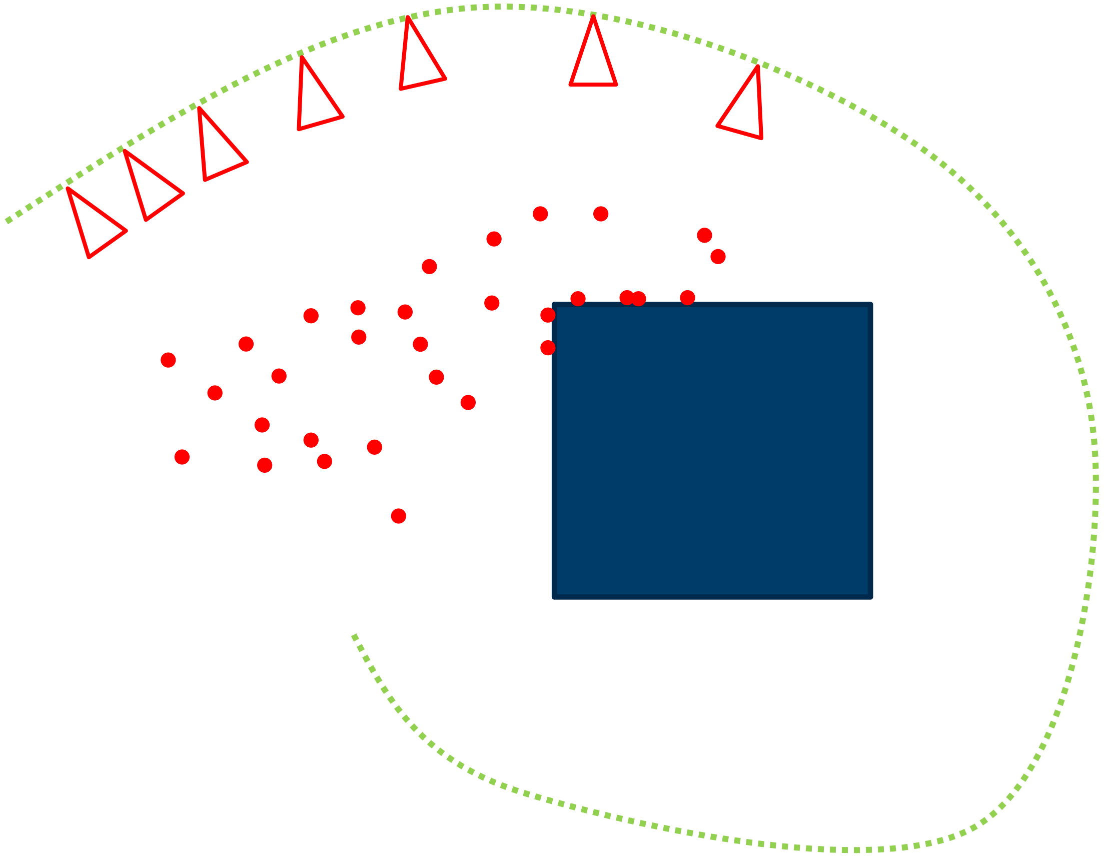

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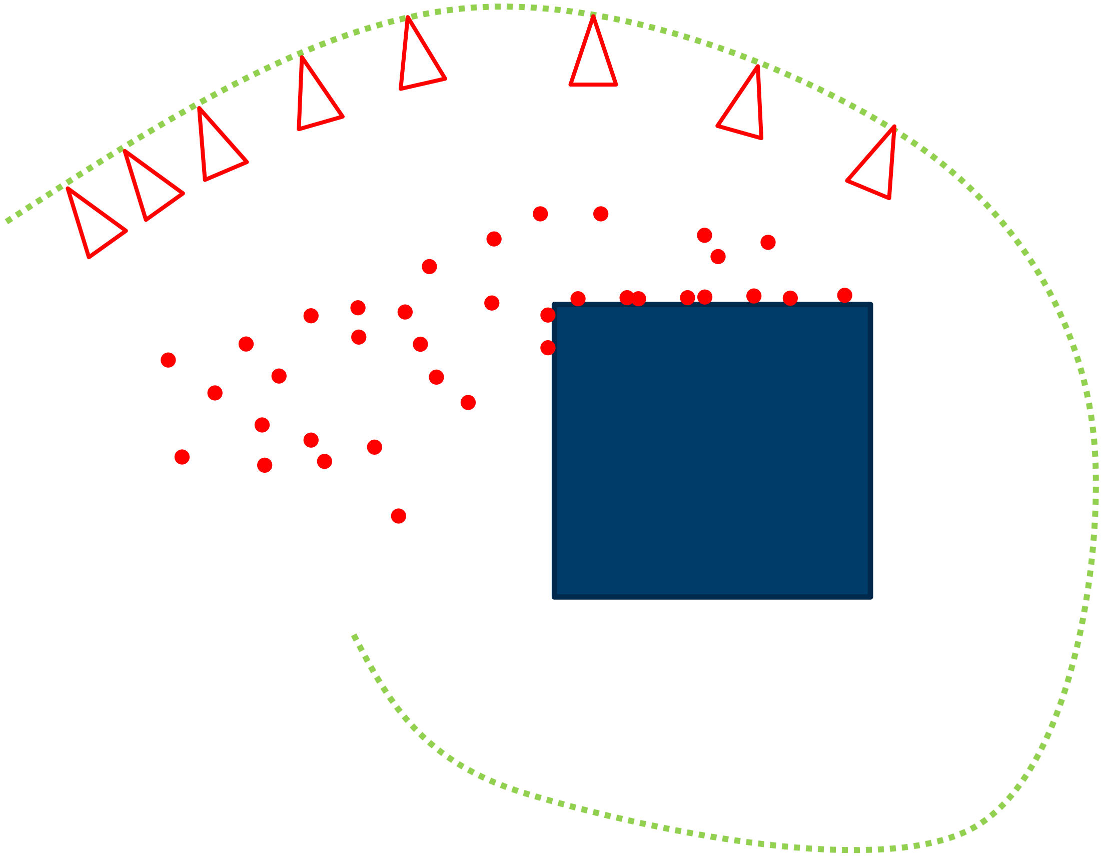

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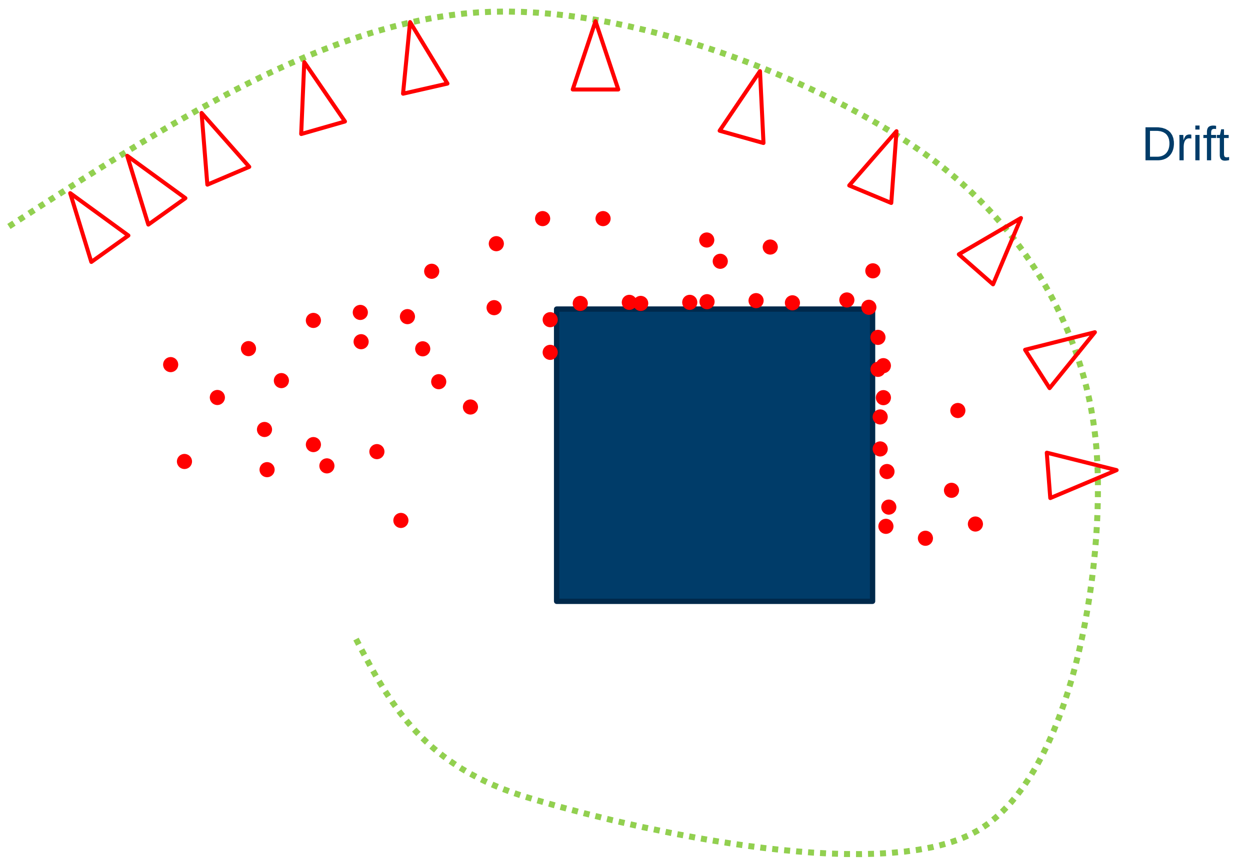

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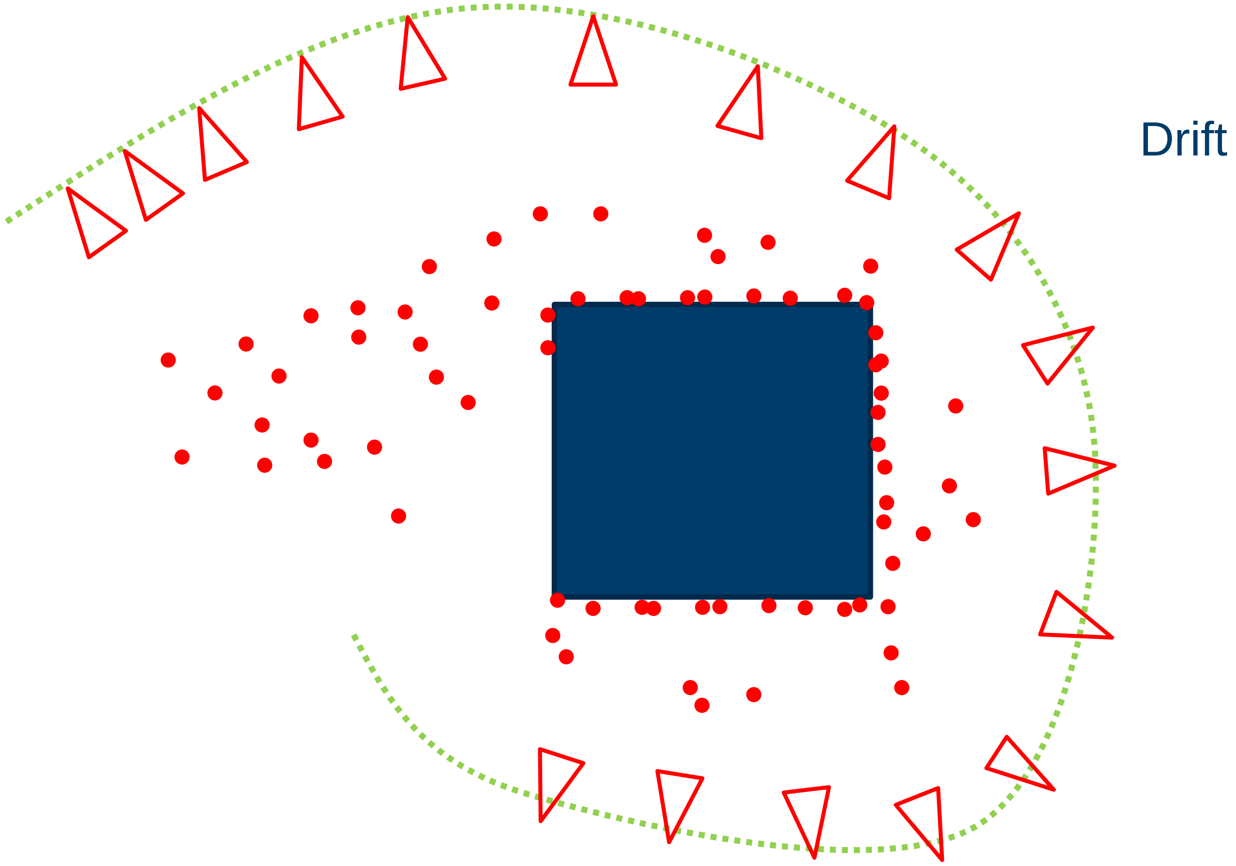

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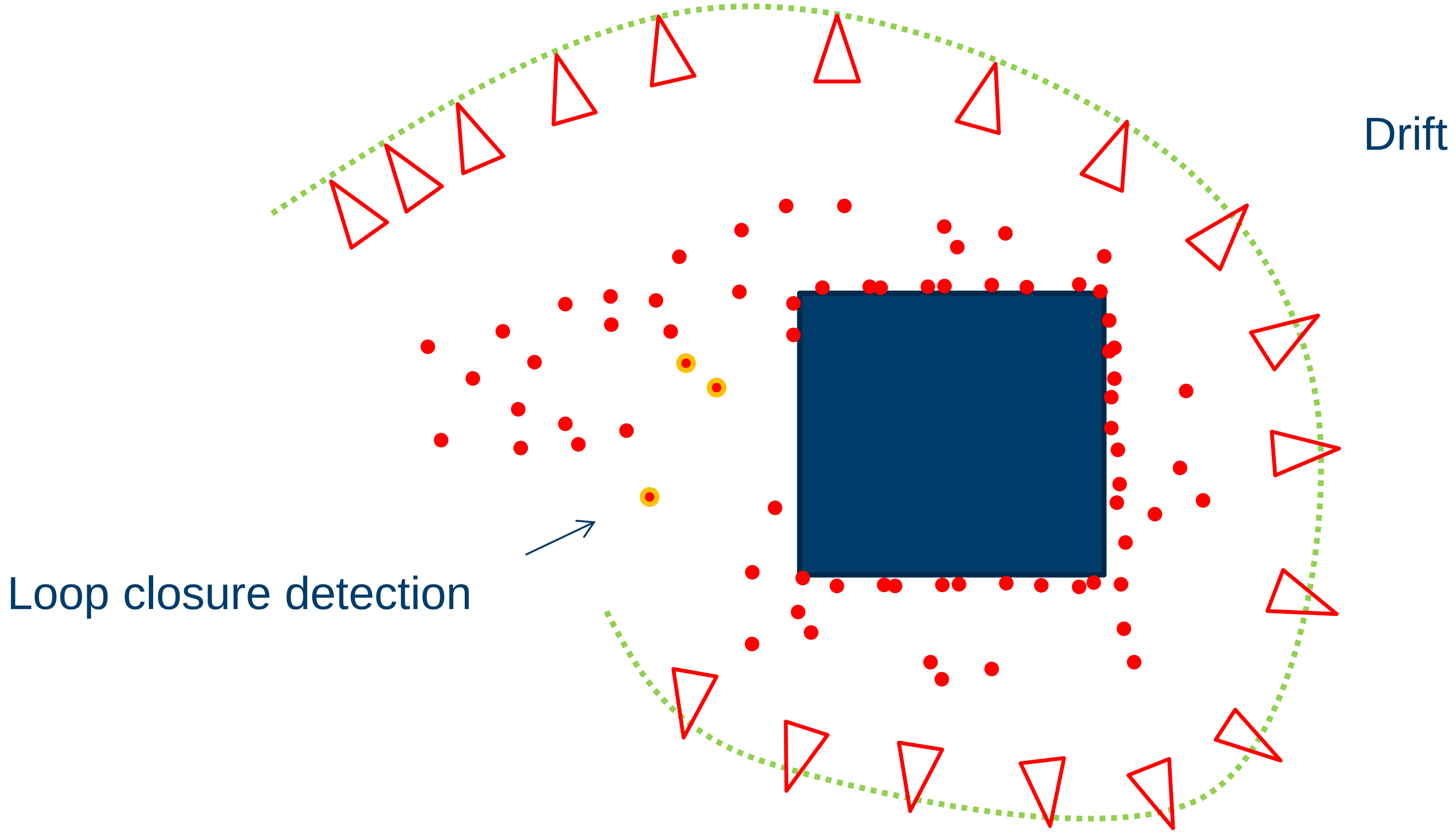

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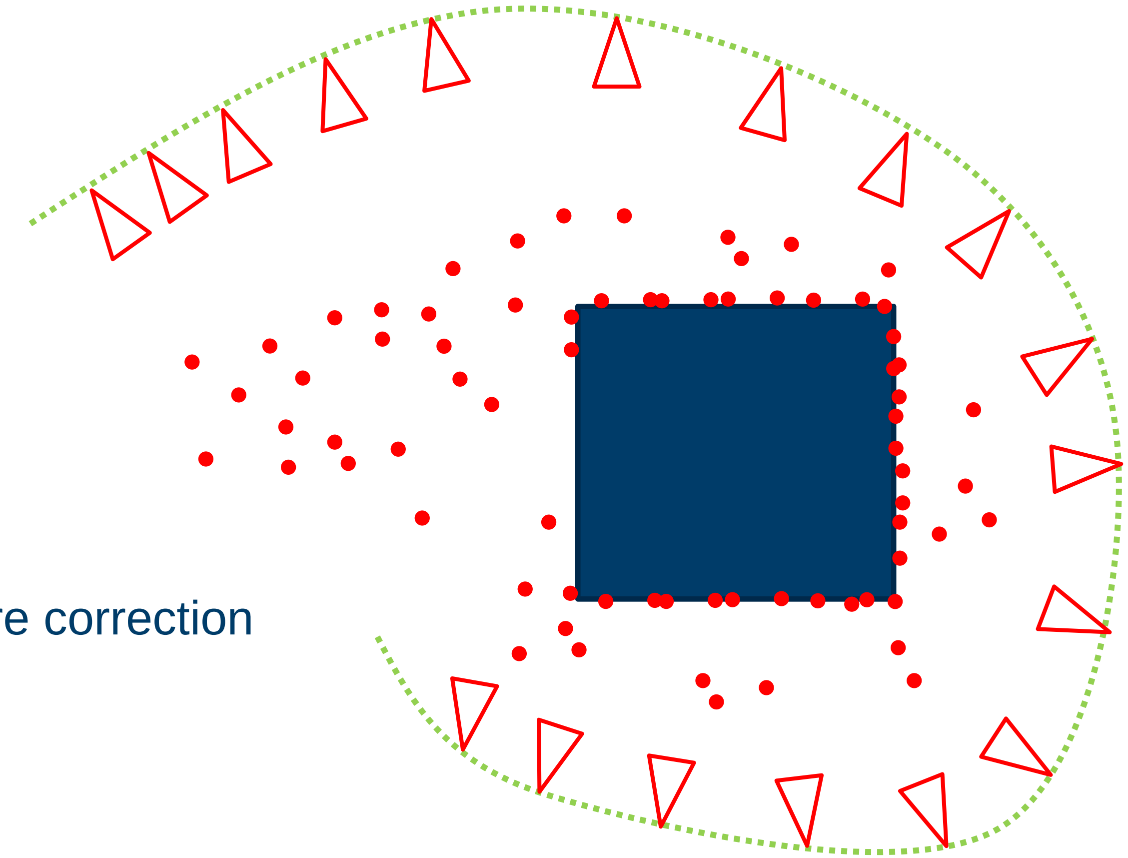
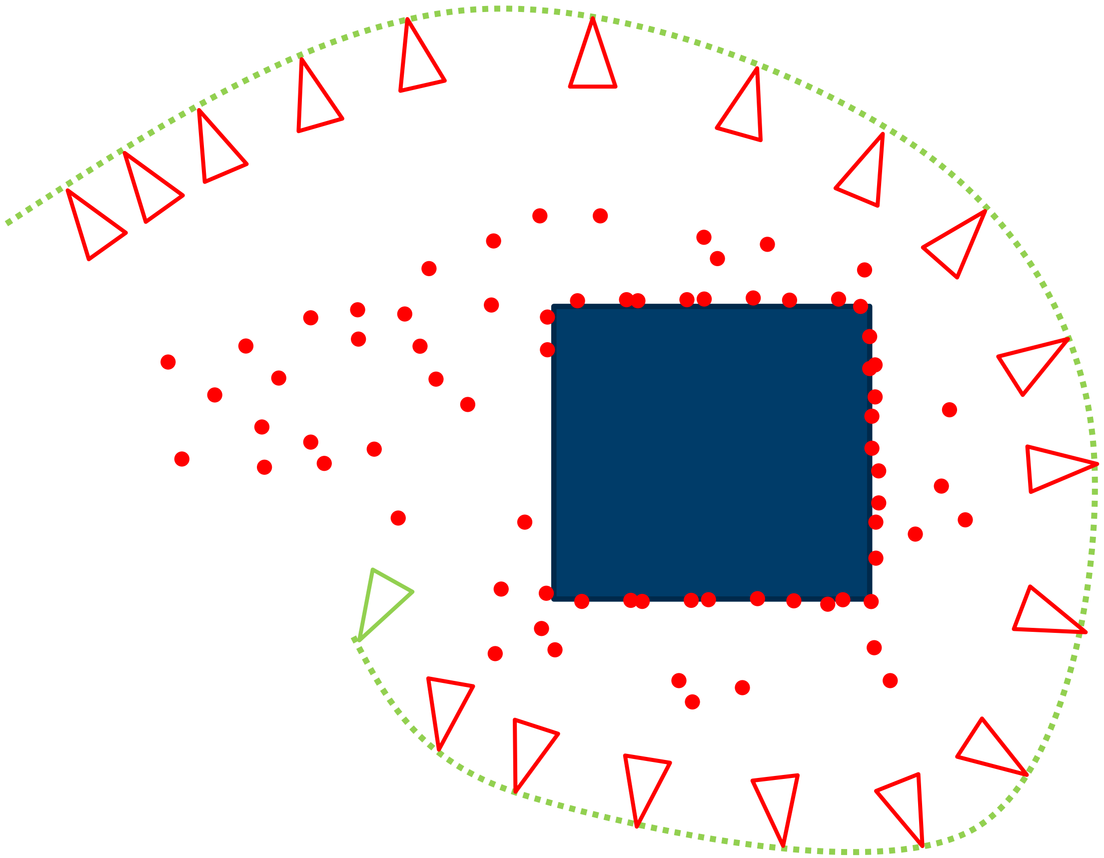


Loop closure correction

Monocular visual SLAM



Visual SLAM with ORB-SLAM

Visual SLAM with ORB-SLAM

- https://github.com/raulmur/ORB_SLAM2

- ORB-SLAM is already installed on the lab machines

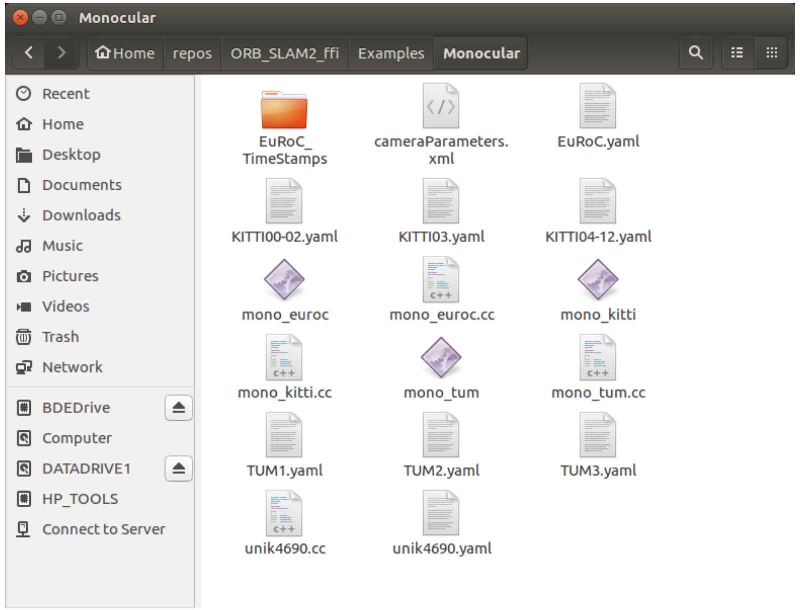
- To use ORB-SLAM with our cameras, we have to
  1. Calibrate the camera
  2. Write a program that captures images from the camera and transfers them to ORB-SLAM
  3. Build the program
  4. Run the program

Visual SLAM with ORB-SLAM

- Step 1: Calibration
  - Use calibration from previous lab
- Or:

```
opencv_interactive-calibration -ci=0 -t=chessboard -sz=30 -w=8 -h=5 -pf=calibSettings.xml
```

  - Fill the calibration into unik4690.yaml, and put it in ORB_SLAM2/Examples/Monocular/:



Visual SLAM with ORB-SLAM

- Step 2: Add the camera capture program
  - Copy unik4690.cc to ORB_SLAM2/Examples/Monocular/
  - Add as a new «target» in ORB_SLAM2/CMakeLists.txt:

```
set(CMAKE_RUNTIME_OUTPUT_DIRECTORY ${PROJECT_SOURCE_DIR}/Examples/Monocular)

add_executable(mono_tum
Examples/Monocular/mono_tum.cc)
target_link_libraries(mono_tum ${PROJECT_NAME})

add_executable(mono_kitti
Examples/Monocular/mono_kitti.cc)
target_link_libraries(mono_kitti ${PROJECT_NAME})

add_executable(mono_euroc
Examples/Monocular/mono_euroc.cc)
target_link_libraries(mono_euroc ${PROJECT_NAME})

add_executable(unik4690
Examples/Monocular/unik4690.cc)
target_link_libraries(unik4690 ${PROJECT_NAME})
```

Visual SLAM with ORB-SLAM

- Step 3: Build
  - In ORB_SLAM2/:
    ```
    ./build.sh
    ```

- Step 4: Run
  - In ORB_SLAM2/Examples/Monocular:
    ```
    ./unik4690 ../../Vocabulary/ORBvoc.txt unik4690.yaml
    ```

- Step 5: Play!

- Step 6: Take a look at the code in ORB_SLAM2!
  - Recognize anything?

3D reconstruction

- Download and try Agisoft Photoscan
  - http://www.agisoft.com/downloads/installer/
- Capture images:
  - Write a program that captures images when you press space
  - Store the images with `cv::imwrite()`
- Or use your phone…