Visualization of the All SLAM Evaluations on the Simulator

- EKF SLAM (Accuracy and Speed)
- FastSLAM (Accuracy and Speed)
- Graph-based SLAM (Accuracy and Speed)

How to use?

1. Please load the configuration file **config01.yaml** while starting the simulator;
2. Make sure that the attribute of **evalution** is enabled;
3. Start the simulator and load one of the maps **slam_example_1** to **slam_example_8**;
4. Click the play button and let the simulator run for a while;
5. Click the button **Plot Slam Evaluation**, the estimation results will be shown in figures, and the raw data will be stored in the file **scripts/sobot_information1.csv** and **scripts/sobot_information2.csv** to analyse.
6. Run all cells in the notebook to obtain figures.
7. Run all cells in the notebook to obtain figures, make sure that the inital working directory is **"./sobot_rimulator/script"**
8. the resulting figures will be in the file **scripts/fig**

In [11]:
```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import os
import math
os.chdir('../')  # set the working directory as "./sobot_rimulator"
os.getcwd()
```

Out[11]:
```
'/home/yixing/code/project_work'
```

In [2]:
```
# Path where the data is saved
# This file records the inaccuracies of SLAM
filename_evaluation = "scripts/sobot_information1.csv"
# This file records the runtime of algorithms
filename_runtime = "scripts/sobot_information2.csv"
```

1. Accuray of the SLAM Evaluations

This analysis is based on the file sobot_information1.csv

In [3]:
```
df = pd.read_csv(filename_evaluation, index_col=0)
df.head(5)
```

Out[3]:

	sim_circle	landmark_id	estimated_landmark_position	estimated_robot_pose	actual_landmark_position	actual_robot_pose	slam_name
0	10	52	(0.1006001162850556, -0.3269232389263757)	(0.03503858262638248, -0.07558573262769268, -2....	(0.08672876526352813, -0.3484355423094351, -1....	(0.04353408280063603, -0.07127297463716915, -2...	EKF SLAM
1	10	52	(0.10052745249405544, -0.3249369578110905)	(0.03572580426945161 4, -0.07340246086189228, -...	(0.08672876526352813, -0.3484355423094351, -1....	(0.04353408280063603, -0.07127297463716915, -2...	FastSLAM
2	11	52	(0.1006001162850556, -0.3269232389263757)	(0.025349270966128372, -0.090023830925939, -2....	(0.08672876526352813, -0.3484355423094351, -1....	(0.03552066851884916, -0.08675590211872318, -2...	EKF SLAM
3	11	52	(0.10267951703101169, -0.3274639478165032 3)	(0.026756356586633896, -0.0904967001901178, -2....	(0.08672876526352813, -0.3484355423094351, -1....	(0.03552066851884916, -0.08675590211872318, -2...	FastSLAM
4	12	52	(0.1006001162850556, -0.3269232389263757)	(0.010566437401550964, -0.10551079106291874 87, -2....	(0.08672876526352813, -0.3484355423094351, -1....	(0.021656718814947 18, -0.10308750035085455, -2....	EKF SLAM

In [4]:
```
df_lm = df[["sim_circle", "slam_name", "landmark_id", "estimated_landmark_position", "actual_landmark_position"]]
actual_landmark_position =  np.array([eval(x)[0:2] for x in df_lm["actual_landmark_position"].tolist()])
estimated_landmark_position = np.array([eval(x) for x in df_lm["estimated_landmark_position"].tolist()])
distance = np.linalg.norm(actual_landmark_position-estimated_landmark_position, axis = 1)
df_lm.loc[:, 'distance'] = distance
```

```
/home/yixing/.local/lib/python3.8/site-packages/pandas/core/indexing.py:1596: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  self.obj[key] = _infer_fill_value(value)
/home/yixing/.local/lib/python3.8/site-packages/pandas/core/indexing.py:1743: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  isetter(ilocs[0], value)
```

In [5]:
```
df_lm_sum = df_lm.groupby(['sim_circle','slam_name'])["distance"].mean().unstack(level = -1)
df_lm_sum.tail(10)
```

Out[5]:

slam_name	EKF SLAM	FastSLAM	Graph-based SLAM
sim_circle			
5157	0.086239	0.135024	0.034914
5158	0.085997	0.135031	0.034914
5159	0.085853	0.135038	0.034914
5160	0.085762	0.135046	0.034914
5161	0.085703	0.135061	0.034914
5162	0.085663	0.135079	0.034914
5163	0.085606	0.135099	0.034914
5164	0.085622	0.135121	0.034914
5165	0.085638	0.135146	0.034914
5166	0.085638	0.135146	0.034914

In [6]:
```
df_robot = df[["sim_circle","estimated_robot_pose","actual_robot_pose","slam_name"]]
df_robot = df_robot.drop_duplicates(["sim_circle", "slam_name"])
estimated_robot_pose = np.array([eval(x)[0:2] for x in df_robot["estimated_robot_pose"].tolist()])
actual_robot_pose = np.array([eval(x)[0:2] for x in df_robot["actual_robot_pose"].tolist()])
distance = np.linalg.norm(estimated_robot_pose-actual_robot_pose, axis = 1)
df_robot.loc[:, 'distance'] = distance
df_robot_pivot = df_robot.pivot(index = "sim_circle", columns = "slam_name",
            values="distance")
```

Average distance to true landmark in meters

In [7]:
```
plt.subplot(1,3,1)
df_lm_sum["EKF SLAM"].plot(color = "k", rot = 0, figsize=(15,3))
plt.xlabel("Simulation cycles")
plt.ylabel("Average distance to true landmark in meters")
plt.title("EKF SLAM")
#plt.ylim(0,6)

plt.subplot(1,3,2)
df_lm_sum["FastSLAM"].plot(color = "k", rot = 0, figsize=(15,3))
plt.xlabel("Simulation cycles")
plt.ylabel("Average distance to true landmark in meters")
plt.title("FastSLAM")

plt.subplot(1,3,3)
df_lm_sum["Graph-based SLAM"].plot(color = "k", rot = 0, figsize=(15,3))
plt.xlabel("Simulation cycles")
plt.ylabel("Average distance to true landmark in meters")
plt.title("Graph-based SLAM")
plt.suptitle("Evaluation of SLAM", size = 18)
plt.tight_layout()
plt.savefig('./scripts/fig/{0}.eps'.format("fig1"), format='eps', bbox_inches='tight')
```

Runtime for Update

This analysis is based on the file sobot_information2.csv

In [8]:
```
df2 = pd.read_csv(filename_runtime, index_col=0)
df2.head(5)
```

Out[8]:

	sim_circle	name	time_per_update
0	1	EKF SLAM	0.000150
1	1	FastSLAM	0.006748
2	1	Graph-based SLAM	0.000042
3	2	EKF SLAM	0.000116
4	2	FastSLAM	0.008304

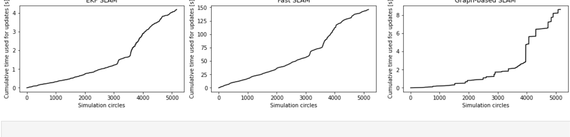
In [9]:
```
df2_mean = df2.groupby(["sim_circle", "name"])["time_per_update"].mean().unstack()
df2_mean.head(5)
```

Out[9]:

name	EKF SLAM	FastSLAM	Graph-based SLAM
sim_circle			
1	0.000150	0.006748	0.000042
2	0.000116	0.008304	0.000069
3	0.000149	0.009091	0.000069
4	0.000097	0.009164	0.000106
5	0.000095	0.007286	0.000071

1. Cumulative Time Used for Updates

In [10]:
```
df2_cum = df2_mean.cumsum() #.plot(subplots=True, layout=(2,3), figsize = (12,8), rot = 0)

plt.subplot(2,3,1)

df2_cum["EKF SLAM"].plot(color = "k", rot = 0, figsize=(15,6))
plt.xlabel("Simulation circles")
plt.ylabel("Cumulative time used for updates [s]")
plt.title("EKF SLAM")

plt.subplot(2,3,2)
df2_cum["FastSLAM"].plot(color = "k", rot = 0, figsize=(15,6))
plt.xlabel("Simulation circles")
plt.ylabel("Cumulative time used for updates [s]")
plt.title("Fast SLAM")

plt.subplot(2,3,3)
df2_cum["Graph-based SLAM"].plot(color = "k", rot = 0, figsize=(15,6))
plt.xlabel("Simulation circles")
plt.ylabel("Cumulative time used for updates [s]")
plt.title("Graph-based SLAM")

plt.suptitle("Cumulative Time Used for Updates", size = 18)
plt.tight_layout()
plt.savefig('./scripts/fig/{0}.eps'.format("fig2"), format='eps', bbox_inches='tight')
```



In [ ]:
```
```