Kalman-and-Bayesian-Filters-in-Python

Preface

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Mar 12th, 2022 https://github.com/duyongquan/LTSLAM

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Outline

- Kalman and Bayesian Filters
- Motivation for this Book
- Reading Online
- PDF Version
- Downloading and Running the Book
- Jupyter
- SciPy, NumPy, and Matplotlib

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Kalman and Bayesian Filters
卡尔曼和贝叶斯滤波

4 Kalman and Bayesian Filters

Sensors are noisy

- GPS in my car reports altitude, Each time pass the same point, it reports a slightly different altitude
- Kitchen scale gives different readings weigh the same object twice.
- Sensor is very noisy, environment makes data collection difficult. How can track?

Rudolf Emil Kálmán
鲁道夫·卡尔曼 匈牙利裔美国数学家

Introduce

- Apollo missions to the moon
- Medical imaging
- Aaircraft, submarines, cruise missiles
- Robots, IoT (Internet of Things) , laboratory instruments

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Motivation for this Book
书的目标

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Motivation for this Book

- The theory is beautiful, but quite difficult to learn
  - signal processing
  - control theory
  - probability and statistics
- Ohter books quite difficult to learn
  - notation is introduced without explanation
  - books are almost devoid of examples or worked problems
  - no idea as to what real world phenomena these words and math were attempting to describe

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Reading Online
在线阅读

8 Reading Online

- GitHub
  - https://github.com/rlabbe/Kalman-and-Bayesian-Filters-in-Python
- ninder
  - binder serves interactive notebooks online
  - http://mybinder.org/repo/rlabbe/Kalman-and-Bayesian-Filters-in-Python
- nbviewe
  - https://nbviewer.org/github/rlabbe/Kalman-and-Bayesian-Filters-in-Python/tree/master/

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PDF Version
PDF 版本

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PDF Version

- PDF book

https://drive.google.com/file/d/0By_SW19c1BfhSVFzNHc0SjduNzg/view?resourcekey=0-41olC9ht9xE3wQe2zHZ45A

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Downloading and Running the Book

下载和运行

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Downloading and Running the Book

Installation

- http://nbviewer.ipython.org/github/rlabbe/Kalman-and-Bayesian-Filters-in-Python/blob/master/Appendix-A-Installation.ipynb

Introduce

This book is intended to be interactive and I recommend using it.
Its a little more effort to set up.
You can perform experiments, see how filters react to different data, see how different filters react to the same data, and so on

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Jupyter
开发环境

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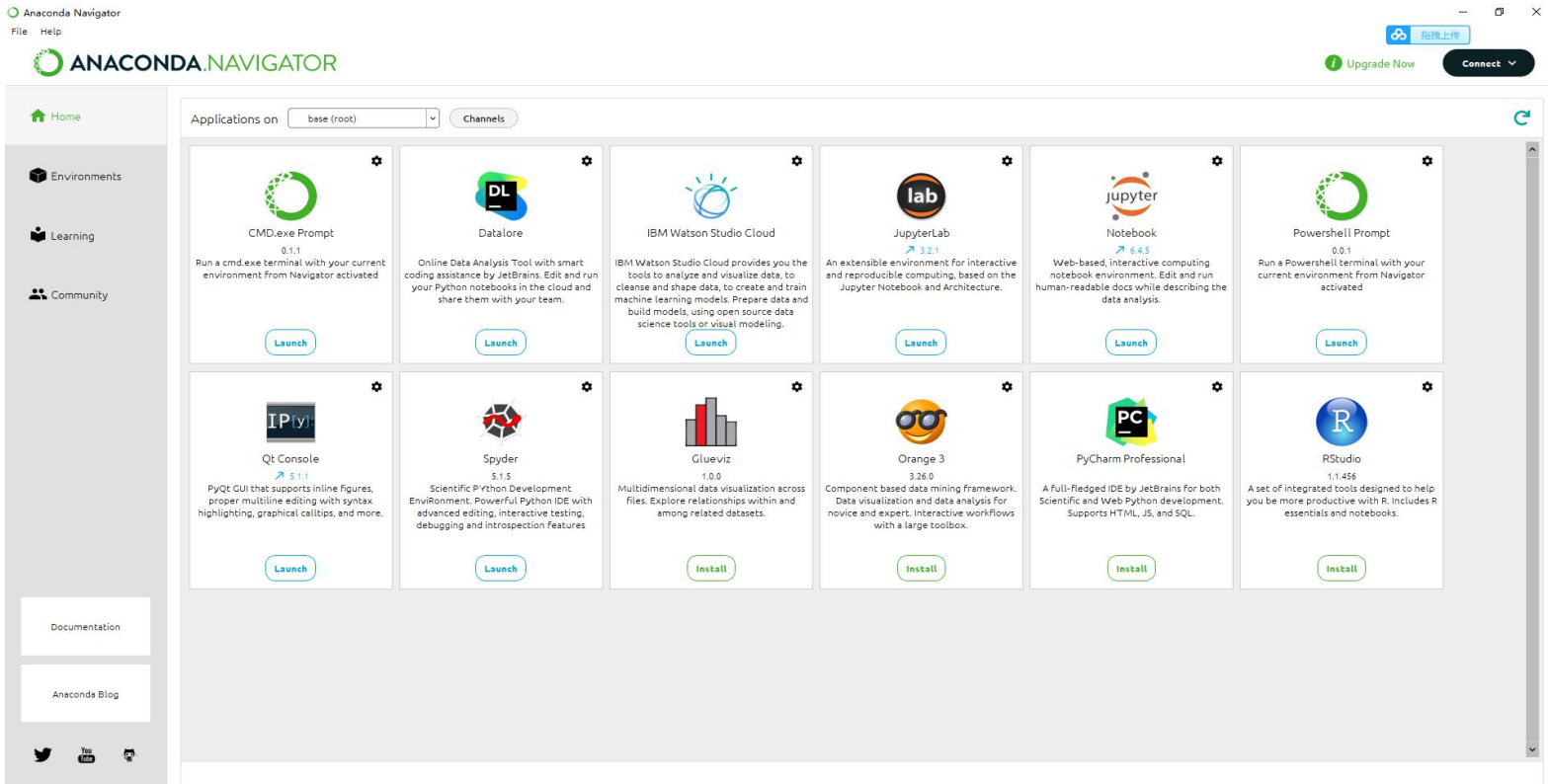
Jupyter

jupyter notebook

安装Anaconda



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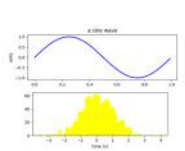
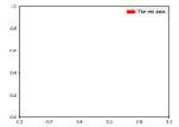
SciPy, NumPy, and Matplotlib Python 库

SciPy, NumPy, and Matplotlib

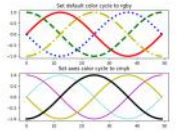
- SciPy is a mathematic
  - array objects
  - linear algebra
  - random numbers
  - https://scipy.org/
- NumPy
- Matplotlib
  - https://matplotlib.org/stable/tutorials/index



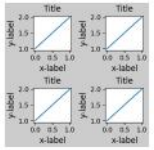
Artist tutorial



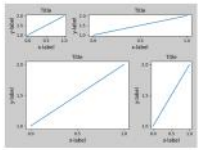
Legend guide



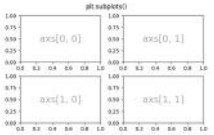
Styling with cycler



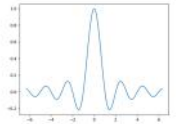
Constrained Layout Guide



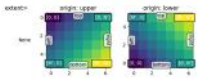
Tight Layout guide



Arranging multiple Axes in a Figure



Autoscaling



origin and extent in imshow

SciPy, NumPy, and Matplotlib

- numpy.array implements a one or more dimensional array

```
In [3]: import numpy as np
        x = np.array([1, 2, 3])
        print(type(x))
        x

<class 'numpy.ndarray'>


Out[3]: array([1, 2, 3])
```

SciPy, NumPy, and Matplotlib

- numpy.array implements a one or more dimensional array

```
In [4]: x = np.array((4,5,6))
        x

Out[4]: array([4, 5, 6])
```

Create multidimensional arrays with nested brackets:

```
In [5]: x = np.array([[1, 2, 3],
                      [4, 5, 6]])
        print(x)

[[1 2 3]
 [4 5 6]]
```

SciPy, NumPy, and Matplotlib

- numpy.array implements a one or more dimensional array

```
In [6]: x = np.array([1, 2, 3], dtype=float)
        print(x)

[1. 2. 3.]
```

You can access the array elements using subscript location:

```
In [7]: x = np.array([[1, 2, 3],
                      [4, 5, 6]])

        print(x[1,2])
```

SciPy, NumPy, and Matplotlib

- numpy.array implements a one or more dimensional array

You can access a column or row by using slices. A colon (:) used as a subscript is shorthand for all data in that row or column. So `x[:,0]` returns an array of all data in the first column (the 0 specifies the first column):

```
In [8]: x[:, 0]

Out[8]: array([1, 4])
```

We can get the second row with:

We can get the second row with:

```
In [9]: x[1, :]

Out[9]: array([4, 5, 6])
```

SciPy, NumPy, and Matplotlib

Get the last two elements of the second row with:

```
In [10]: x[1, 1:]

Out[10]: array([5, 6])
```

As with Python `lists`, you can use negative indexes to refer to the end of the array. -1 refers to the last index. So another way to get the last two elements of the second (last) row would be:

```
In [11]: x[-1, -2:]

Out[11]: array([5, 6])
```

SciPy, NumPy, and Matplotlib

You can perform matrix addition with the + operator, but matrix multiplication requires the `dot` method or function. The * operator performs element-wise multiplication, which is **not** what you want for linear algebra.

```
In [12]: x = np.array([[1., 2.],
                       [3., 4.]])
         print('addition:\n', x + x)
         print('\nelement-wise multiplication\n', x * x)
         print('\nmultiplication\n', np.dot(x, x))
         print('\ndot is also a member of np.array\n', x.dot(x))
```

```
addition:
 [[2. 4.]
 [6. 8.]]

element-wise multiplication
 [[ 1.  4.]
 [ 9. 16.]]

multiplication
 [[ 7. 10.]
 [15. 22.]]

dot is also a member of np.array
 [[ 7. 10.]
 [15. 22.]]
```

SciPy, NumPy, and Matplotlib

- Python 3.5 introduced the `@` operator for matrix multiplication.

```
In [13]: x @ x

Out[13]: array([[ 7., 10.],
                [15., 22.]])
```

- transpose and the inverse

```
In [14]: import scipy.linalg as linalg
         print('transpose\n', x.T)
         print('\nNumPy ninverse\n', np.linalg.inv(x))
         print('\nSciPy inverse\n', linalg.inv(x))
```

```
transpose
 [[1. 3.]
 [2. 4.]]

NumPy ninverse
 [[-2.   1. ]
 [ 1.5 -0.5]]

SciPy inverse
 [[-2.   1. ]
 [ 1.5 -0.5]]
```

SciPy, NumPy, and Matplotlib

- zeros matrix , ones matrix, eye identity matrix

```
In [15]: print('zeros\n', np.zeros(7))
         print('\nzeros(3x2)\n', np.zeros((3, 2)))
         print('\neye\n', np.eye(3))

zeros
 [0. 0. 0. 0. 0. 0. 0.]

zeros(3x2)
 [[0. 0.]
 [0. 0.]
 [0. 0.]]

eye
 [[1. 0. 0.]
 [0. 1. 0.]
 [0. 0. 1.]]
```

SciPy, NumPy, and Matplotlib

```
In [16]: np.arange(0, 2, 0.1)

Out[16]: array([0. , 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1. , 1.1,
                1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9])
```

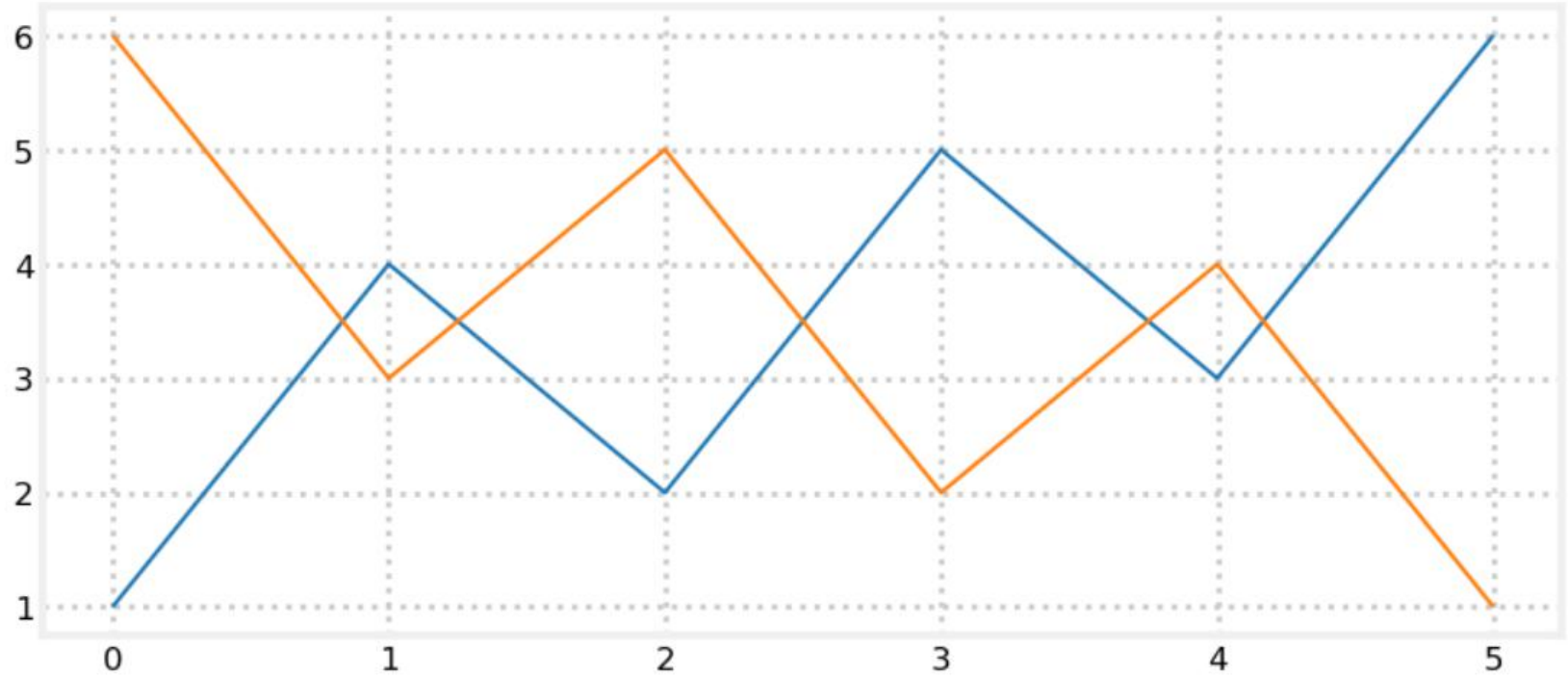
```
In [17]: np.linspace(0, 2, 20)

Out[17]: array([0.   , 0.105, 0.211, 0.316, 0.421, 0.526, 0.632, 0.737, 0.842,
                0.947, 1.053, 1.158, 1.263, 1.368, 1.474, 1.579, 1.684, 1.789,
                1.895, 2.   ])
```

SciPy, NumPy, and Matplotlib

```
In [18]: import matplotlib.pyplot as plt
         a = np.array([6, 3, 5, 2, 4, 1])
         plt.plot([1, 4, 2, 5, 3, 6])
         plt.plot(a)

Out[18]: [<matplotlib.lines.Line2D at 0x298bcc7b4c8>]
```

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