# ob-ipython Introduction

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# Outline

# Goals

1. Introduce ob-ipython
   - This means we must discuss org, babel
2. Do a quick live example
3. Comments from my experience
4. Generate this talk

# Emacs org-mode

## What is it?

- "Your life in plain text"
- sophistacated mark up language, designed for organization

## Features

- outlining
- manages tasks, agendas, todos
- folding, navigation, links
- easily exported
- much more
  - really, org has an enormous amount of functionality

# Babel

Dispatch source code and execute it inside org mode.

- Support for shell, R, perl, and more
- Can generate tables
- Can include figures inline
- "Literate Programming"

## Example

```
#+BEGIN_SRC python
import numpy as np
x = np.arange(5)
return x
#+END_SRC
```

## Evaluates to

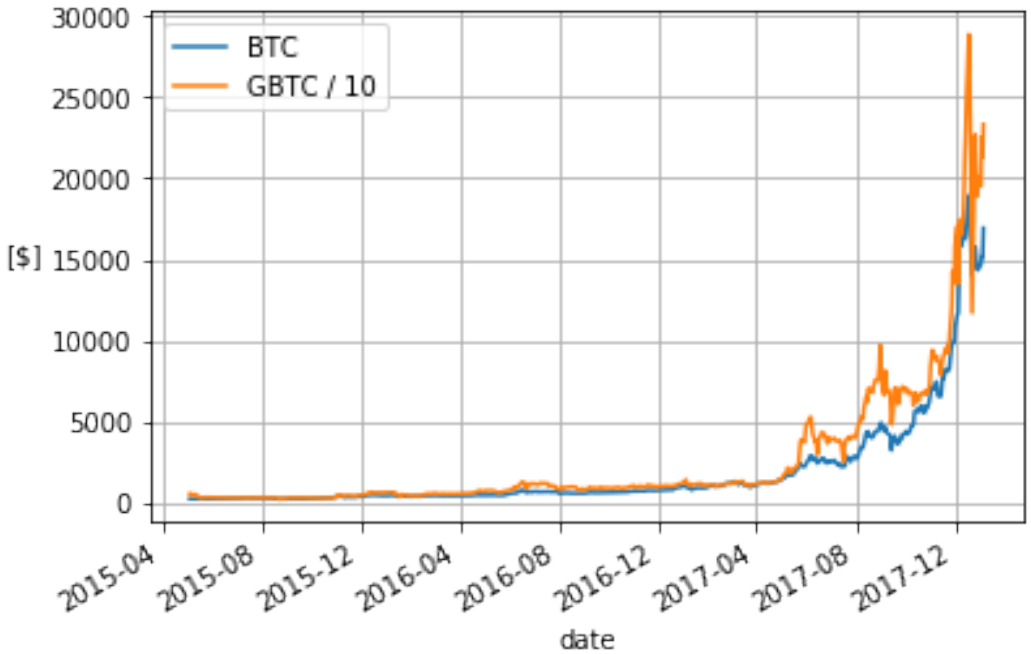
| | | | | |
|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 |

# ob-ipython

- Allows Babel to interact with a Jupyter kernel
- Different kernel types
  - I havent tried this
- Remote kernels
- Inline plotting
- ipython features

# Bitcoin - GBTC

- GBTC is a trust that holds BTC
  - Manges serves, security, etc.
- One GBTC share represents .1 BTC
- Generally more liquid than BTC
- Only trades Monday - Friday

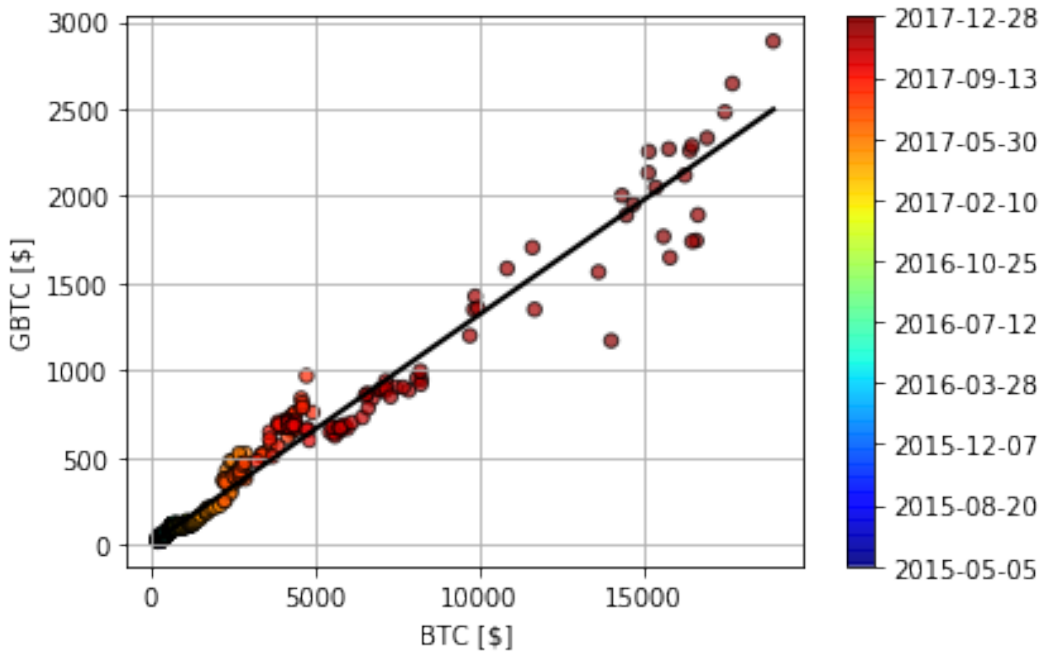



## Thesis

When GBTC dips relative to BTC it could be an opportunity.

# Fit with Least Squares

- Ok, it has a linear relationship
- But, does this model the aspects that we want to trade?



# Kalman Filter Approach (1)

A kalman filter may be used to dynamically estimate the relationship between the two sets of data.
Allow

$$\vec{x}_t = \begin{bmatrix} m_t \\ b_t \end{bmatrix} \tag{1}$$

where $m_t$ is the slope and $b_t$ is the intercept, similar to our fit above.
Then, the kalman transition equation may be written, trivially as

$$\vec{x}_{t+1} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \vec{x}_t + \vec{q} \tag{2}$$

and

$$z_t = \begin{bmatrix} BTC_t & 1 \end{bmatrix} \vec{x}_t + R \tag{3}$$

# Kalman Filter Approach (2)

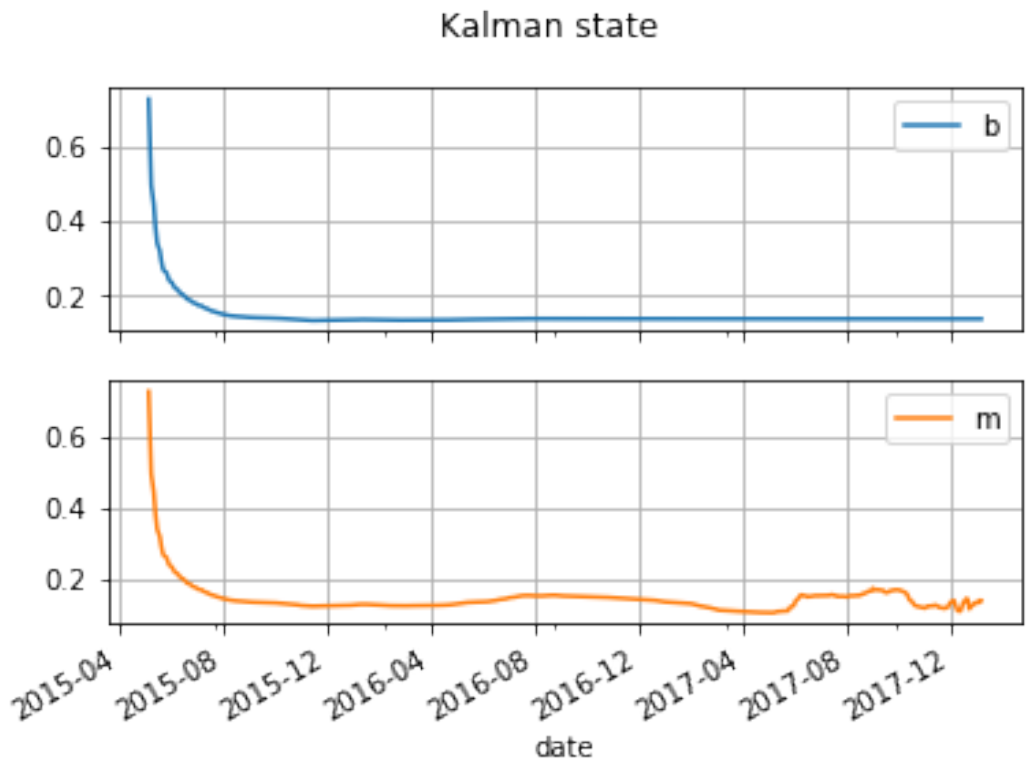
Our system has now been written as a Kalman filter with $z_t$ representing the state $t$ of the price of GBTC and $h_t$ representing the price of BTC at time $t$. In this system, the Kalman state, $x_t$ is our fit parameters $m$ and $b$, the tradtional Kalman transition matrix,

$$A_t = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \tag{4}$$

and the observation matrix $H_t$ holds the Bitcoin prices.

# Apply Kalman Filter

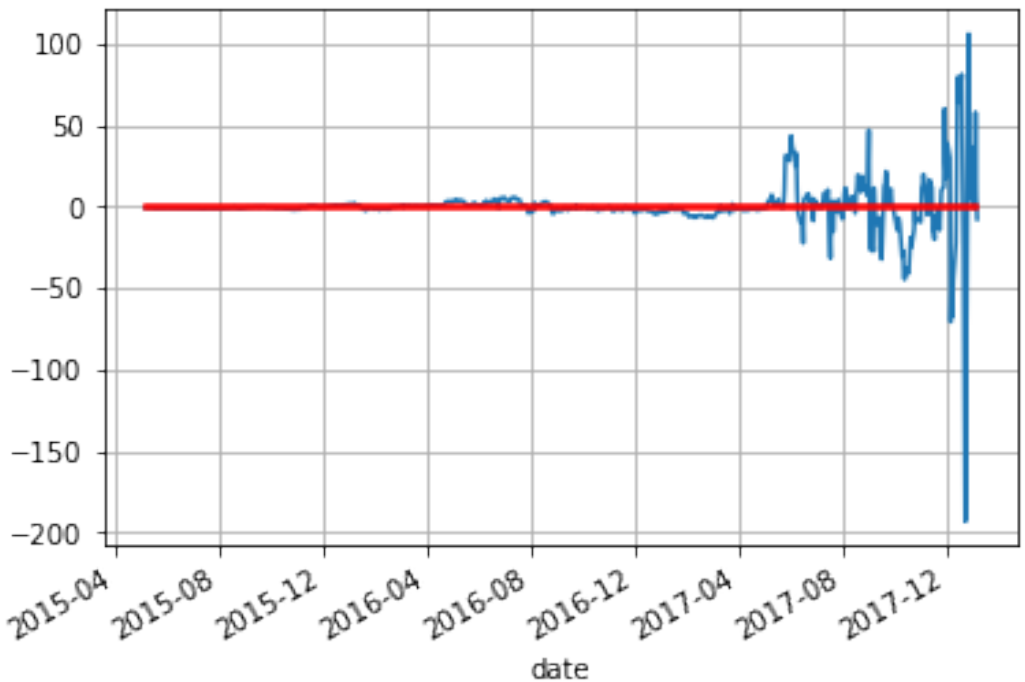
- Used pykalman package
- Slope, intercept $(m, b)$ for each data point
- Covariances for each data point



# Residuals (1)

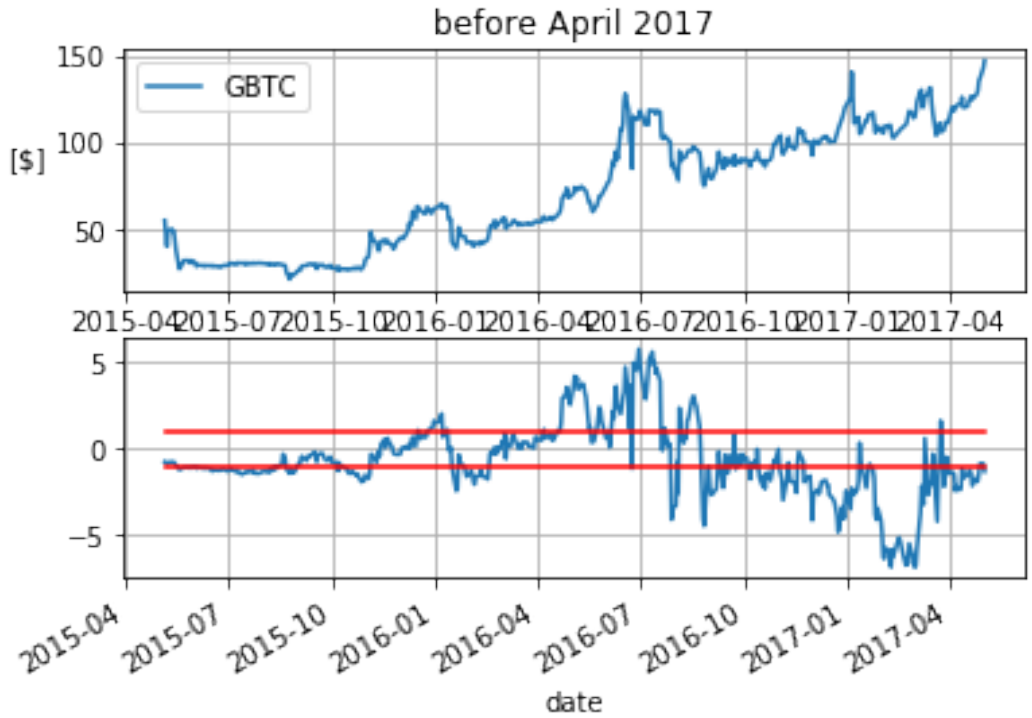
$$r_t = \frac{GBTC_t - m_t BTC_t - b_t}{\sigma_t}$$

- Calculate errors from the returned state covariance
- Clearly this system behaves differently as bitcoin takes off



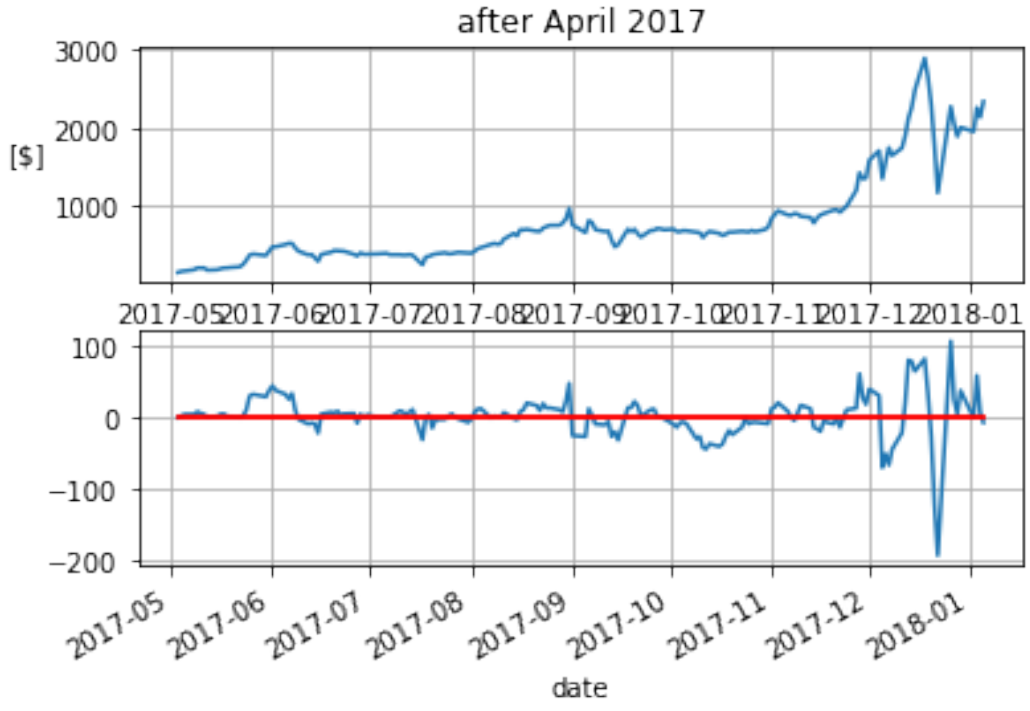
# Residuals (2)

- Up to April 2017
- Thesis seems to play out



# Residuals (3)

- After to April 2017
- Model performance has completely changed
  - Choices for $R$, $q$ for the whole data set



# Backtest

- When GBTC dips below $\sigma$ buy
- Sell at above $\sigma$
- Should have just held BTC from 2009 ;-)

## Simulation

```
thresh = 1.0
money = [(gbtc.index[0], 0.0)]
in_trade = False
buys = []
sells = []
for date, price, res in zip(gbtc.index, gbtc, residuals):
    if in_trade:
        if res > thresh:
            money.append((date, money[-1][1] + price))
            in_trade = False
            sells.append((date, price))
    else:
        if res < -1 * thresh:
            money.append((date, money[-1][1] - price))
            in_trade = True
            buys.append((date, price))
if in_trade:
    money.append((date, money[-1][1] + price))
    sells.append((date, price))

buys = np.array(buys)
sells = np.array(sells)
money = np.array(money)
```

# Trades

- Not a particular exciting trade
- Should have just held BTC from 2009 ;-)


## What are we left with?

1628.89

# ob-ipython versus python notebooks (IMO)

## For

- Integrates with org and emacs
- Works better with source control
- Code is just text files
- Better tools for documents

## Against

- Needs emacs
- More cumbersome to excute lots of cells
- Lots of boilerplate
- No else on my team uses this
- I hate LaTeX

# Resources

## org-mode

- https://orgmode.org
- **Recommended**: https://www.youtube.com/watch?v=oJTwQvgfgMM&t=512s

## Babel

- https://orgmode.org/worg/org-contrib/babel/intro.html

## ob-ipython

- https://github.com/gregsexton/ob-ipython

## Beamer

- https://github.com/dfeich/org-babel-examples/blob/master/beamer/beamer-example.org

## Kalman Analysis

- https://www.quantopian.com/posts/quantcon-2016-using-the-kalman-filter-in-algorithmic-trading