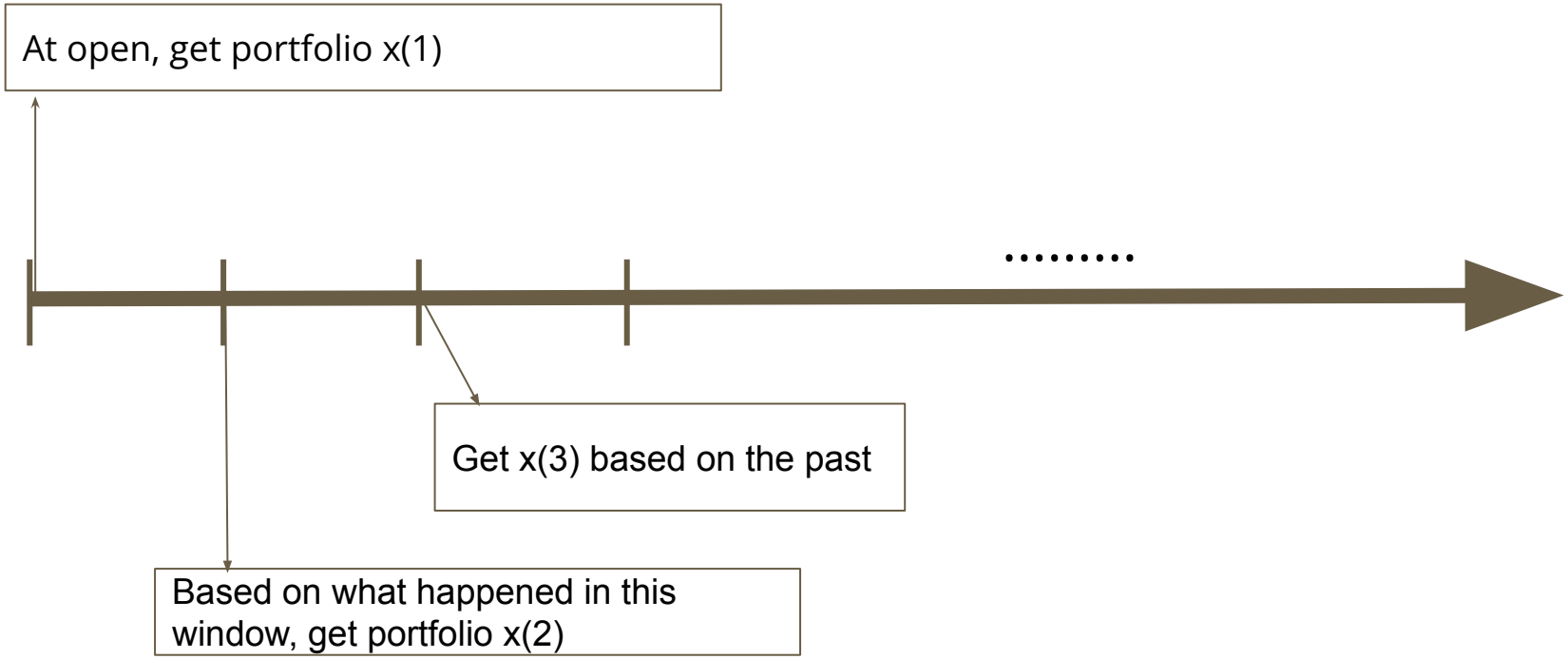
Online Portfolio Selection

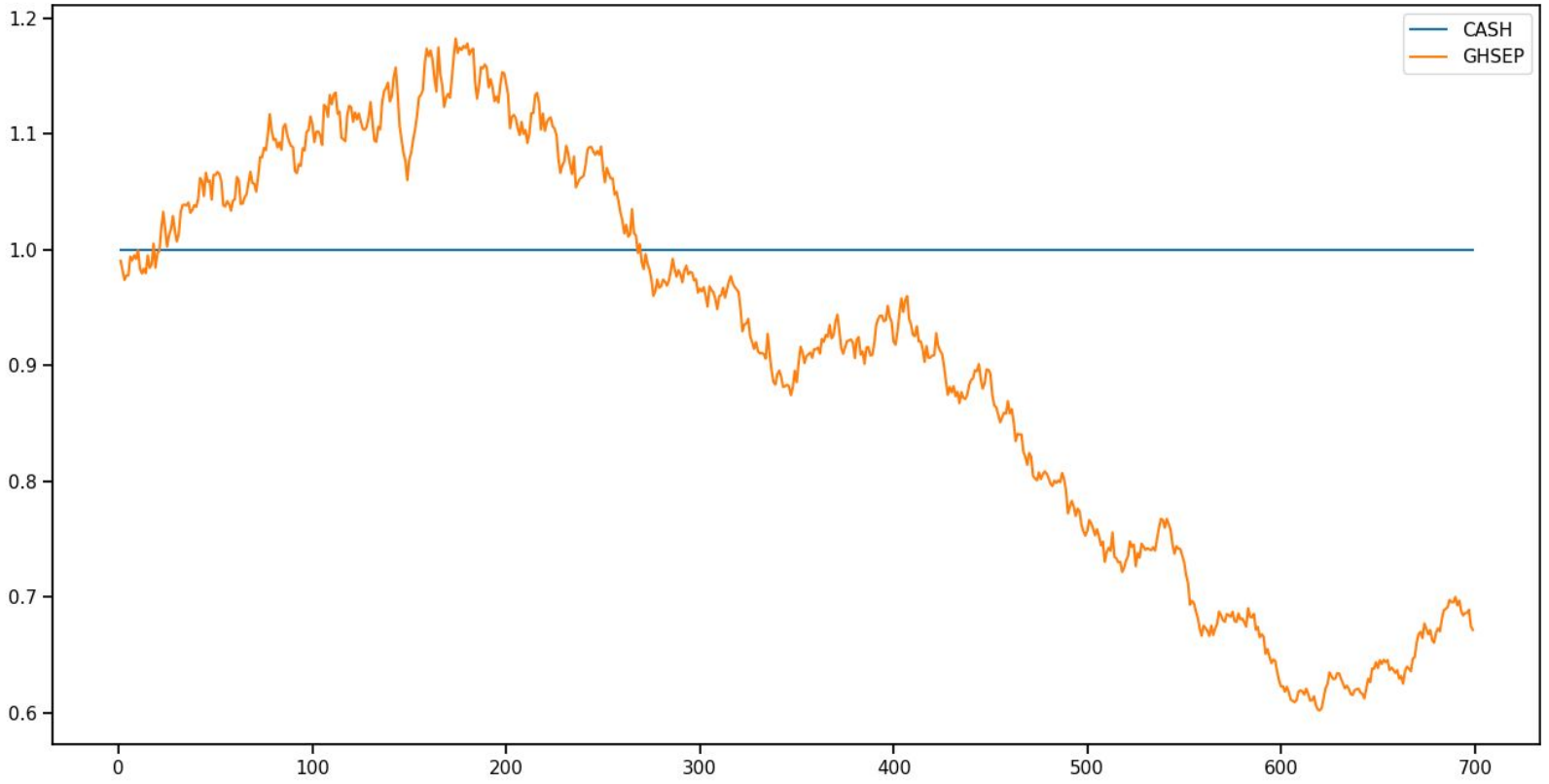
DDMIF

Sudeep

Interaction Protocol



1 asset and cash GBM



Online Portfolio Selection Techniques

1. Follow-The-Leader
2. Exponentiated Gradient
3. Online Newton Step
4. Passive Aggressive Mean Revision
5. Online Moving Average Revision

Trading Strategy Development

1. We run algorithms weekly data.
2. Rebalancing portfolios every week.
3. We allow shorting.

If we have n assets and cash, the portfolio space with shorting is:

$$\Delta_n = \{x \in \mathbb{R}^{n+1} : x_0 \geq 0, \sum_{i=0}^{n} (x_i)^+ = 1, \sum_{i=1}^{n} |x_i| \leq 1\}$$

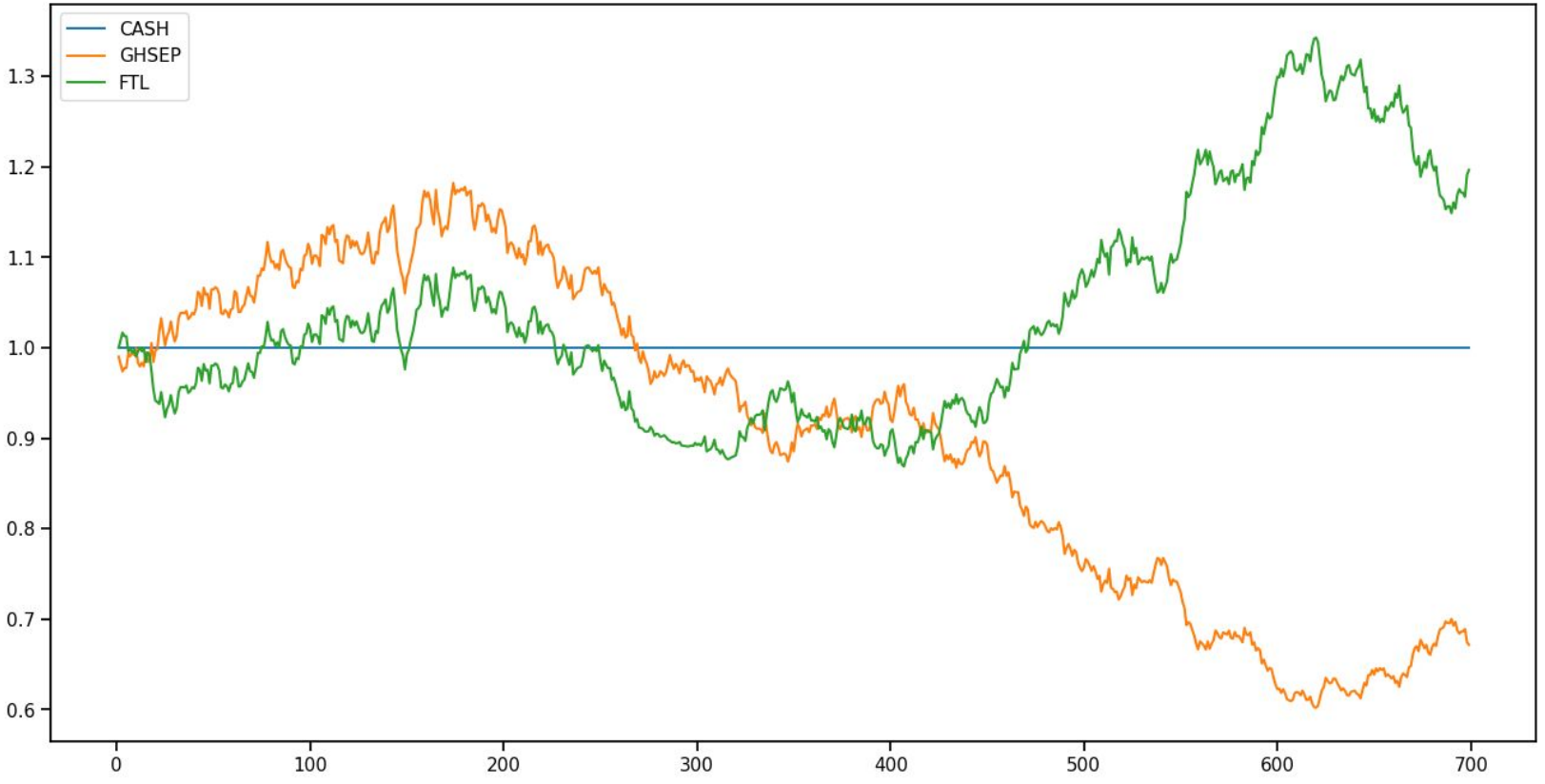
Follow the Leader

At time t, we know the returns from 1 to t-1. So, we optimize:

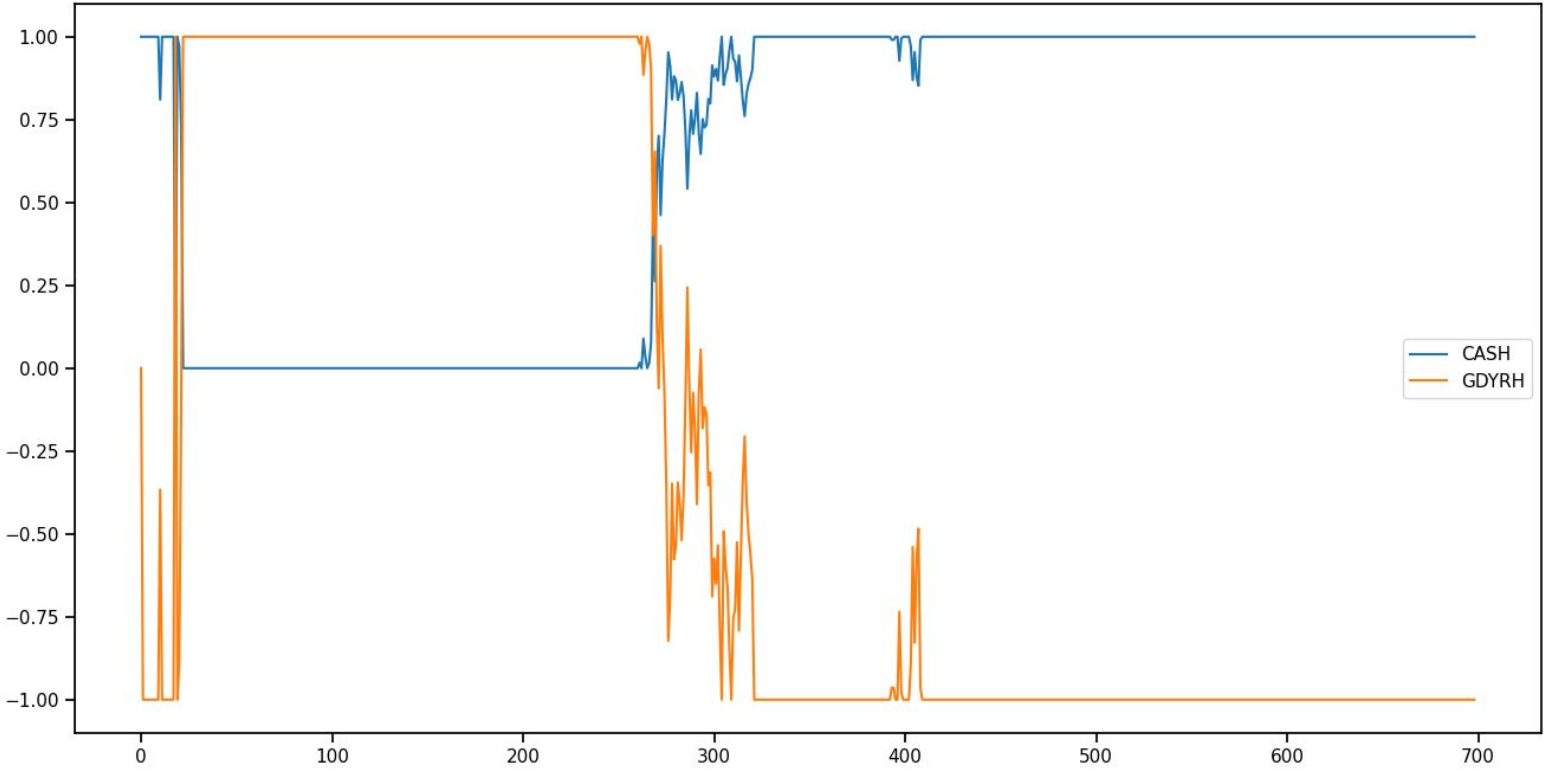
$$x_t = \arg\max_{x \in \Delta_n} \sum_{s=1}^{t-1} \log(1 + r_s^\top x)$$

Here r_s is the return vector

FTL performance



FTL portfolio



Exponentiated Gradient

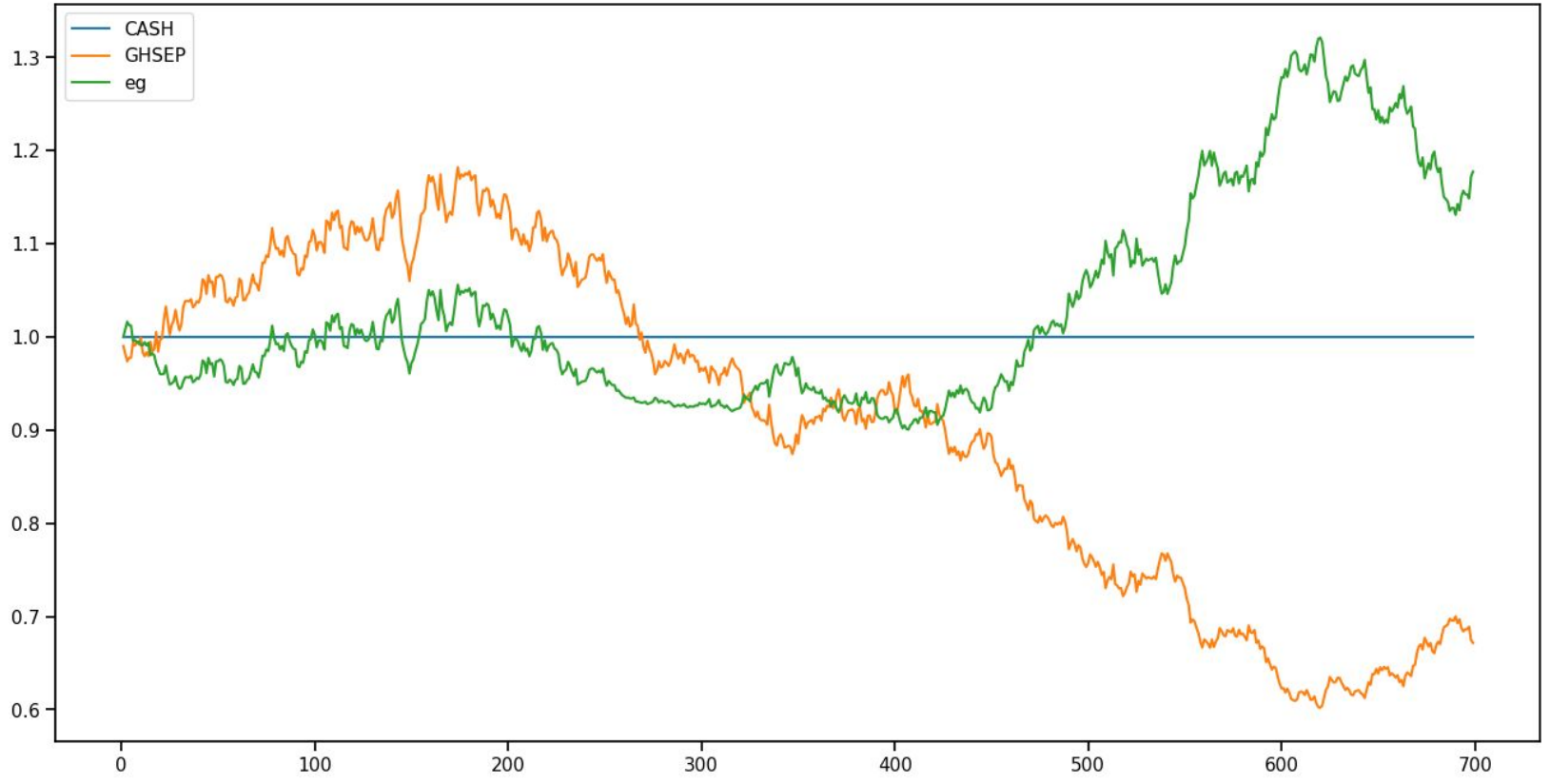
Follow the Linearized Leader with Regularization:

$$x_t = \arg\min_{x \in \Delta_n} \sum_{s=1}^{t-1} g_s^\top x + \lambda_{t-1} R(x)$$

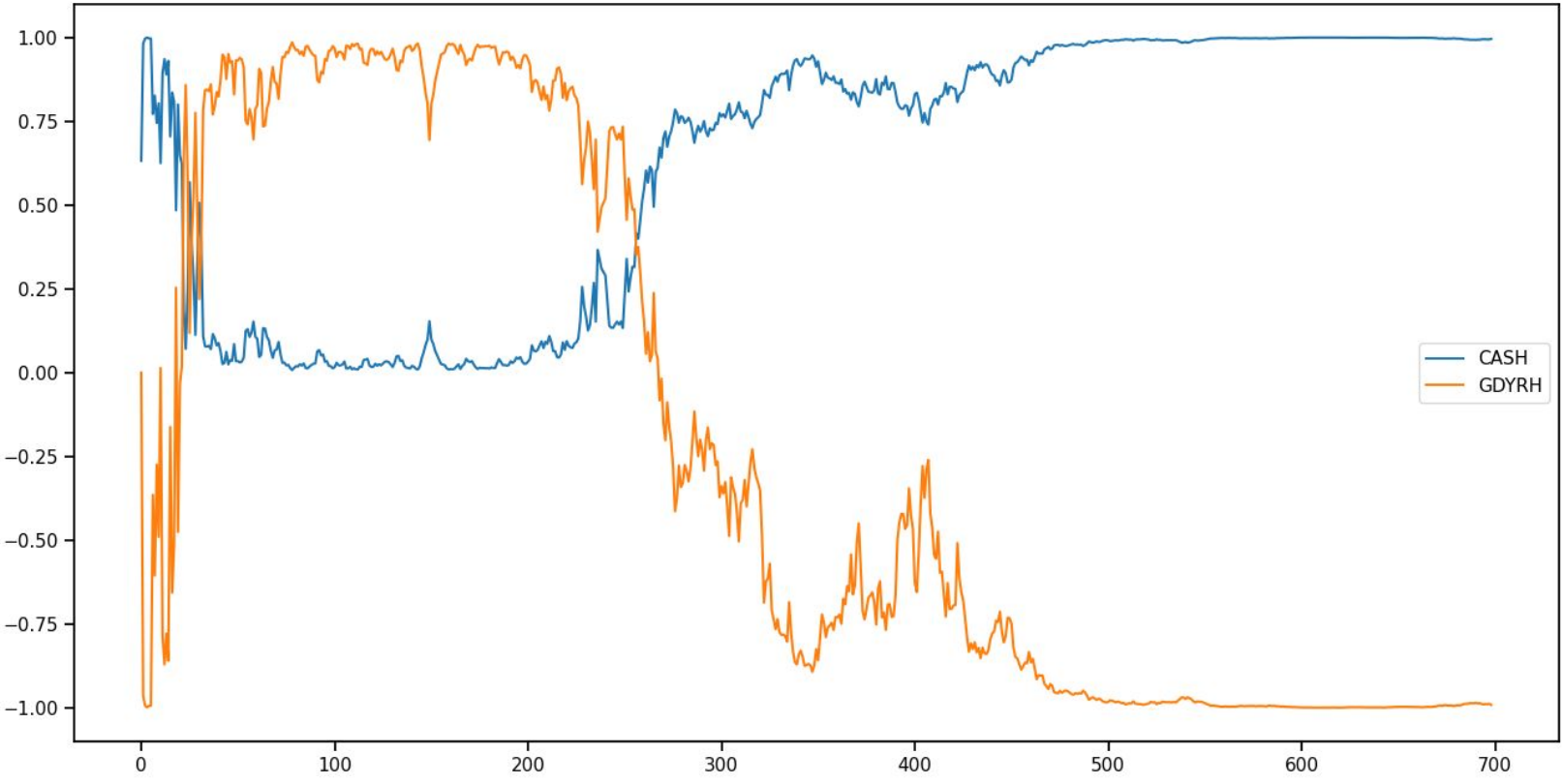
$$g_s = \frac{-r_s}{1 + r_s^\top x_s} \quad \text{and} \quad \lambda_{t-1} = \sqrt{\sum_{s=1}^{t-1} \|g_s\|_2^2}$$

There are different choices for R(x) like entropy and 2-norm. The version with entropy is called Exponentiated gradient.

EG performance



EG portfolio



Online Newton Step

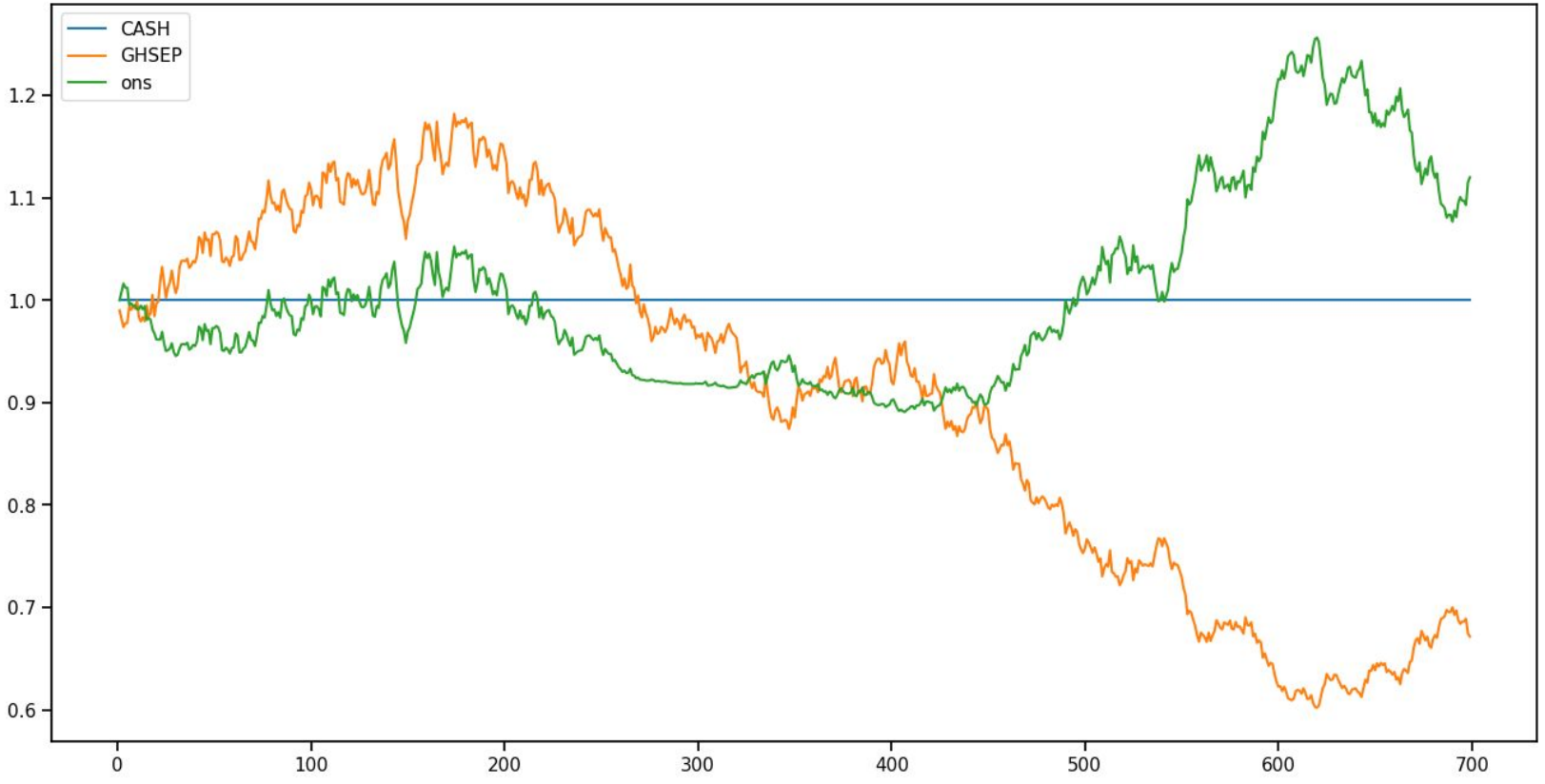
Follow the Quadratic Leader with Regularization

$$x_t = \arg\min_{x \in \Delta_n} \sum_{s=1}^{t-1} \left(\frac{1}{2} x^\top A_s x + b_s^\top x \right) + \lambda_{t-1} R(x)$$

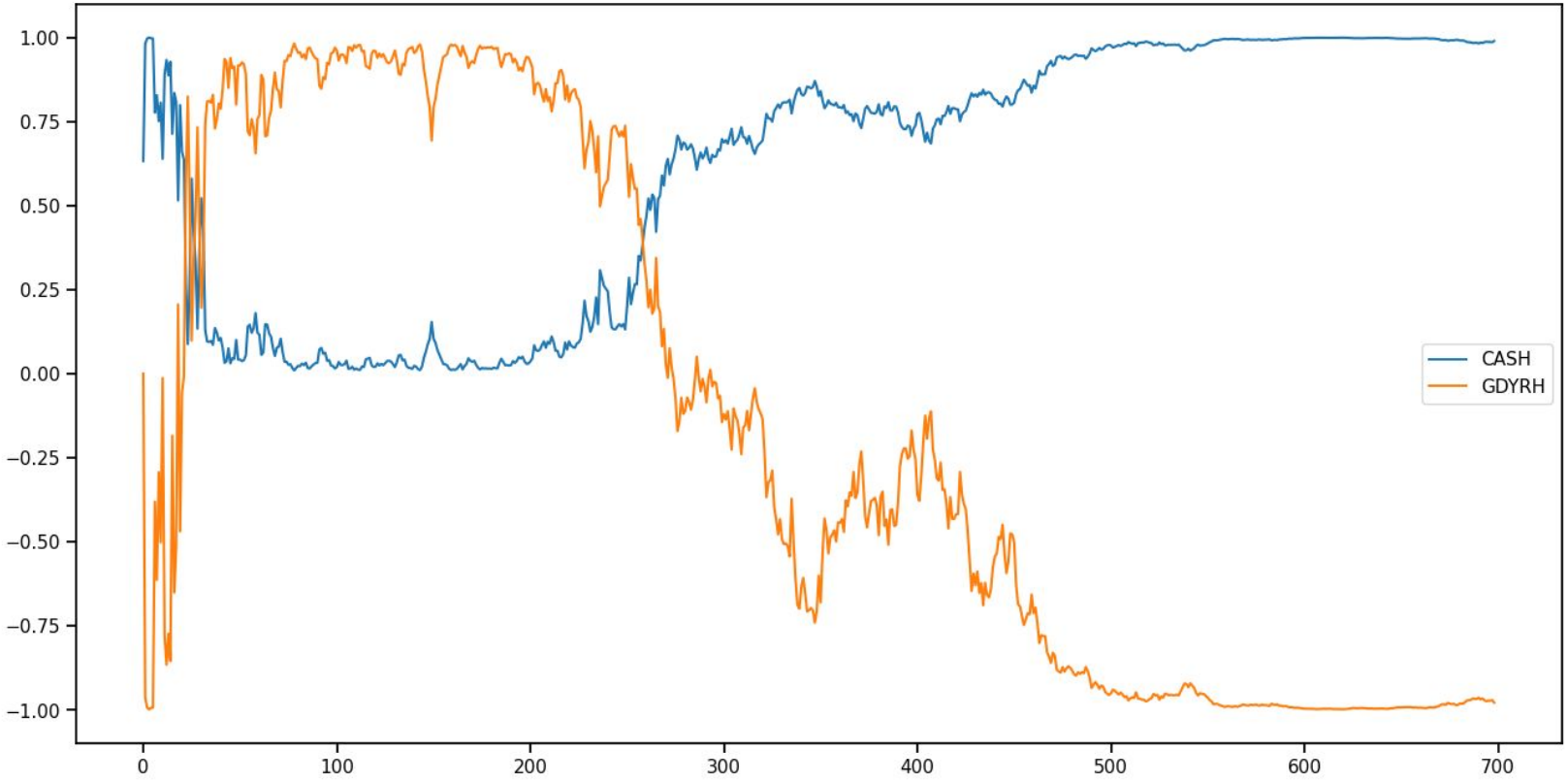
$$A_s = \frac{r_s r_s^\top}{1 + r_s^\top x_s} \quad , \quad b_s = -r_s \quad \text{and} \quad \lambda_{t-1} = \sqrt{\sum_{s=1}^{t-1} \|g_s\|_2^2}$$

There are different choices for R(x) like entropy and 2-norm. The version with 2-norm is called Online Newton Step

ONS performance



ONS portfolio



Mean Revision

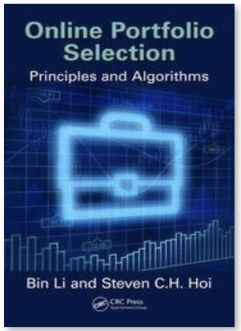
Ada-PAMR

$$x_t = \arg\min_{x \in \Delta_n} \|x - x_{t-1}\|_2^2 + \eta_t r_{t-1}^\top x$$

Ada-OLMAR

$$x_t = \arg\min_{x \in \Delta_n} \|x - x_{t-1}\|_2^2 - \eta_t \tilde{r}_t^\top x$$

References



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Book

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