# Single Step Change Point Detection Algorithm (SSCP)

Objective: Given a series of observations, and a Wasserstein threshold detect if and when a distributional change occurs.

Step 1: Given a total of $n\_1+n\_2$ multidimensional samples, split the dataset in two parts of size $n\_1$ and $n\_2$

Step 2: Associate four decision variables $p\_1$ and $p\_2$ with each sample ($p\_1$, $p\_2$ in $\mathbb{R}^{n\_1+n\_2}$) and $\gamma\_1$ and $\gamma\_2$ with each sample pair ($\gamma\_1$, $\gamma\_2$ in $\mathbb{R}^{n\_1+n\_2 \times n\_1+n\_2}$

Step 3: Solve the optimization problem $\ref{eqn} for $p\_1$, $p\_2$, $\gamma\_1$ and $\gamma\_2$

Step 4: For each sample, calculate the detector $\phi$ = sign(p\_1 – p\_2)

Step 5: Specify and set target average run length (time between false alarms to be sufficiently high) \footnote{\cite{} uses 10000 in their paper}

Step 6: Set b to achieve the target average run length based on a detection time calculated using the cumulative sum method.

Step 7: If T = n\_1+n\_2 then no detection. Otherwise detection occurs at T = n\_1+n\_2+1

Step 8: Output time T

**Figure 1:**

**Observation set 2**



**Observation set 1**



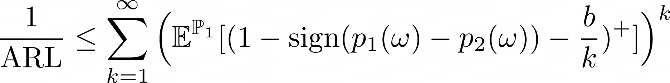
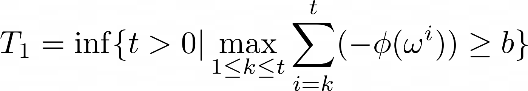
Solve optimization problem for



Calculate signal



Set b to achieve a target average run length using CuSum Method and determine T



**t**

**T**

# Rebalancing Time Generation Algorithm

The algorithm applies the change point detection algorithm iteratively on a dataset to output stopping times that represent when a distributional shift occurs i.e a good time to consider rebalancing the portfolio that does cheat by using any data after the outputted times.

Step 1: Given a time series of $n$ observations, specify the parameters $n\_1$ and $n\_2$, and initialize a variable $t\_mid$ that represents the time value of the first observation after $n\_1$. Further, initialize a variable called that represents the current time $t\_now$, which is given by $n\_2$ time steps after $t\_mid$.

**Step 2: Iterate through the dataset by applying the single step change point algorithm repeatedly through sequences of the dataset.**

**Pseudo Code:**

**While $t\_{mid} \leq n – n\_2 – 1$**

$t\_now = t\_{mid} + n\_2$

$Store $t\_{now} for reference$

#T is stopping time

$\text{Signals}, \text{ARL}, p\_1, p\_2, T$ = **Run SSCP(\delta) #T is**

If T == 2\*n – 1 then no change detected and the next mid point is incremented by n\_2.

$t\_mid = t\_mid + n\_2$

If there was a change after $t\_now + n\_1$ (T > n) then the next mid point occurs at that stopping time

$t\_mid = t\_now - n\_1 - n\_2 + T$

Store: the current time $t\_now$ and the a-posteriori stopping time $T$, and the Average Run Length

**Figure 2:**

Input Dataset

**Observation set 2**



**Observation set 1**



Calculate signal



Set b to achieve a target average run length using CuSum Method

**t**

**T**

Calculate signal



**Observation set 1**



**Observation set 2**



Set b to achieve a target average run length using CuSum Method

**T**

OUTPUT: Re balancing times and a-posteriori change points

# Introduction

Introduce the problem in general.

Portfolio optimization is concerned with investor's decisions to buy or sell specific assets in an attempt to achieve an objective for a portfolio. The seminal work on portfolio optimization by \cite{markowitz1952portfolio} is the most commonly used and well-known approach to selecting portfolios. \cite{markowitz1952portfolio} proposes selecting the portfolio that minimizes the portfolio's variance subject to an expected return constraint over some time horizon.

Motivation for the problem,

discuss and distill contributions

# Literature Review

Portfolio Optimization

Optimizers Curse

IID Assumption

Hypothesis testing

Hypothesis testing and portfolio optimization

# Proposed Methodology

Combine signal detection and portfolio optimization to tackle the dynamic problem

# Experiments

Comparison of financial results

# Conclusions and Next Steps

# Appendix