Weight Function Model for Quantitative Analysis of Functional Resonance Analysis Method

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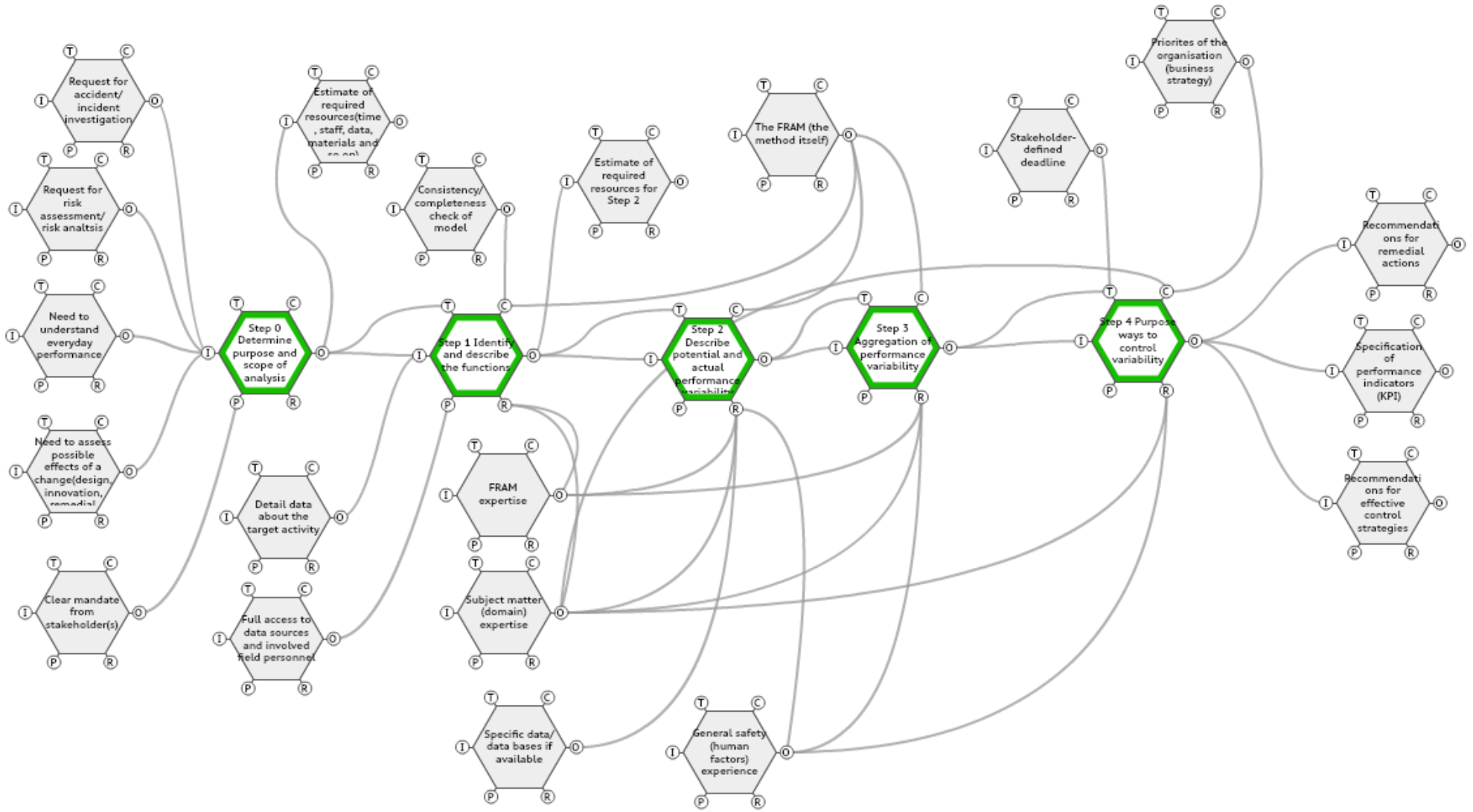
Outline

1. Qualitative Analysis in FRAM
2. Data Analysis
3. Weight Function Model
4. Conclusion

Traditional Qualitative FRAM



The Problems with FRAM

Describe & Aggregate Variability

- Very subjective
- Time consuming
- Difficult to interpret

Possible source of variability		Likelihood
Internal	Very many, physiological and psychological	High frequency, large amplitude
External	Very many, social and organisational	High frequency, large amplitude

Potential Output variability with regard to time	
○ Too early	Possible (snap answer, serendipity)
○ On time	Possible, should be typical
○ Too late	Possible, more likely than too early
○ Not at all	Possible, to a lesser degree

Potential Output variability with regard to precision	
○ Precise	Possible, but unlikely
○ Acceptable	Typical
○ Imprecise	Possible, likely

Research Aim

How to solve the problem?

- More brainstorming?
- More time spending?
- More experts?

Purposed solution

- Semi-Quantitative to analyze

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Steps of FRAM

0: Describe purpose of modeling
1: Describe essential functions
2: Characterize variability
3: Analyze instantiations
4: Propose way to manage the performance

Steps of FRAM

0: Describe purpose of modeling

1: Describe essential functions

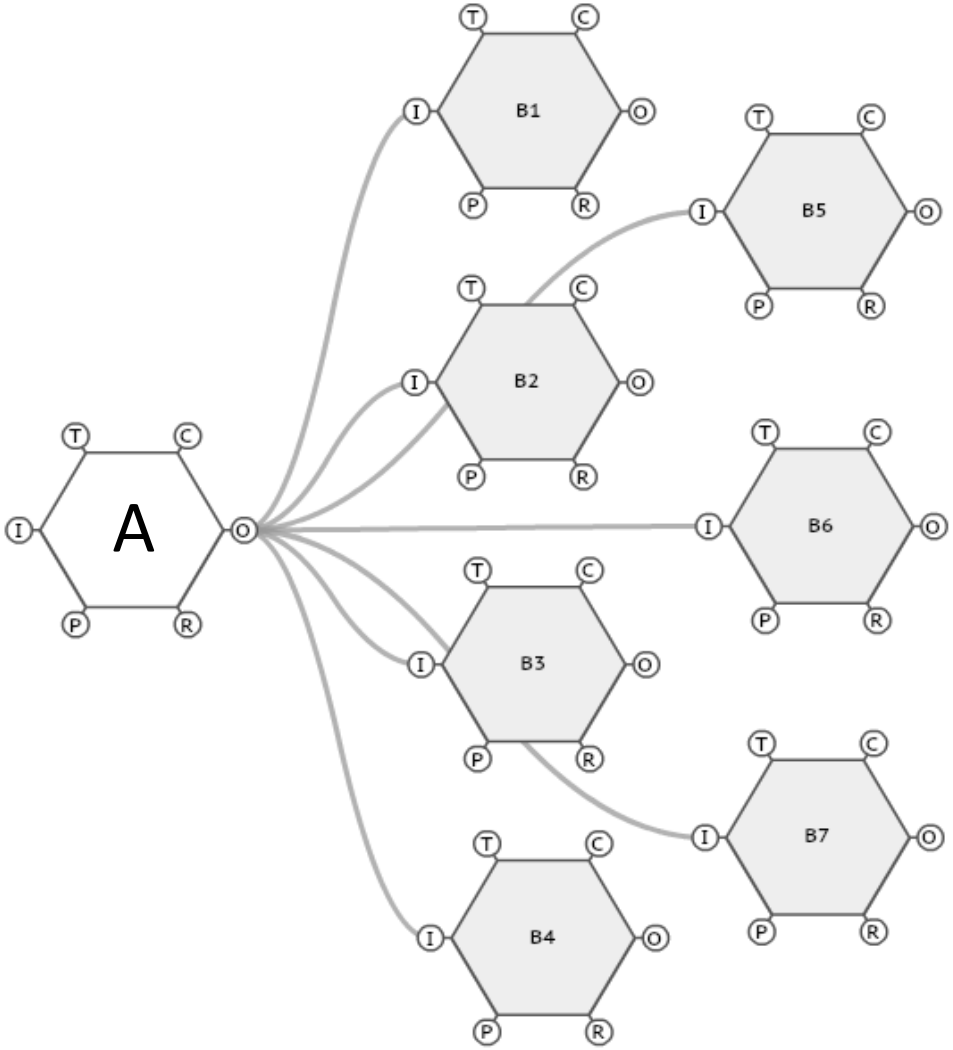
2: Characterize variability

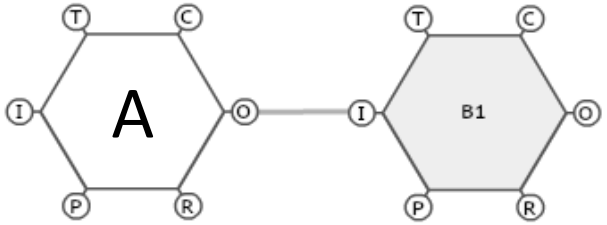
2.5: Characterize the weight of function and couple

3: Analyze instantiations

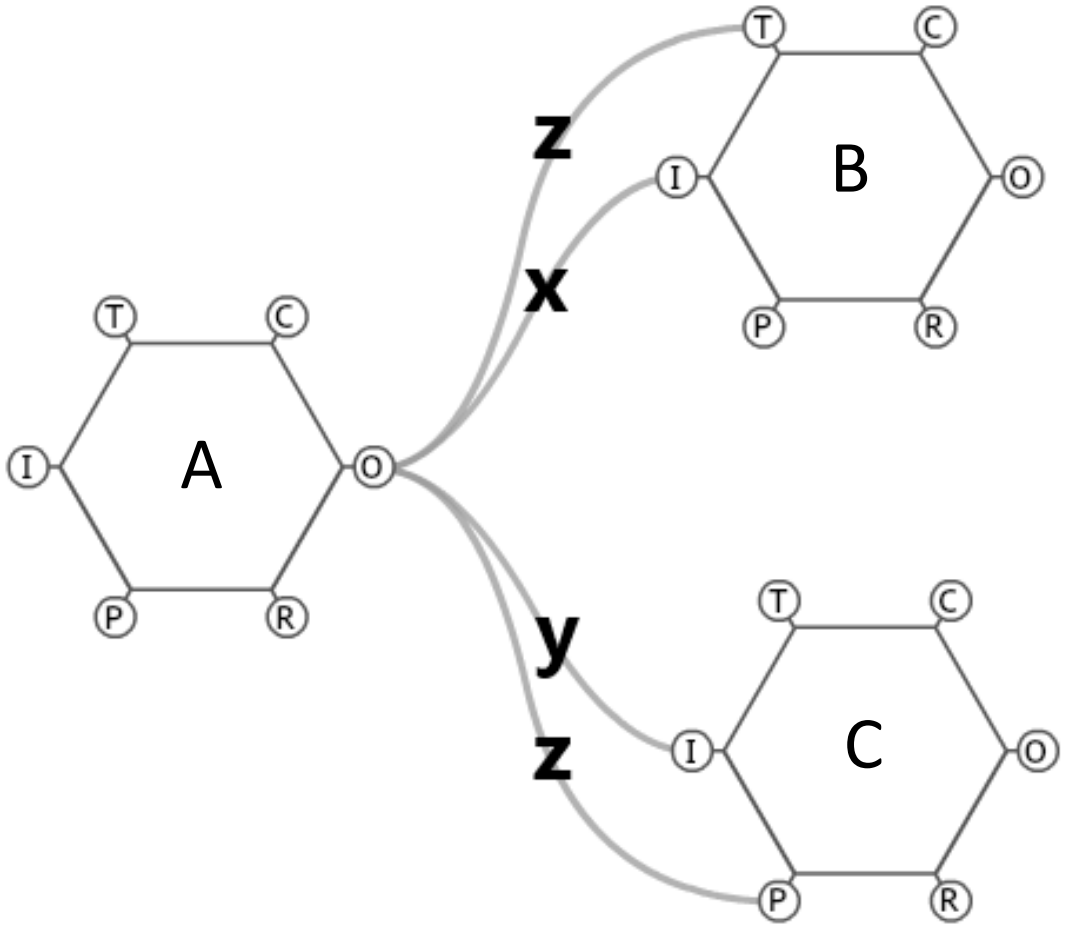
4: Propose way to manage the performance

The Importance of Function





The Importance of Coupling



Significant Imbalance

Difference of significant

- Core function vs Interface function
- Same upstream difference downstream

Manually assign the weight?

- More expert?
- More vagueness?

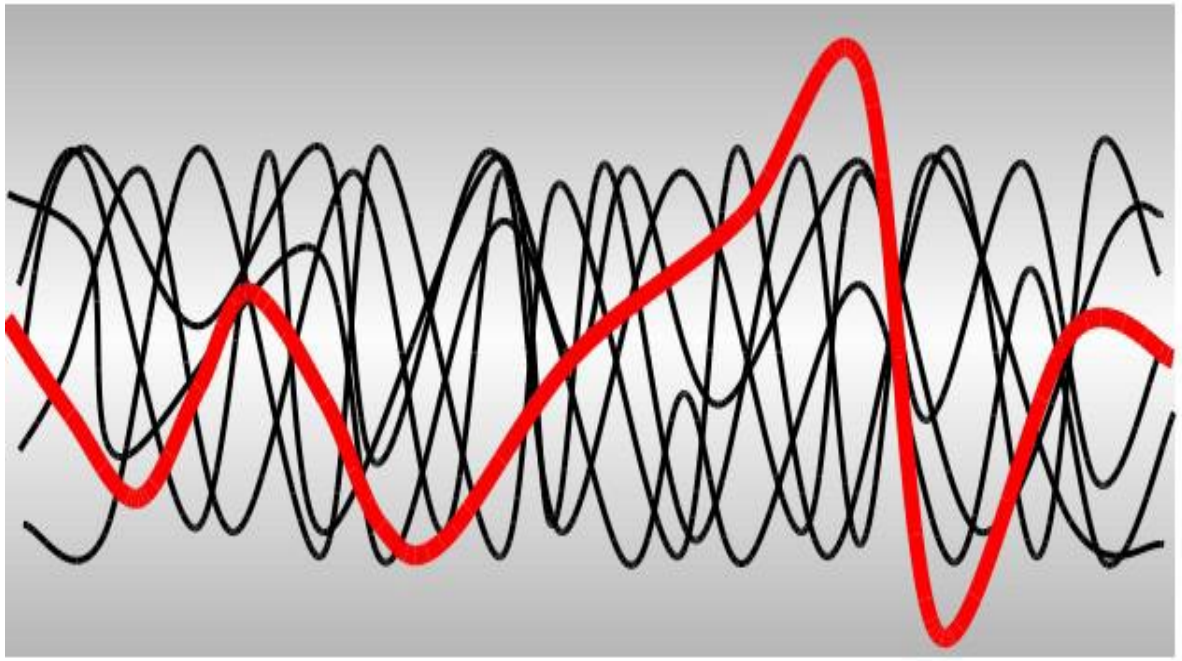
Deal with Resonance?

Characteristic of resonance

- Special case
- Pattern
- Combination of failure

Statistical data

- Large number of test cases
- Reliable



Ref: Introduction to FRAM - The Four Underlying Principles

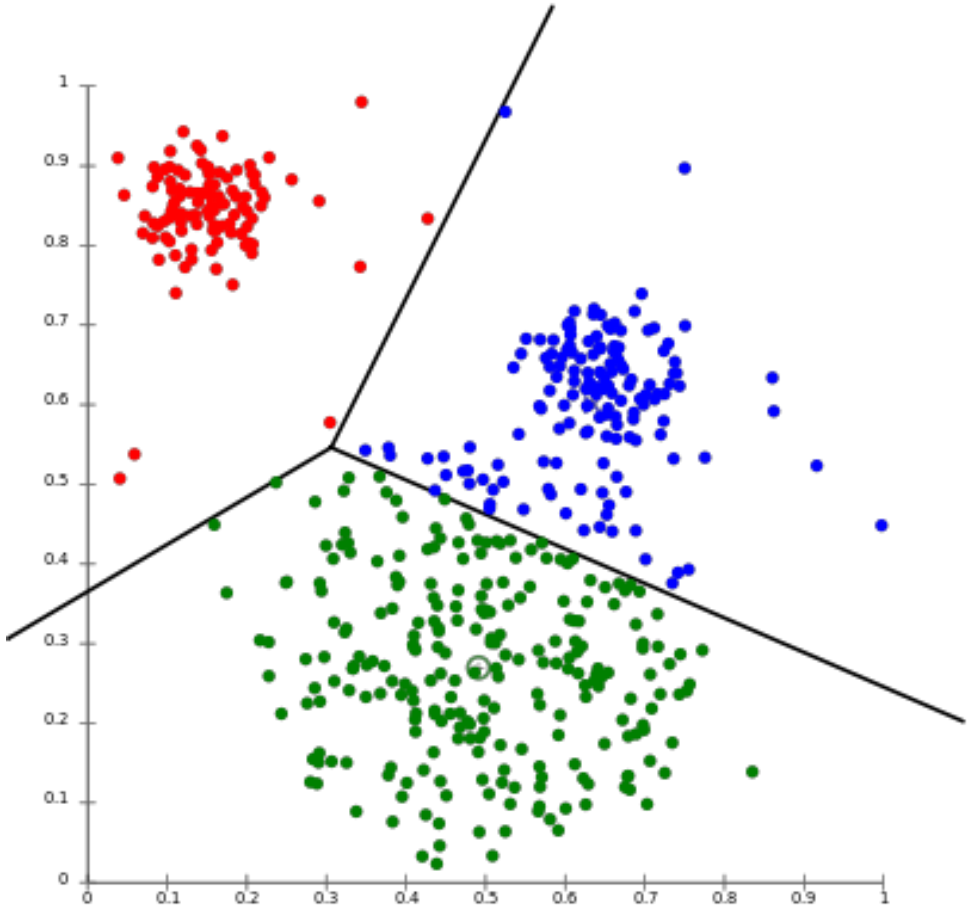
Group of Data

Data in the same group

- Share the similar behavior
- Combination of specific behavior

Data in the difference group

- Distinct by some behavior



Ref: https://en.wikipedia.org/wiki/Cluster_analysis

Weight Function Model

$$O_i = W_i \prod_a V_i^a$$

O_i = output variability of function i

W_i = weight of function i

V_i^a = variability of function i respect to phenotypes a

Phenotypes of variability

= {time, precision, speed, object, direction, force}

Weight Function Model

$$C_i = \sum_{j=0}^{N} \sum_{k=0}^{R} \left(W_{ijk} \prod_{a} V_i^a * W_j \prod_{a} V_j^a \right)$$

C_i = coupling variability of function i

W_{ijk} = weight of coupling k of function i and j

N = number of functions in the system

R = number of coupling of function i and j

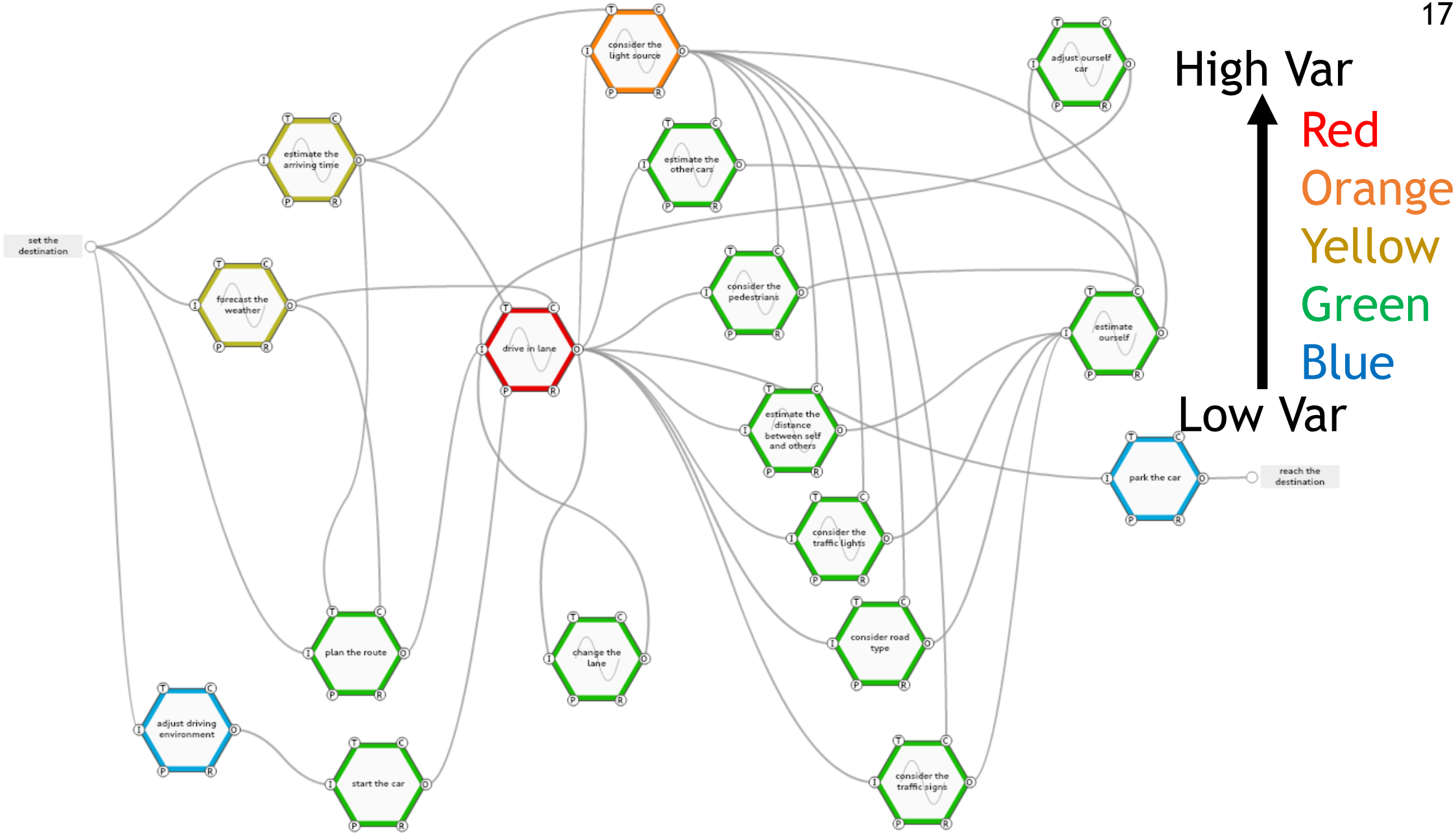
Weight Function Model

$$S = \sum_{i=0}^{N}\left(W_i\prod_{a}V_i^a + \sum_{j=0}^{N}\sum_{k=0}^{R}\left(W_{ijk}\prod_{a}V_i^a * W_j\prod_{a}V_j^a\right)\right)$$

S = summation of system variability

Summation of variability from each functions in system

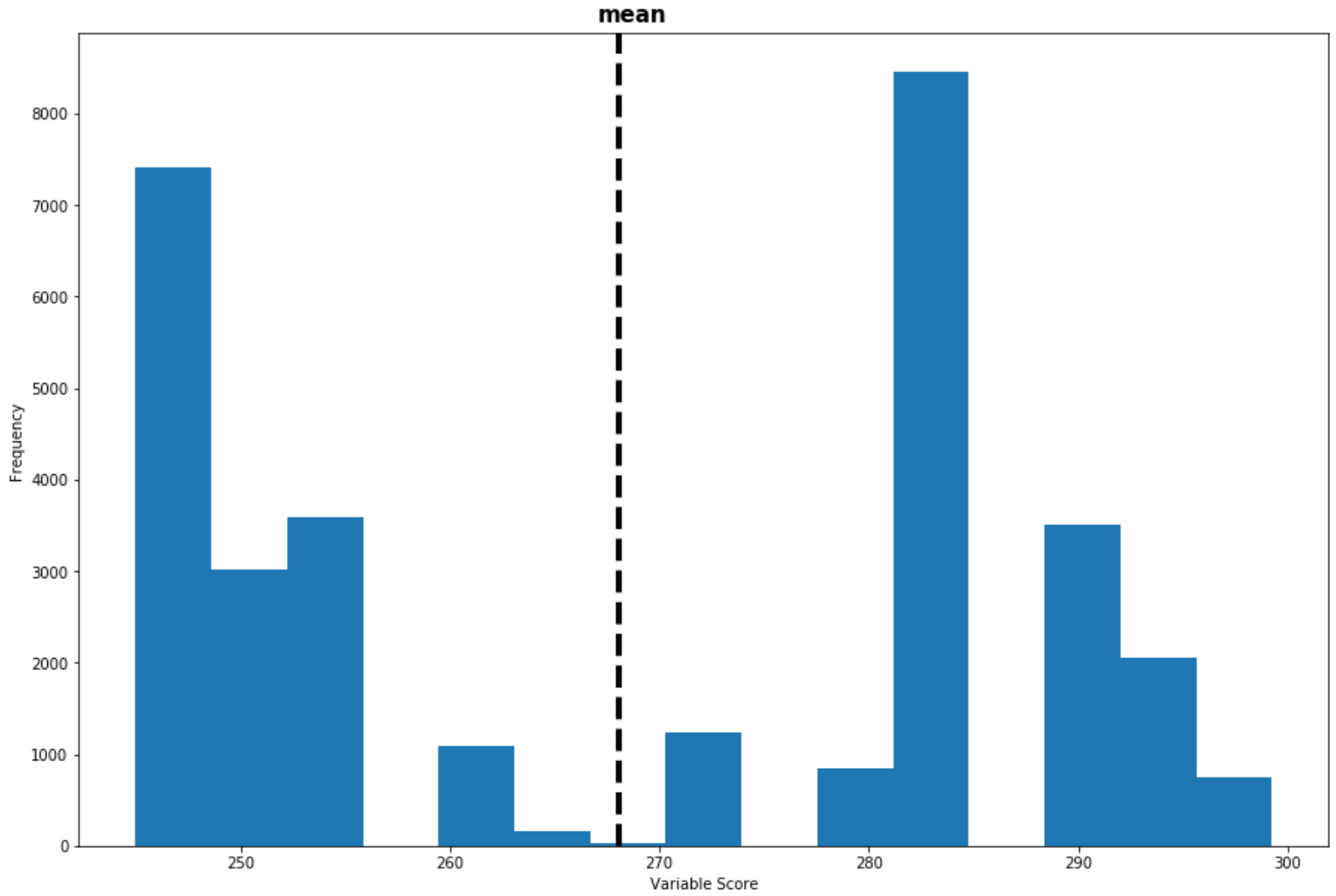

set the destination
estimate the arriving time
forecast the weather
plan the route
adjust driving environment
start the car
drive in lane
change the lane
consider the light source
estimate the other cars
consider the pedestrians
estimate the distance between self and others
consider the traffic lights
consider road type
consider the traffic signs
adjust ourself car
estimate ourself
park the car
reach the destination


set the destination
estimate the arriving time
forecast the weather
consider the light source
estimate the other cars
drive in lane
plan the route
change the lane
adjust driving environment
start the car
adjust ourself car
consider the pedestrians
estimate ourself
estimate the distance between self and others
consider the traffic lights
consider road type
consider the traffic signs
park the car
reach the destination
High Var
Red
Orange
Yellow
Green
Blue
Low Var

Experiment with Dataset

Dataset

- Min: 244.97
- Max: 299.26
- Mean: 272.02



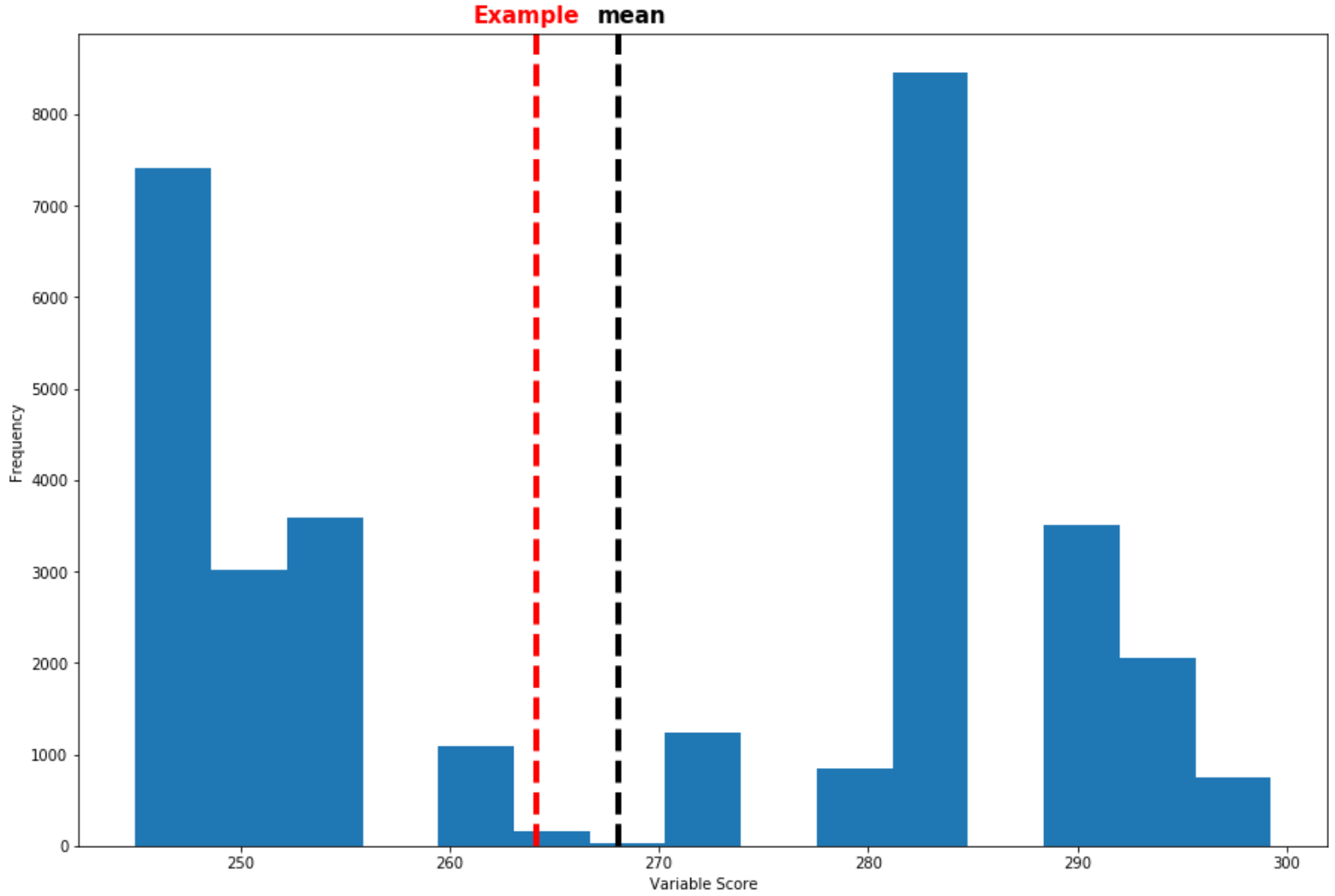
Example of One Possibility

Dataset

- Min: 244.97
- Max: 299.26
- Mean: 272.02

Example Event

- Score: 264.10



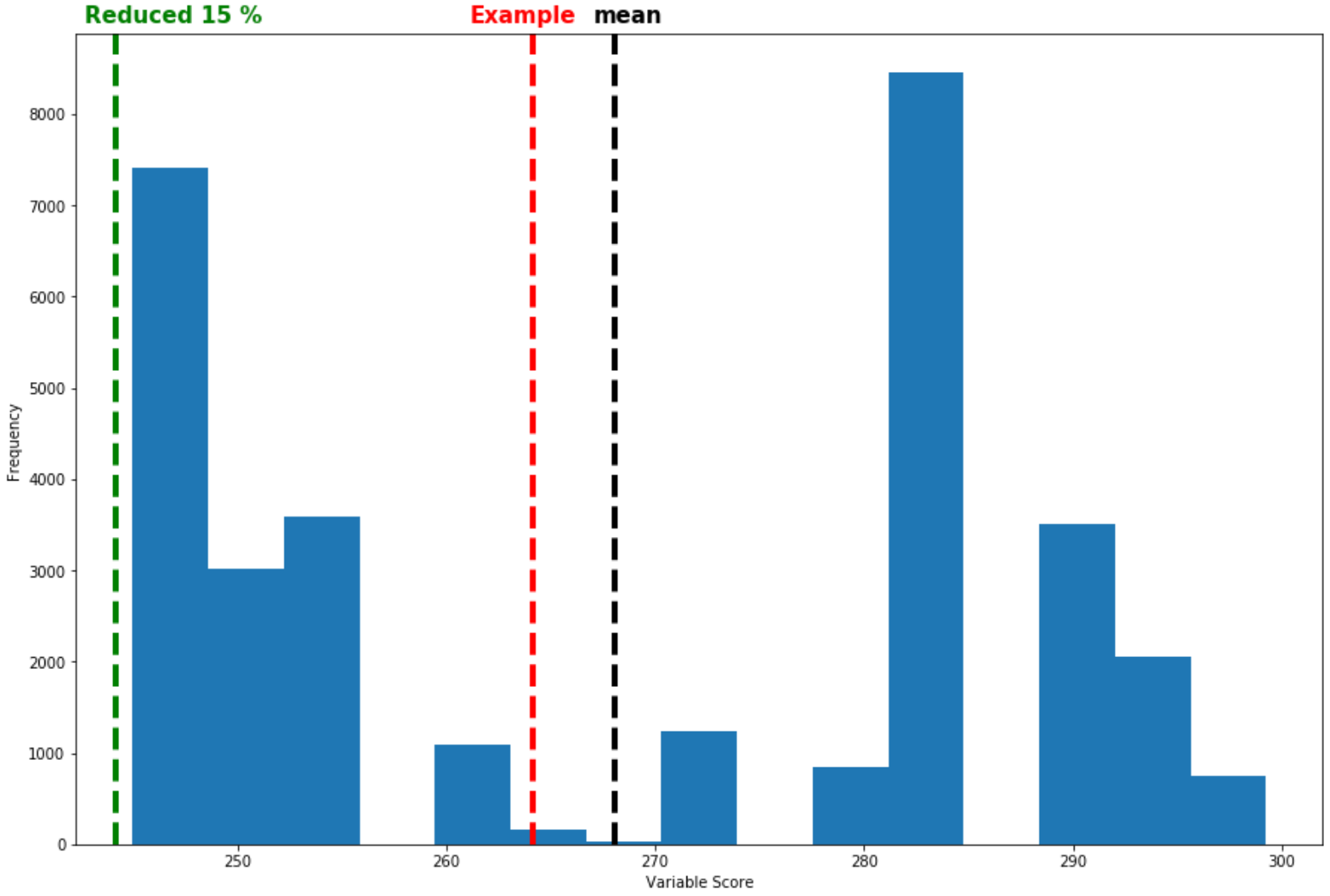
Reducing Core Function Variability

Dataset

- Min: 244.97
- Max: 299.26
- Mean: 272.02

Example Event

- Score: 264.10
- Reduce 15%: 244.16



Conclusion

$$S = \sum_{i=0}^{N}\left(W_i \prod_a V_i^a + \sum_{j=0}^{N}\sum_{k=0}^{R}\left(W_{ijk}\prod_a V_i^a * W_j \prod_a V_j^a\right)\right)$$

Problems

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