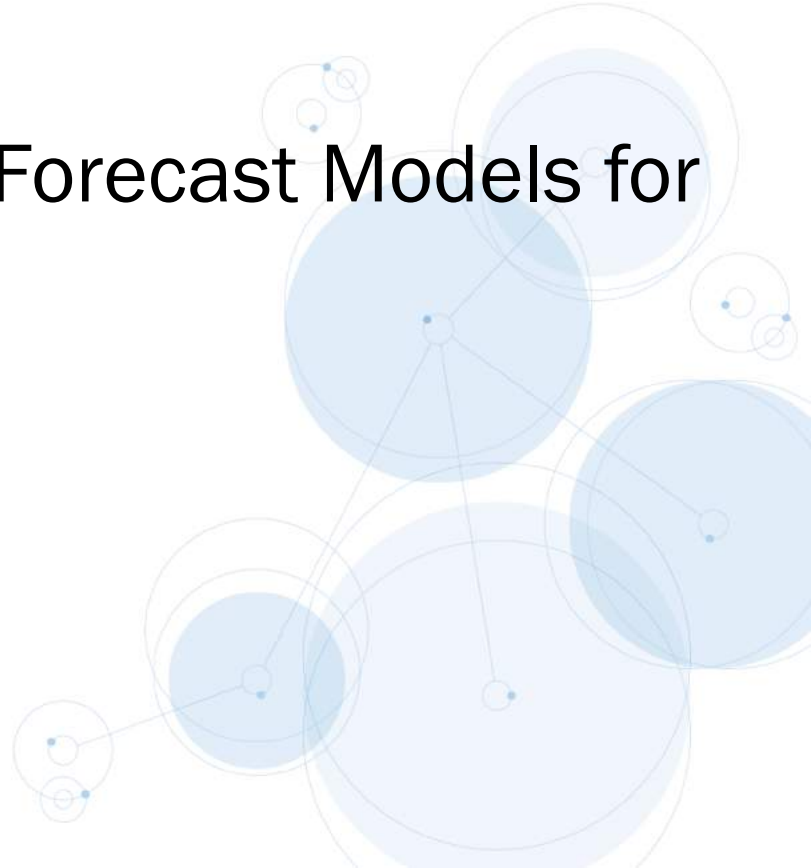


# AYASDI

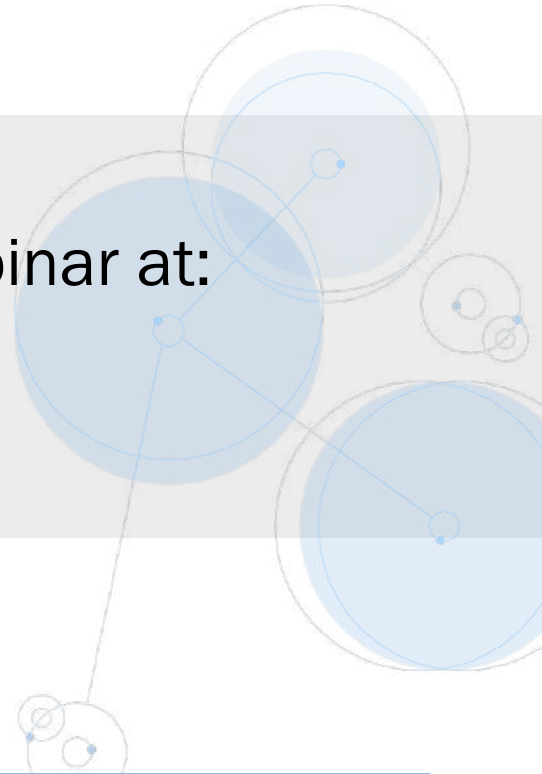
## Creating Effective Revenue Forecast Models for CCAR

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Michael Woods, Principal Data Scientist



To see this content presented, view the webinar at:  
<https://youtu.be/8pnpdrSis7w>



# Complexity is the Challenge

---

# of possible insights  
in the Dataset is  
exponential in size

# of possible insights in  
the Dataset next year  
after it grows another  
40%



**Dataset**

# Inadequate Response to Complexity

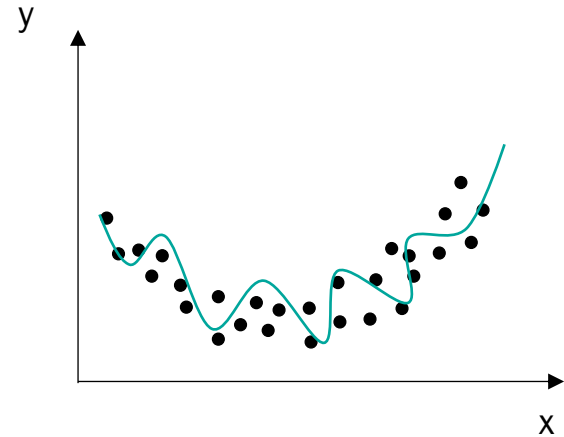
Quants



Conventional  
Analytical Approaches



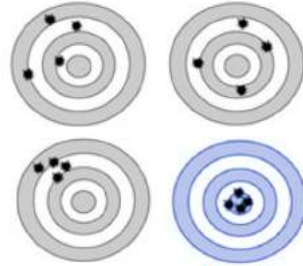
Overfitting



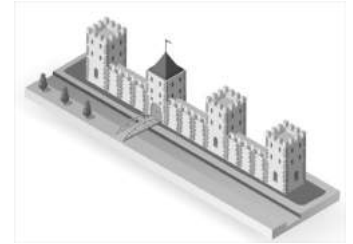
# Clean Slate Requirements



Speed

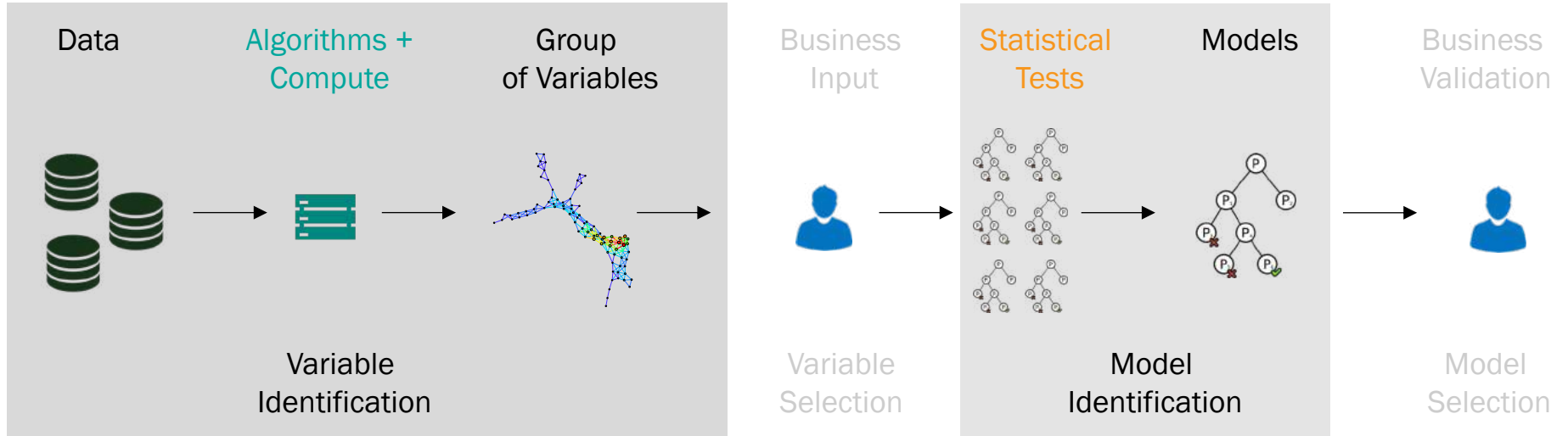


Accuracy



Defensibility

# A Man-Machine Workflow



# Machine Intelligence

Scalable  
Compute



+

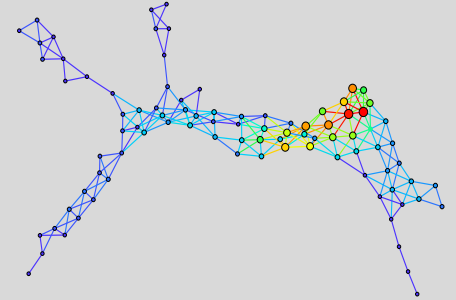
Machine Learning, Geometric + Statistical  
Algorithms



$$f(x) = \frac{1}{\delta\sqrt{2\pi}} e^{-\frac{1}{2}\left(\frac{x-\mu}{\delta}\right)^2}$$

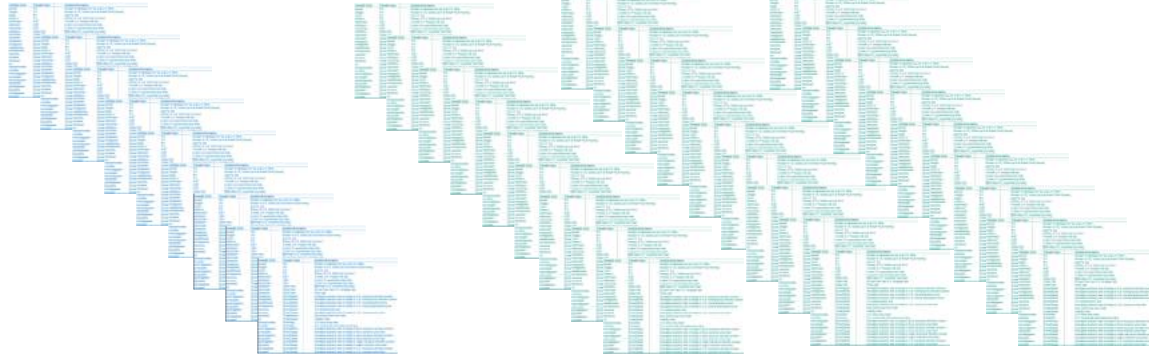
+

Topological Data  
Analysis



# Transforming Data to Insight

| Variable | Type                 | Description                             |
|----------|----------------------|---|
| GDP      | Real GDP             | Number of quarters per year 12. Data    |
| UNEMP    | Unemployment         | Number of 15. Unemployment rate. Data   |
| INT      | Interest Rate        | Number of 3. Risk-free rate. Data       |
| INF      | Inflation            | Number of 1. Inflation rate. Data       |
| CPI      | Consumer Price Index | Number of 1. Consumer Price Index. Data |
| PPI      | Producer Price Index | Number of 1. Producer Price Index. Data |
| YIELD    | Yield                | Number of 1. Yield rate. Data           |
| DEF      | Deficit              | Number of 1. Deficit rate. Data         |
| FED      | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDFUNDS | Federal Funds Rate   | Number of 1. Federal Funds Rate. Data   |
| FEDRES   | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESCH | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESL  | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESM  | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESO  | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESQ  | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESR  | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESY  | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESZ  | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESAA | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESBB | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESCC | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESDD | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESFF | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESGG | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESHH | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESJJ | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESKK | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESLL | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESMM | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESNN | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESOO | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESPP | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESQQ | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESRR | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESSS | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESUU | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESVV | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESWW | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESXX | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESYY | Federal Reserve      | Number of 1. Federal Reserve rate. Data |
| FEDRESZZ | Federal Reserve      | Number of 1. Federal Reserve rate. Data |



**CCAR Supervisory Severe Adverse Scenario Assumptions**

- Supervisory Severe Adverse Scenario, as constructed and presented by the Federal Reserve, assumes a substantially weakened economic environment
- Assume deterioration of all capital planning factors
- Results reflect the impact of stressed economic and market conditions on capital, including:
  - Financial institution's loan loss, market risk, service related loan revaluations and operational and other (not on plan) and off-balance sheet positions
  - Pre-provisioned allowances

**Key Economic Assumptions**

- A. Real GDP (2013 output) - Declines nearly 4.7% (annual) in the first quarter of 2013 and the end of 2014**
- A.1. Real GDP (2013 output) - The four-quarter percent change in the Consumer Price Index (CPI) declines to less than 1% by the end of 2014 and remains below 1% through 2015**
- A.2. Inflation - The four-quarter percent change in the Consumer Price Index (CPI) declines to less than 1% by the end of 2014 and remains below 1% through 2015**
- A.3. Unemployment rate - The unemployment rate increases 6 percentage points from levels at September 30, 2012 (at 7.9%); the unemployment rate remains elevated over the period and reaches a low of 11.6 percent in the middle of 2014. Monthly, the unemployment rate falls into 2014 to end 2015 remains above any level experienced during the past 17 years**
- Unemployment Rate - Falls (peak to trough) - The rate declines 50% during the recovery period**
- Equity Markets - Equity prices fall nearly 80 percent over the course of the recession and the equity market volatility index reaches 8 points in 2014**
- Short-term and long-term yields - Short-term interest rates remain below zero through 2015. The yield on the long-term Treasury security declines to 3% by the end of 2014 before recovering to approximately 4 percent by the end of 2015**
- Event horizon - Assumes an immediate shock occurring from 2009 to 2010 over the period of 2013. As a result, assume zero long-term Treasury yields, corporate borrowing rates (see next slide) peak (and fall) if a percent in mid 2013**
- International - The international component of the economy remains relatively flat over the period from the Euro zone, the United Kingdom, and Japan, and shows the moderate growth in emerging Asia**

Fed Macro  
Variables  
~300

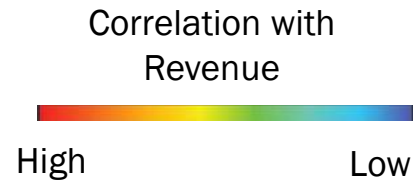
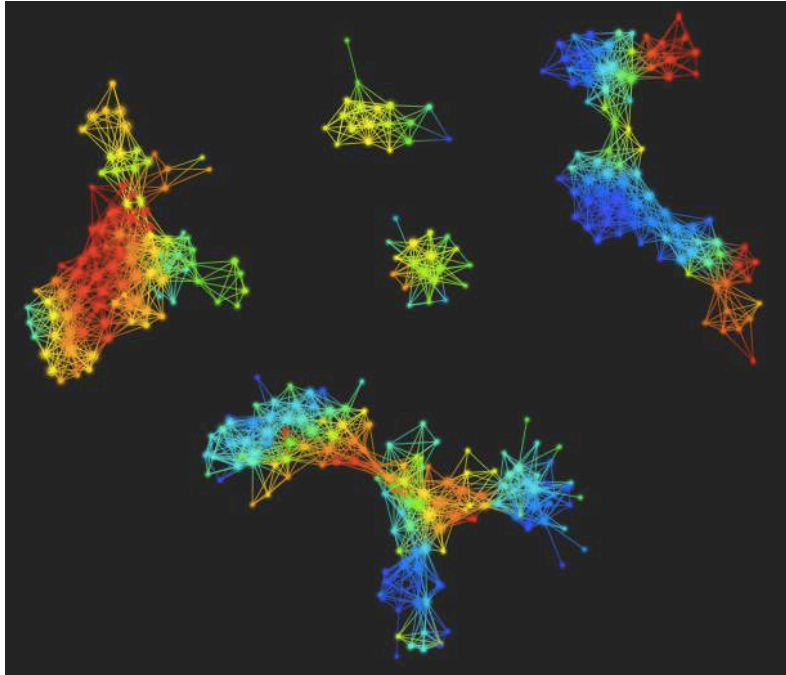
Transforms  
~900

Lagged  
~2700

Distillable  
Model

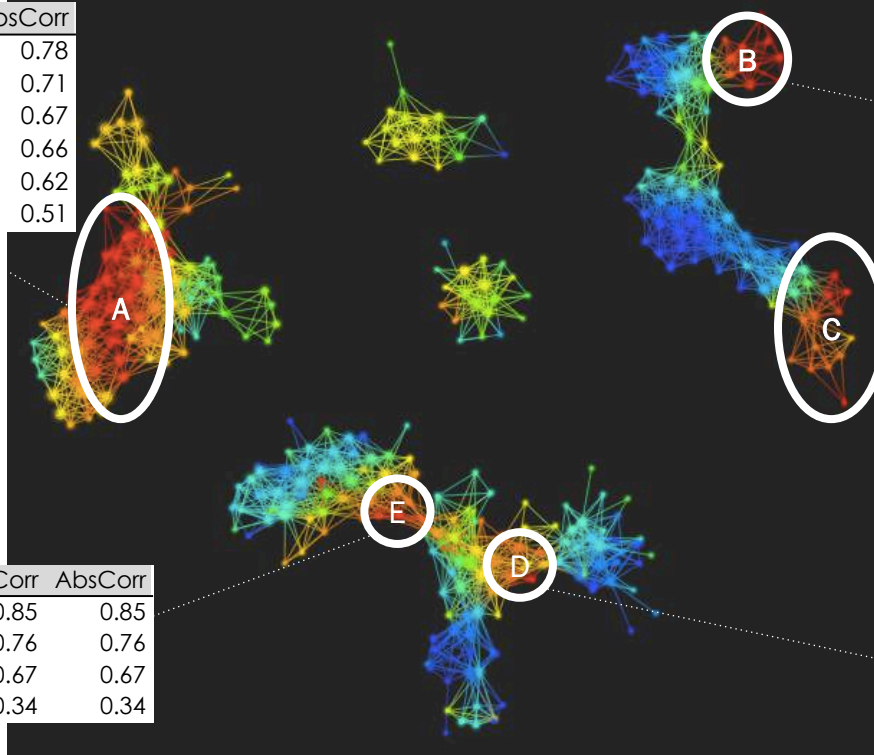


# Correlate Variables with Business Performance



# Identify Statistically Significant Variables

| Group A | Eurozone Interest Rates | Corr  | AbsCorr |
|---------|-------------------------|-------|---------|
|         | Eurozonei1MLibor        | 0.78  | 0.78    |
|         | UKi1MLibor              | 0.71  | 0.71    |
|         | Eurozonei5YrSwap        | 0.67  | 0.67    |
|         | EurozoneUnemployment    | -0.66 | 0.66    |
|         | 20-Bond GO Index_Lag_1  | 0.62  | 0.62    |
|         | UKGB10Yr                | 0.51  | 0.51    |



| Group B | Macro Growth      | Corr  | AbsCorr |
|---------|-------------------|-------|---------|
|         | EurozoneGDP_Index | 0.66  | 0.66    |
|         | UKGDP_Index       | 0.59  | 0.59    |
|         | USUnemployment    | -0.57 | 0.57    |
|         | UKHousing_Lag_2   | 0.47  | 0.47    |

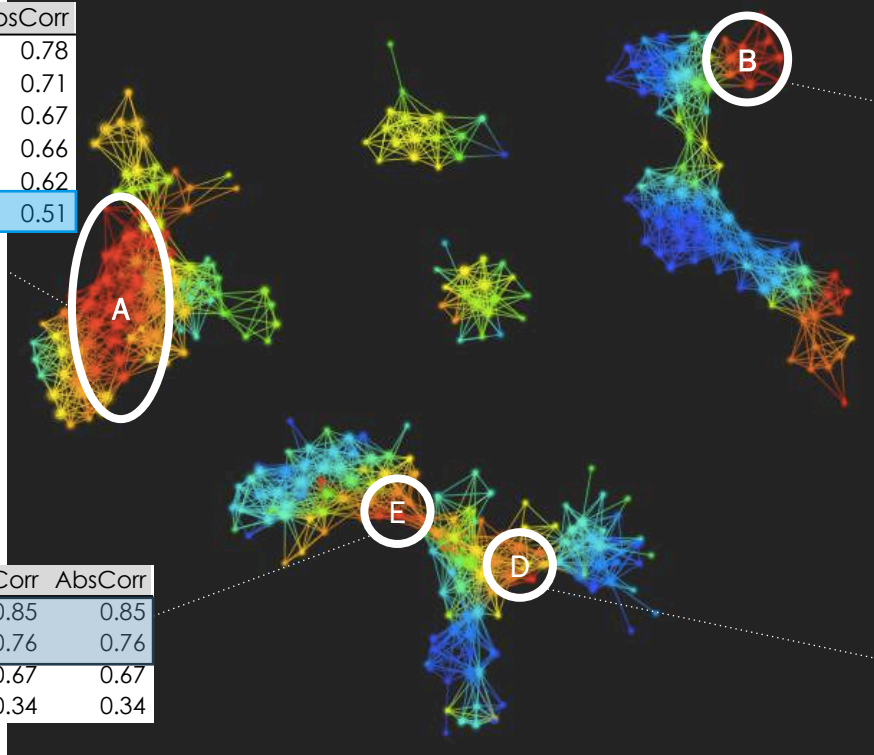
| Group C | Emerging Risk    | Corr  | AbsCorr |
|---------|------------------|-------|---------|
|         | ASIAHangseng     | -0.67 | 0.67    |
|         | MexicoFxrate     | -0.51 | 0.51    |
|         | EMEAMXEMEA_Lag_2 | 0.49  | 0.49    |
|         | UKFxrate         | -0.48 | 0.48    |

| Group E | Funding Stress         | Corr  | AbsCorr |
|---------|------------------------|-------|---------|
|         | TED                    | 0.85  | 0.85    |
|         | LIBOR_less_OIS         | 0.76  | 0.76    |
|         | LIBOR_Less_FED         | 0.67  | 0.67    |
|         | Eurozonei1MLibor_delta | -0.34 | 0.34    |

| Group D | Credit Spreads             | Corr | AbsCorr |
|---------|----------------------------|------|---------|
|         | USCDS_US10YR_BBB_pctChange | 0.70 | 0.70    |
|         | USCDXnonIG_pctChange       | 0.70 | 0.70    |
|         | USCDS_US10YR_A_pctChange   | 0.68 | 0.68    |
|         | USCDS_US25YR_BBB_pctChange | 0.65 | 0.65    |
|         | USCDXIG_pctChange          | 0.58 | 0.58    |

# Identify Statistically Significant Variables

| Group A                 |       | Corr | AbsCorr |
|-------------------------|-------|------|---------|
| Eurozone Interest Rates |       |      |         |
| Eurozonei1MLibor        | 0.78  | 0.78 |         |
| UKi1MLibor              | 0.71  | 0.71 |         |
| Eurozonei5YrSwap        | 0.67  | 0.67 |         |
| EurozoneUnemployment    | -0.66 | 0.66 |         |
| 20-Bond_GO Index_Lag_1  | 0.62  | 0.62 |         |
| UKGB10Yr                | 0.51  | 0.51 |         |

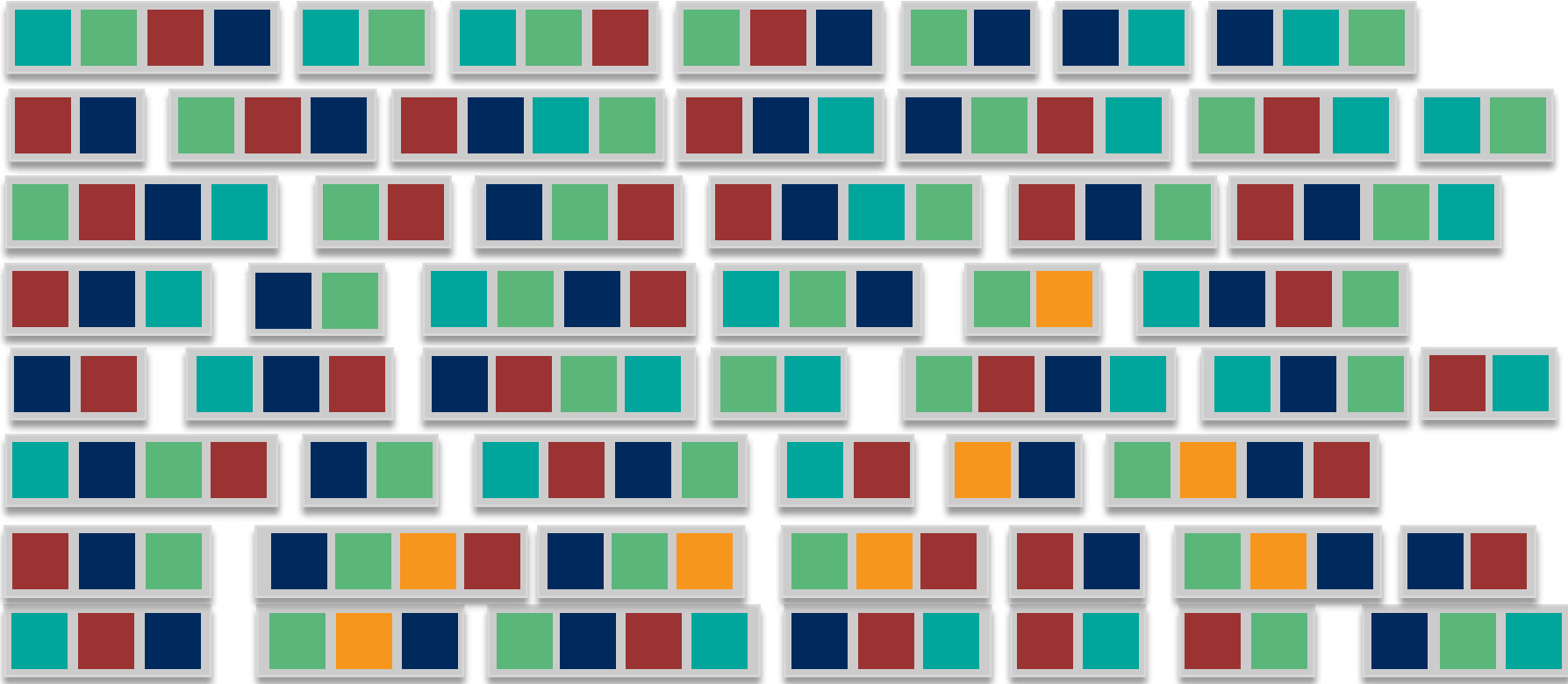


| Group B           |       | Corr | AbsCorr |
|-------------------|-------|------|---------|
| Macro Growth      |       |      |         |
| EurozoneGDP_Index | 0.66  | 0.66 |         |
| UKGDP_Index       | 0.59  | 0.59 |         |
| USUnemployment    | -0.57 | 0.57 |         |
| UKHousing_Lag_2   | 0.47  | 0.47 |         |

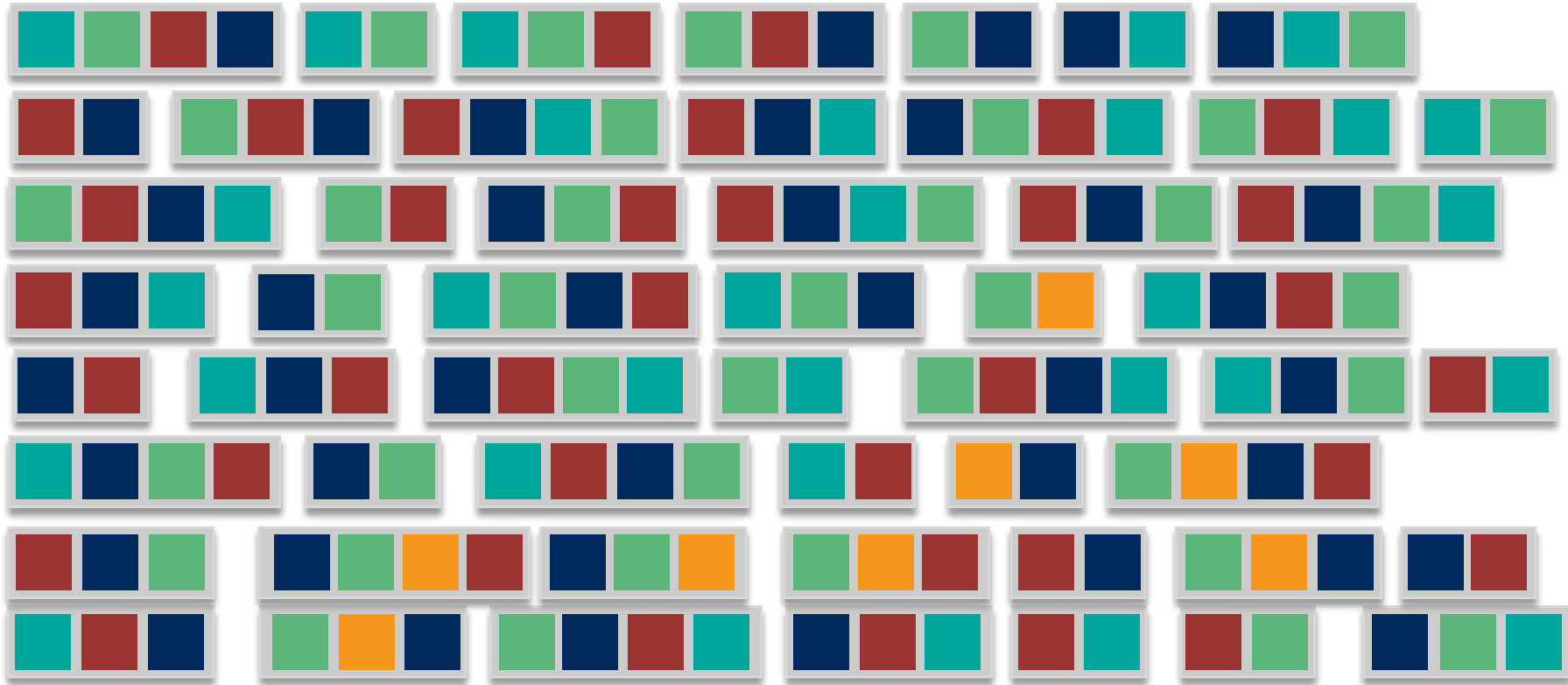
| Group E                |       | Corr | AbsCorr |
|------------------------|-------|------|---------|
| Funding Stress         |       |      |         |
| TED                    | 0.85  | 0.85 |         |
| LIBOR_less_OIS         | 0.76  | 0.76 |         |
| LIBOR_Less_FED         | 0.67  | 0.67 |         |
| Eurozonei1MLibor_delta | -0.34 | 0.34 |         |

| Group D                    |      | Corr | AbsCorr |
|----------------------------|------|------|---------|
| Credit Spreads             |      |      |         |
| USCDS_US10YR_BBB_pctChange | 0.70 | 0.70 |         |
| USCDXnonIG_pctChange       | 0.70 | 0.70 |         |
| USCDS_US10YR_A_pctChange   | 0.68 | 0.68 |         |
| USCDS_US25YR_BBB_pctChange | 0.65 | 0.65 |         |
| USCDXIG_pctChange          | 0.58 | 0.58 |         |

# Generate Permutation Set of Models



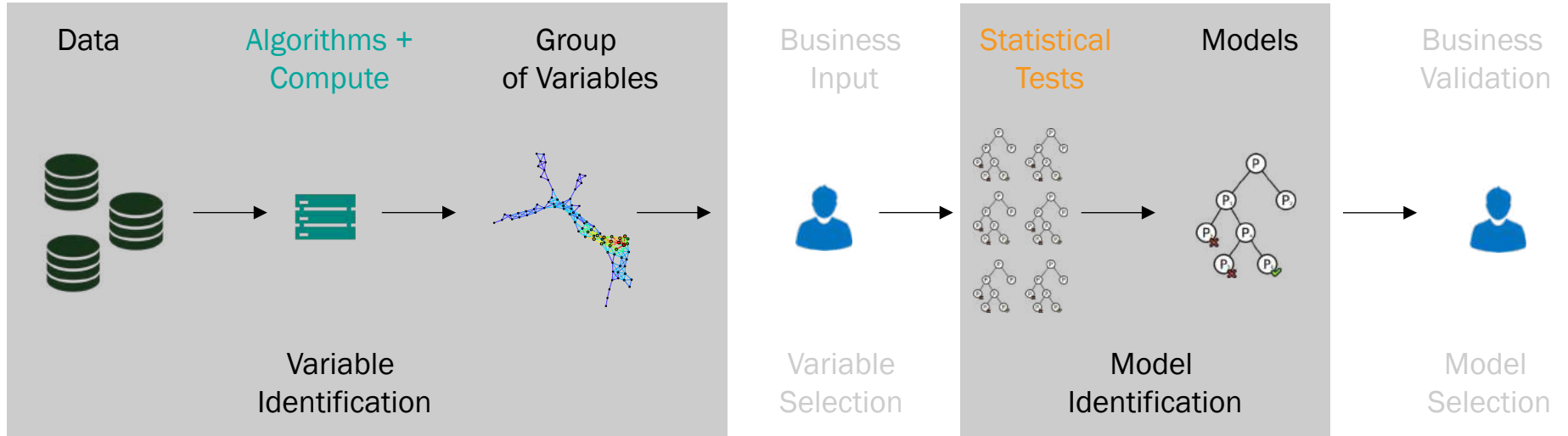
# Select for Empirical Validity



# Identify the Champion Model



# A Man-Machine Workflow





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