

# Forecasting Analytics

Professor Casey Lichtendahl (Classes 1-5)

Professor Galit Shmuéli (Classes 6-10)



## What You Can Learn

techcrunch.com/2013/01/15/book-now-or-wait-kayak-brings-price-forecasting-to-its-flight-search-results/

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flight +  
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kayak +  
Apps -

### Book Now Or Wait? Kayak Adds Price Forecasting To Its Flight Search Results

Posted Jan 15, 2013 by Rip Empson (@ripemp)

Like 0 Tweet 864 Share 0

Next Story

**KAYAK** Flights Hotels Cars Deals

New York, NY Los Angeles, CA 12/25/2012

Hide toolbox -  
Price alert Fare charts  
Airline feed Add baggage  
Airline Matrix +/- 3 days

483 of 1340 flights show all

Check Prices Virgin America  
Fly with WiFi, on-demand to Virgin America

Price Trend  
Prices may rise within 7 days

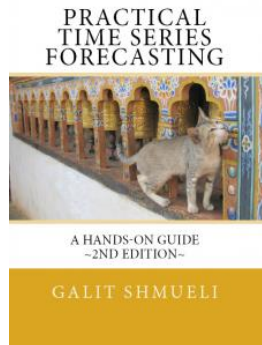
Book now \$746 US Airways

It was just over two months ago that Kayak and Priceline sent ripples through the online travel industry with a blockbuster deal in which Priceline shelled out a whopping \$1.8 billion to acquire the

### Related Videos

Fly or Die: TYLT Energy+ Backpack

## Technical stuff: Outside of class



[ForecastingBook.com](http://ForecastingBook.com)

### Deliverables

- 3 Assignments
- 1 Group Project

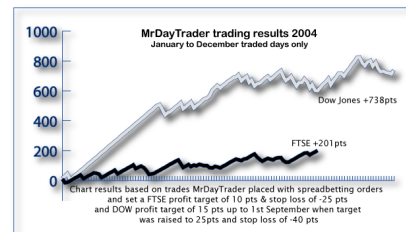
**LMS** Indian School of Business



## WHY FORECAST?

“Forecast”= predict the future value  
of a time series

## Time Series Everywhere



### Explore flu trends around the world

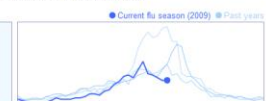
English | [Español](#)

We've found that certain search terms are good indicators of flu activity. Google Flu Trends uses aggregated Google search data to estimate flu activity up to two weeks faster than traditional systems. [Learn more.](#)

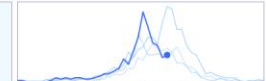
#### Southern hemisphere

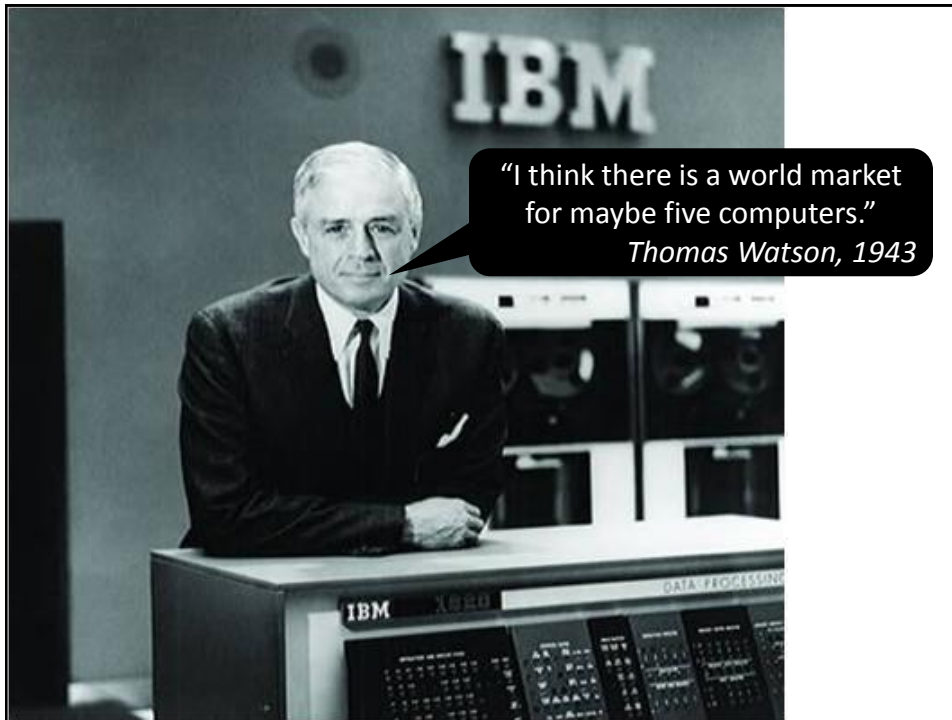
Influenza is currently more active in the southern hemisphere, where flu season typically spans from May to September, the southern autumn and winter months.

Australia Low



New Zealand Moderate





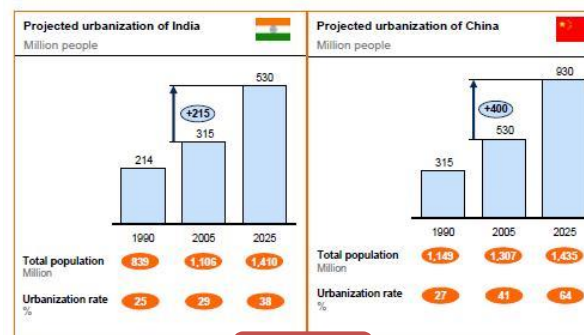
## Who generates forecasts?

Governments  
NGOs

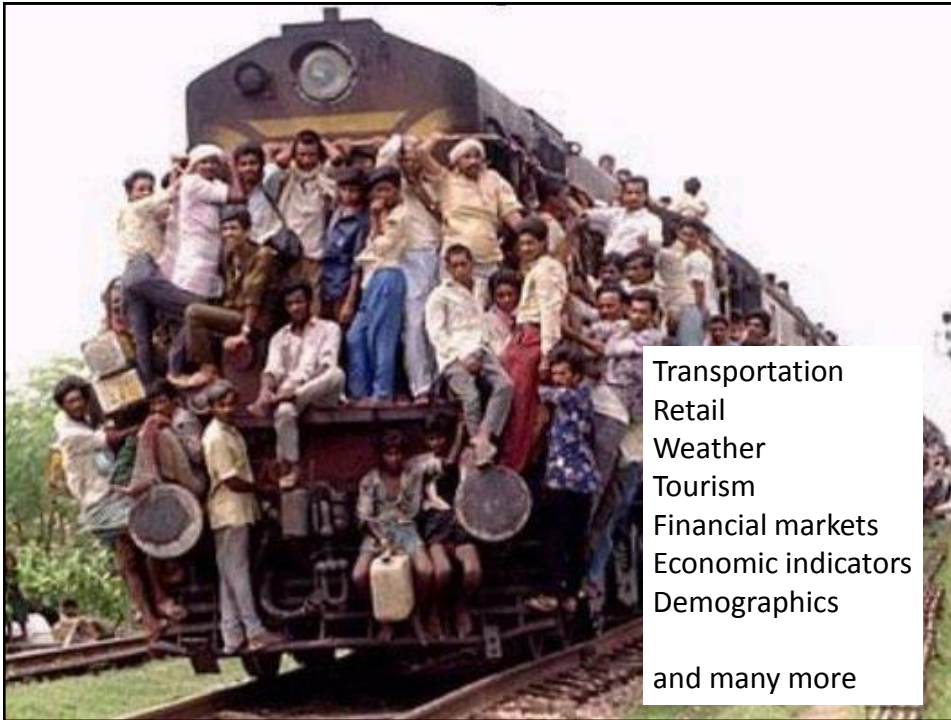
Corporates  
Private sector

Consulting firms

China is more urbanized than India today and will urbanize more quickly



SOURCE: India Urbanization Econometric Model; McKinsey Global Institute; China All City Model



## Forecasting Retail Sales of \$1 Billion

### Zappos

Company

Zappos.com is an online shoe and clothing shop currently based in Las Vegas, Nevada. In July 2009, the company announced it would be acquired by Amazon.com in an all-stock deal worth about \$1.2 billion. [Wikipedia](#)

**Customer service:** +1 800-927-7671

**CEO:** [Tony Hsieh](#)

**Founder:** [Nick Swinmurn](#)

**Founded:** 1999





“We have to plan well in order to keep our fulfillment center operating efficiently!”

– Amanda Nevins, Zappos.com

- two fulfillment centers in Shepherdsville, KY (near UPS hub)
- automated warehouse 24/7, not the most efficient way to run a warehouse, but it gets the orders out to our customers as quickly as possible
- a lot of customers order as late as midnight Eastern Standard Time and their orders show up on their doorstep 8 hours later
- 1 out of every 60 OVERNIGHT packages shipped by UPS is a Zappos box
- **we primarily use historical data, trends, and buyer/ financial experience to set financial and operating plans using excel**



www.manh.com/solutions/planning-and-forecasting/demand-forecasting

Galit Shmueli | Scom Viz | Scribter | Forecasting Hyndman | Forecasting Course ... | Stack Exchange | Viz | Import to Mendeley | Cowles 10-15 | Ar

## Manhattan Associates

The Supply Chain People.

**Solutions** | Platforms | Industries | Service

Home » Solutions » Planning and Forecasting » Demand Forecasting

### Demand Forecasting

Manhattan Associates' Demand Forecasting software manages the delicate balancing act between supply and demand, between minimizing inventory investment and optimizing revenue opportunities. It is a sophisticated, yet easy-to-use tool for managing the complex forecasting challenges that overwhelm many retailers and wholesalers, including demand cleansing, seasonal profiling, demand forecasting and exception management.

- **Demand cleansing.** Promotions, markdowns, weather and entry errors are just some of the factors that can distort your forecasts. Demand Forecasting has built-in demand cleansing so you won't be misled by these anomalies.
- **Seasonal profiling.** Seasonal profile management in Demand Forecasting automatically accounts for seasonal curves related to moving holidays, has advanced profiling science that selects and assigns the best profile from multiple profile/aggregation iterations, and can optionally do an automatic refresh of profiles just before an SKU comes into its next season.
- **Demand forecasting.** Whether initializing a forecast for the first time, re-initializing after a structural change in demand history or updating the forecast based on recent demand, Demand Forecasting uses our proprietary Unified Forecast Method™ to dynamically sense demand and adapt the proper forecasting components from multiple forecast methodologies to provide the best demand forecast scenario.
- **Exception management.** Our Advanced Exception Management gives you the flexibility to adjust the logic and business rules that govern the creation and management of exceptions. This feature improves productivity by enabling automatic detection and self-correction of many problems including conditional proactive re-adjustment of forecasts.

Contact a Manhattan representative to learn more about how Demand Forecasting can tackle the statistical heavy lifting, while you benefit from the best-trended, seasonally adjusted forecasts possible.

**Office Locations**

**Americas**

**Corporate Headquarters**

Manhattan Associates  
2000 Wood Ridge Parkway  
10th Floor  
Atlanta, GA 30339  
View Map  
+1 770.955.7070  
+1 770.955.0300

Manhattan Associates  
1155 N. Meridian Street  
Suite 520  
Carmel, IN 46032  
View Map  
+1 317.568.5266  
+1 317.568.0664

**Manhattan Minute: Manhattan Associates Unified Forecasting Method™**

**Explore The Solution**

Case Studies | Events

## The Forecast Analyst

Provides decision makers with **forecasts** of

- Sales
- Cash flow
- Inventory
- Cost
- Workload
- Demand, etc.

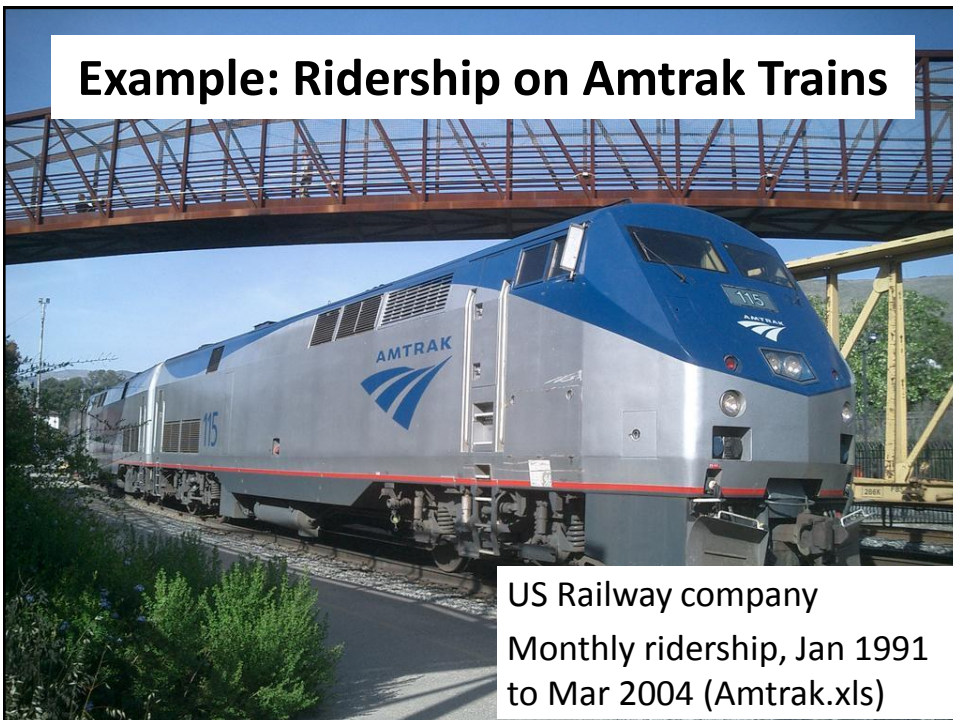
The **value and limitation** of the forecasts



## Time series vs. cross-sectional data



### Example: Ridership on Amtrak Trains



US Railway company  
Monthly ridership, Jan 1991  
to Mar 2004 (Amtrak.xls)



## Basic Notation

$t=1,2,3\dots$  = time period index

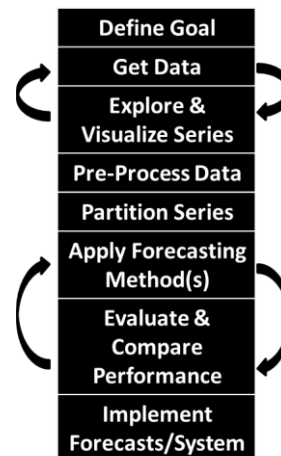
$Y_t$  = value of the series at time period  $t$

$F_{t+k}$  = forecast for time period  $t+k$ ,  
given data until time  $t$

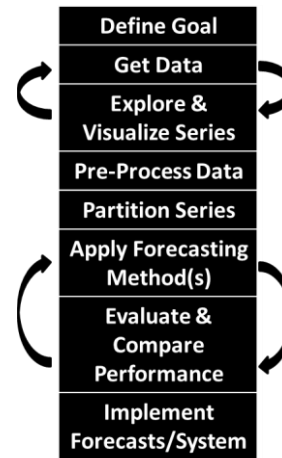
$e_t$  = forecast error for period  $t$

Month	Ridership
1/1/1991	1709
2/1/1991	1621
3/1/1991	1973
4/1/1991	1812
5/1/1991	1975
6/1/1991	1862
7/1/1991	1940
8/1/1991	2013
9/1/1991	1596
10/1/1991	1725
11/1/1991	1676
12/1/1991	1814
1/1/1992	1615
2/1/1992	1557
3/1/1992	1891
4/1/1992	1956
5/1/1992	1885
6/1/1992	1623
7/1/1992	1903
8/1/1992	1997
9/1/1992	1704
10/1/1992	1810

## The Forecasting Process



## GOAL DEFINITION



### #1: Is the goal descriptive or predictive?

Descriptive = *time series analysis, retrospective, explanatory*

Predictive = *time series forecasting, prospective*

## #2: What is the forecast horizon?

How far into the future? ( $k$  in  $F_{t+k}$ )

Rolling forward or at single time point?

One-time forecasting, or ongoing task?

### **Implications:**

How much data is needed?

Choice of forecasting methods

Expected levels of accuracy

Performance evaluation

Model deployment

## #3: How will the forecast(s) be used?

Who are the stakeholders?

Numerical or event forecast?

Cost of over-prediction and under-prediction

Will forecasts undergo “adjustments”?

## #4: Forecasting expertise and automation

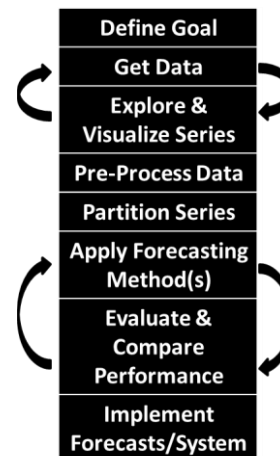
In-house forecasting or consultants?

How many series? How often?

One-time forecasting or ongoing?

Data and software availability

### DATA COLLECTION



## **#1: Data Quality**

Typically small sample, so need good quality

Data same as series to be forecasted

## **#2: Temporal Frequency**

Should we use real-time ticket collection data?

Balance between signal & noise

Sometimes: aggregation, modeling, aggregated forecasts, then disaggregation

### #3: Series Granularity

Coverage of the data

Geographical, population, time,...

Should be aligned with goal!

Implications: zero/low counts vs. mixed populations



Particular routes

Particular populations  
(senior citizens, children)

Particular days (weekends)

### #4: Domain Expertise

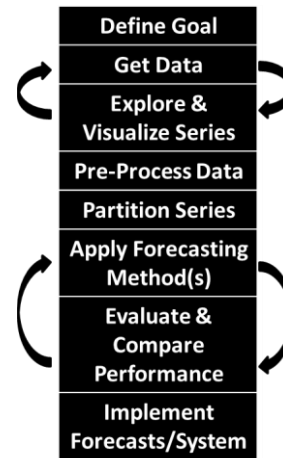
Necessary information source!

Affects modeling process from start to end

Level of communication/coordination between  
forecasters and domain experts



## EXPLORE & VISUALIZE SERIES



## Time Series Components

### Systematic part

- Level
- Trend
- Seasonal patterns

### Non-systematic part

- “Noise”

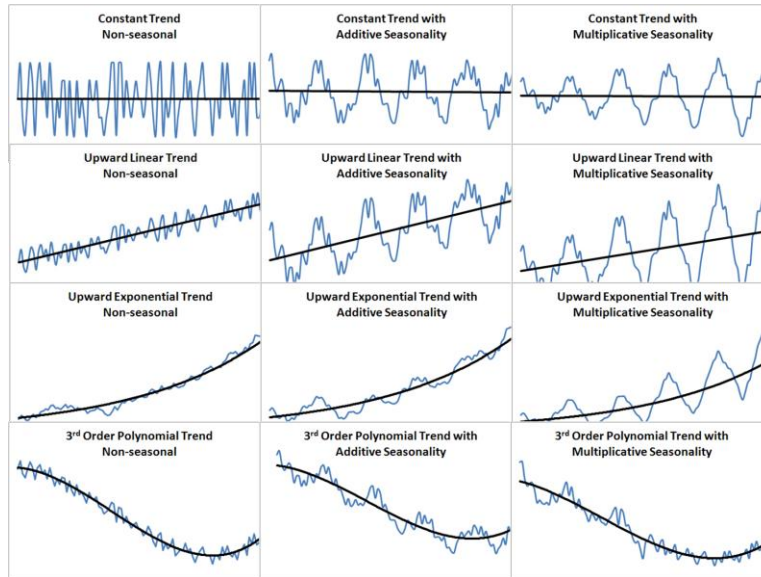
*Additive:*

$$Y_t = \text{Level} + \text{Trend} + \text{Seasonality} + \text{Noise}$$

*Multiplicative:*

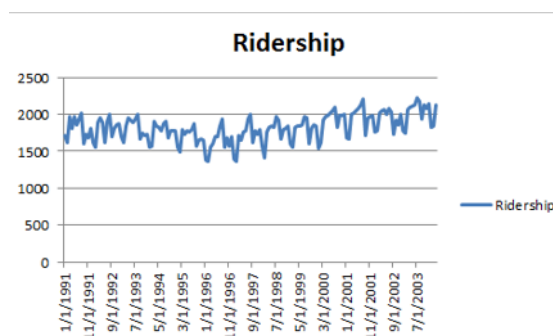
$$Y_t = \text{Level} \times \text{Trend} \times \text{Seasonality} \times \text{Noise}$$

## Time series components



The Amtrak ridership series contains which components? (choose 1 or more)

1. Level
2. Trend
3. Seasonality
4. Noise

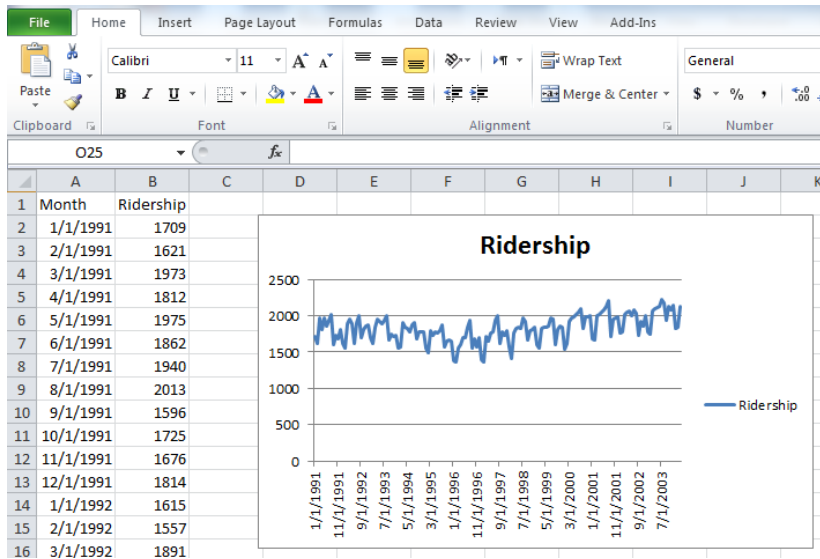




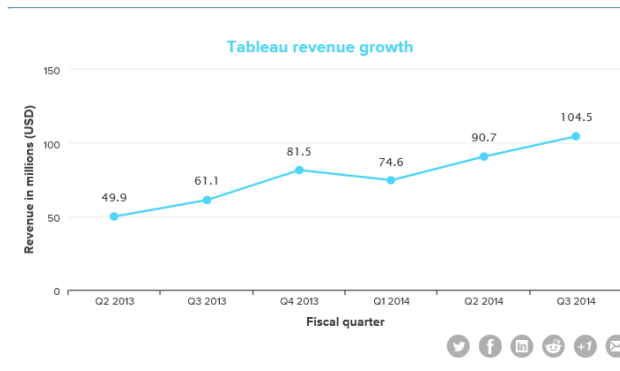
## Visualizing Time Series

- Why visualize? Why interactively?
- Introduction to Tableau software
- Visualizing past data, levels, trendlines, seasonality, forecasts

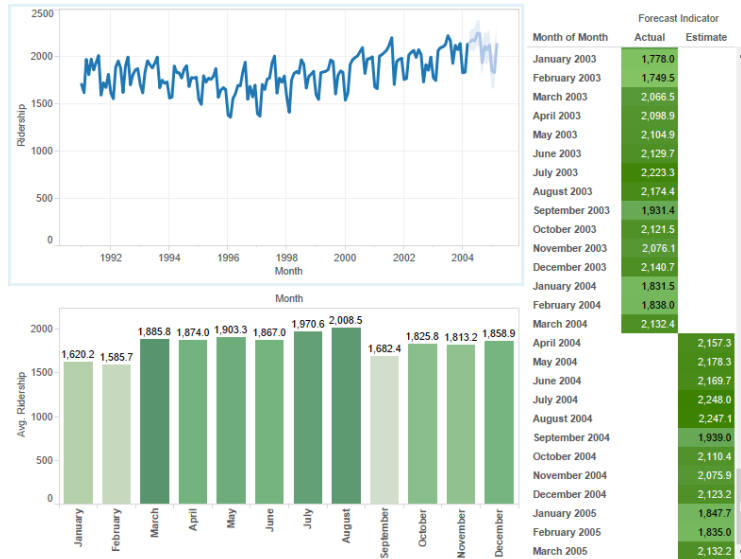
# Microsoft Excel



# Tableau



## Interactive Visualization: Tableau Dashboard

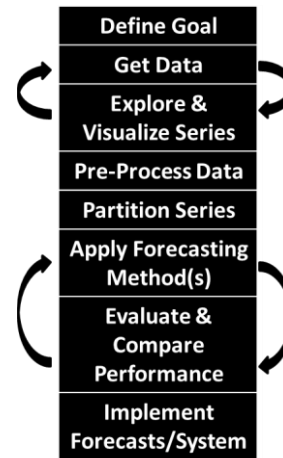


## Interactive Visualization

- Zoom and pan
- Filtering
- Change of scale
- Temporal hierarchies and aggregation
- Color
- Dashboards

Supports **detecting patterns** and **exceptions**

## PRE-PROCESS DATA



Before modeling, we must **detect** potential challenges

- Missing values
- Unequally-spaced series
- Extreme values
- Time span (how far back?)

Good visualization is very useful



Before next class

Send team names  
(5 students) to AA

