

# Learning the Learner, Using Machine Learning to Track the Performance of Machine Learning Algorithms

Ira Cohen, Chief Data Scientist  
6<sup>th</sup> June, 2016



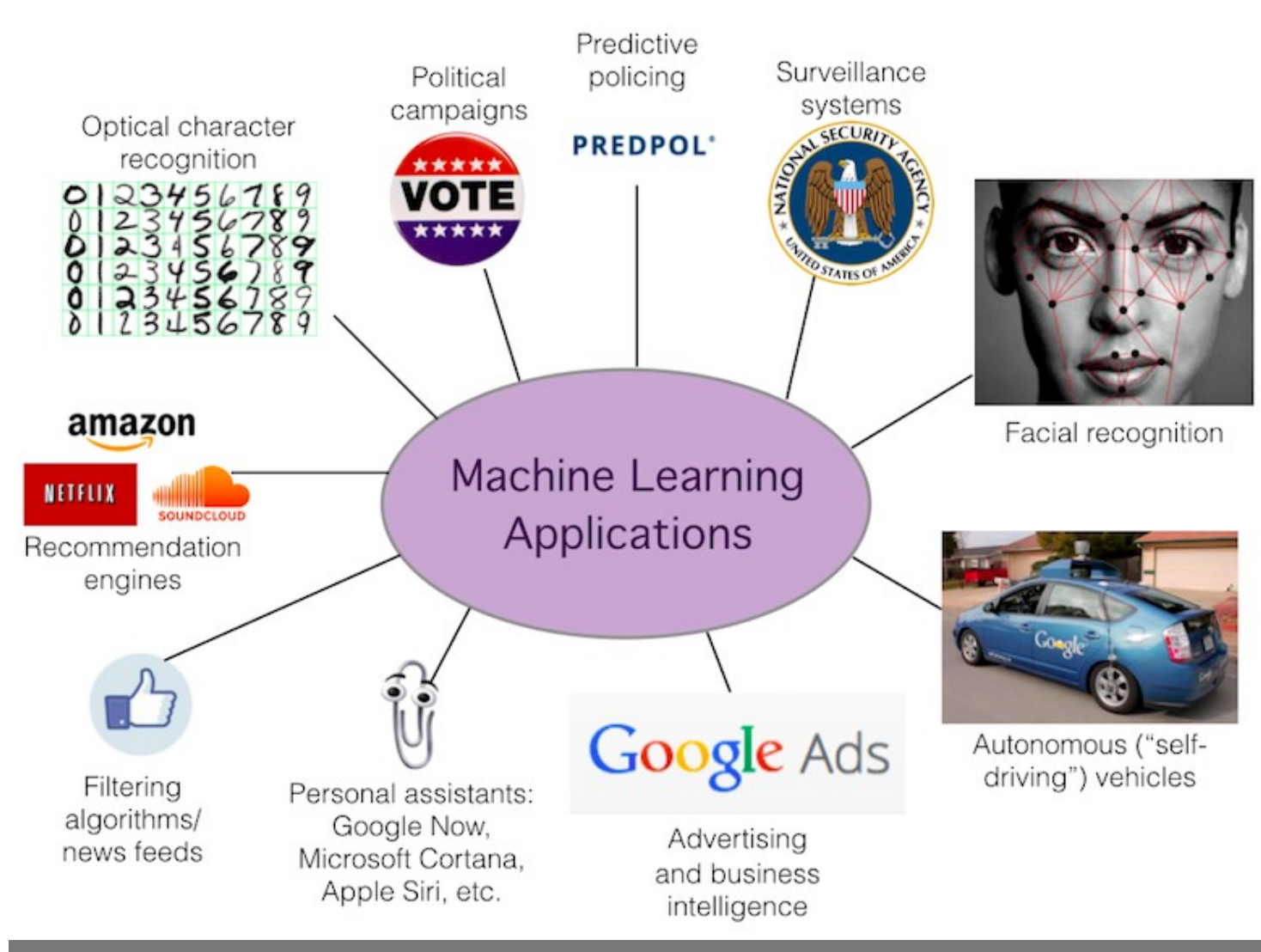
**Gartner**

**Cool  
Vendor  
2016**

# Machine Learning used to be about publishing papers at NIPS and ICML...



# The coming of age of Machine Learning...



and now it is sexy...

**DATA SCIENTIST**  
THE SEXIEST JOB OF THE 21ST CENTURY

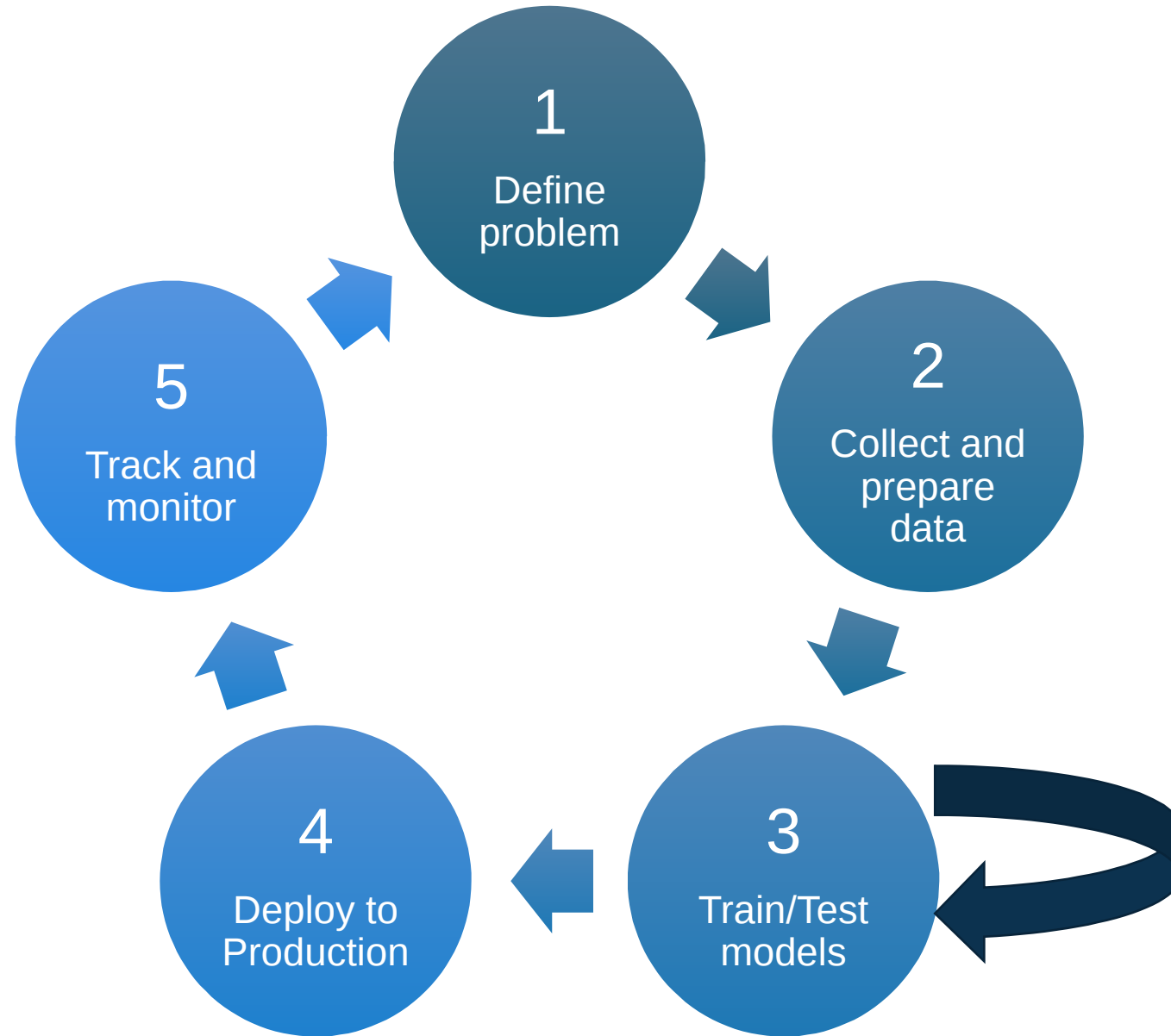
87% 36% 24%

TIME ZONES

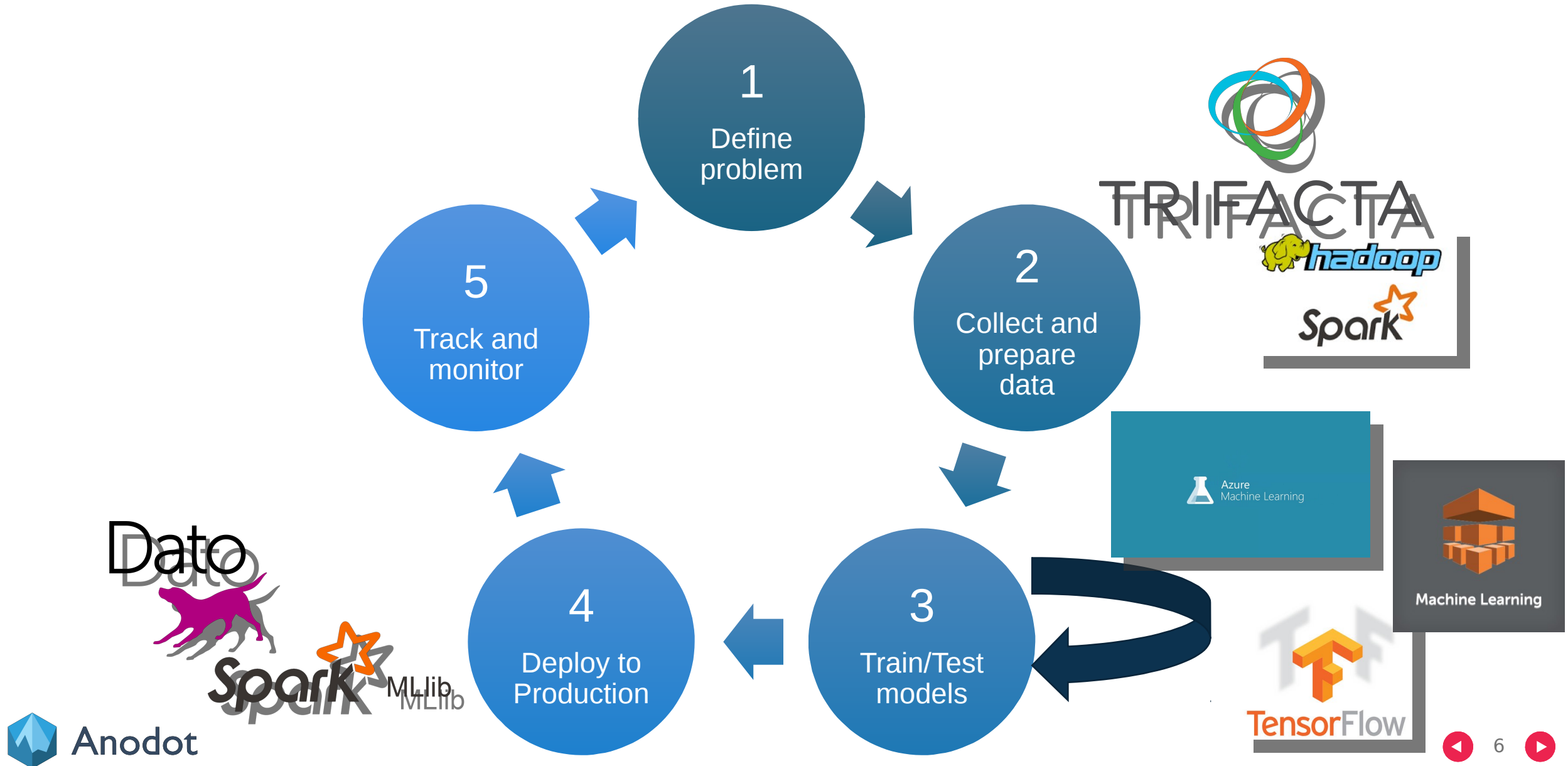
**15 MARCA 2013 WYDZIAŁ INFORMATYKI ZUT**  
KONFERENCJA W SALI 126 W12 ZUT UL. ŻOŁNIERSKA 52 GODZ 10.00 | AFTERPARTY GODZ 20.00

UNIVERSITY OF ZUT  
KNM MARKETING  
Bigbit  
BRAINS  
ZUT

# The Practical Machine Learning Process



# The Practical Machine Learning Process: The race for automation...



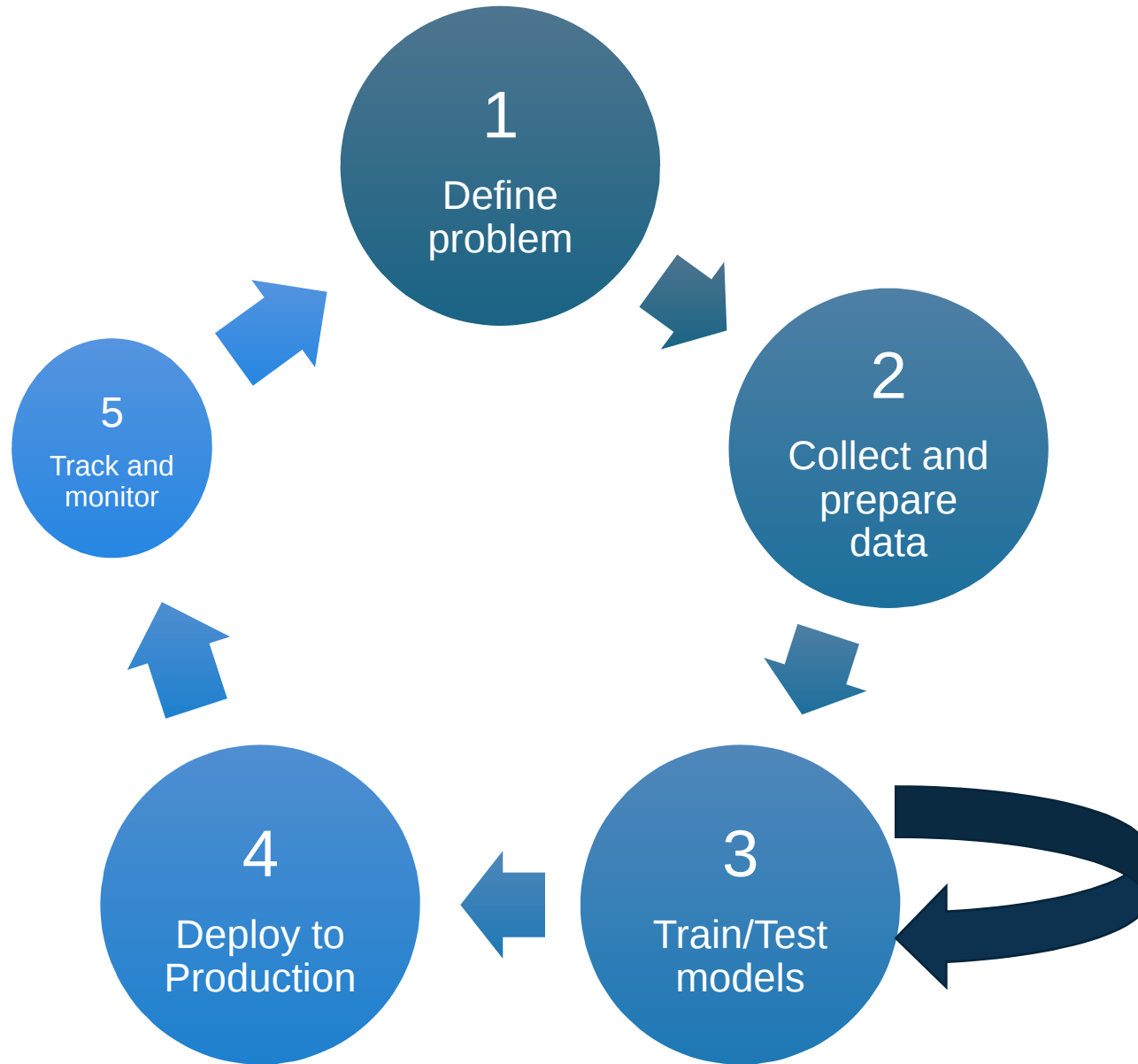


# Lots of tools/platforms/solutions !

## MACHINE INTELLIGENCE 2.0

AGENTS			AUTONOMOUS SYSTEMS			
<b>PROFESSIONAL</b> Howdy! x.ai @ clara KASIST DigitalGenius OVERLAP.CC meekan fuse machines PRIMER	<b>PERSONAL</b> facebook XIAOICE assistant.ai large nestor @wesome Magic	<b>OS INTERFACES</b> Siri Cortana VIV maluba api.ai COGNEA Google Now	<b>AIR</b> SDR DJI PROJECT LOON VERTICAL DroneDeploy AIRDOG SKYCATCH SKYDIO Airware LILY	<b>GROUND</b> Google UBER TESLA CRUISE MOBILEYE COMMA AdasWorks	<b>SEA</b> LIQUID ROBOTICS bluefin data OPENRV BluHaptics	<b>INDUSTRIAL</b> KIVA Systems fetch HARVEST CLEARPATH AVIDBOTS ENERGID rethink robotics GREYORANGE OSARO
ENTERPRISE						
<b>SECURITY / FRAUD</b> Sentinel graphistry BITSIGHT feedzai AREA1 drawbridge siftscience CYCLANCE Brighterion	<b>HR / RECRUITING</b> textio hiQ gild SpringRole entelo unilive GIGSTER	<b>SALES</b> sense clari infer Preact Gainsight AVISO salespredict sentient Vidora people pattern Prism	<b>MARKETING</b> LiftIgniter RADIUS brightfunnel retention AIRPR	<b>CUSTOMER SUPPORT</b> CLARABRIDGE QUANTIFIND Wiseio ACTIONIQ FRAMED DigitalGenius	<b>INTERNAL INTEL</b> Alation ADATAO Palantir sapho lucid Rainbird SKIPFLAG ogolo Digital Reasoning Narrative Science	<b>MARKET INTEL</b> Quid mattermark DataFox bottlenose PREMISE enigma CB INSIGHTS
PLATFORMS						
<b>RESEARCH / AGI</b> OpenAI vicarious Google DeepMind Numanta Cyncorp nna:sense SCALED INFERENCE 格CURIOUS GEOMETRIC INTELLIGENCE	<b>FULL STACK</b> context relevant CognitiveScale NVIDIA TERADEEP QUALCOMM nervana SYSTEMS	<b>MACHINE LEARNING</b> Dato rapidminer cortical.io AYASDI amazon Azure nario:logics PredictionIO SKYTREE big blueyonder	<b>INDUSTRIAL IOT</b> ThingWorx UPTAKE IMUBIT Preferred Networks Alluvium xively PLANET OS	<b>AUDIO</b> Gridspace TalkIQ nexidia vocaliq NUANCE Expect Labs popUP archive	<b>VISION</b> ORBITAL INSIGHT Descartes Labs DEXTRO cortica clarifai MetaMind	<b>DATA ENRICHMENT</b> diffbot Paxata TRIFACTA IDIBON WorkFusion loop CrowdFlower
INDUSTRIES						
<b>ADTECH</b> ADTHEORETIC dstillery BEYONDVERBAL METAMARKETS TAPAD rocketfuel affectiva	<b>AGRICULTURE</b> BLUE RIVER tute TerraVision mavrx THE CLIMATE CORPORATION CERES HONEYCOMB	<b>FOR GOOD</b> Conservation Metrics DataKind thorn BAYES IMPACT	<b>RETAIL FINANCE</b> inVenture Affirm earnest MIRADOR Lendo finance LendUp	<b>LEGAL</b> Everlaw RAVEL LEGAL ROBOT 3seal BEAGLE ROSS Lex Machina	<b>MATERIALS &amp; MFG</b> zymergen AUGMATE GINKGO BIOWORKS TRINITECHNOLOGIES CALCULARIO Eigen Innovations	<b>HEALTHCARE</b> deep genomics 3SCAN enlithic Calico Atomwise Recombine color METABIOTA GRAND ROUNDS Google Sciences IBM Watson Health
INDUSTRIES (CONT'D)			TECH USER TOOLS			
<b>EDUCATION</b> KNEWTON coursera turnitin gradescope UDACITY KHANACADEMY	<b>TRANSPORT &amp; LOGISTICS</b> NAUTO taleris PRETECKT clearmetal	<b>INVESTMENT FINANCE</b> Bloomberg Quantopian Dataminr KENSHC ISENTIUM NEURENSIC alphasense	<b>DATA SCIENCE</b> DOMINO kaggle Sentana sense yseop Outlier yhat DataRobot	<b>MACHINE LEARNING</b> Cortana Analytics AlchemyAPI glowfl.sh IBM Watson Platform Anodot MonkeyLearn (h [s]) HyperScience fuzzy.io SIGOPT Oxdath.o SPARKBEYOND indico	<b>OPEN SOURCE</b> SKYMIND TensorFlow seldon Caffe theano Spark MLlib Microsoft Py spaCy DL4J SciKit CGT	

# The Practical Machine Learning Process – The overlooked 5<sup>th</sup> step...





# Monitoring and Tracking

But How to Track and Monitor?  
Manually is **NOT** an option...

Step 1

Define performance  
metrics and expected  
behavior

Step 2

Collect metrics  
continuously in production

Step 3

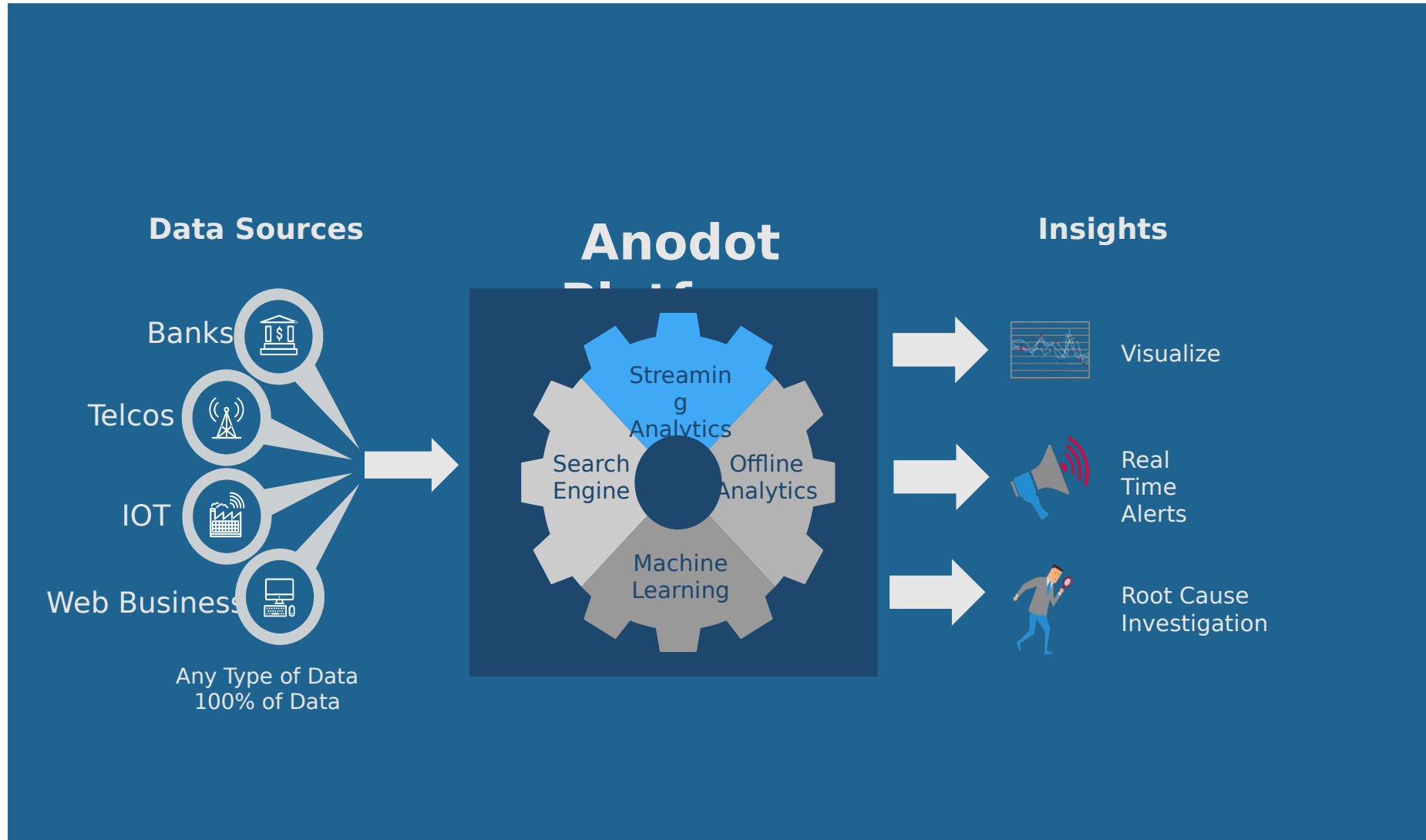
Track for unexpected  
changes in metrics



Anomaly Detection

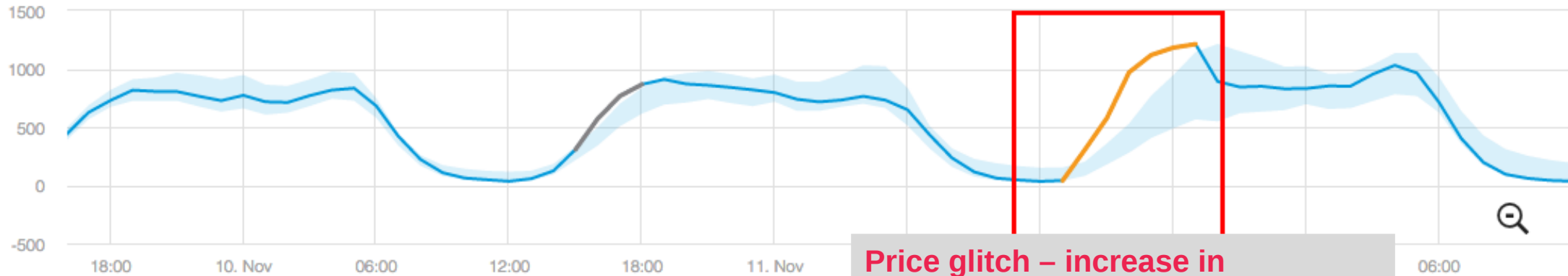


# Anodot's Business Incident Detection Platform



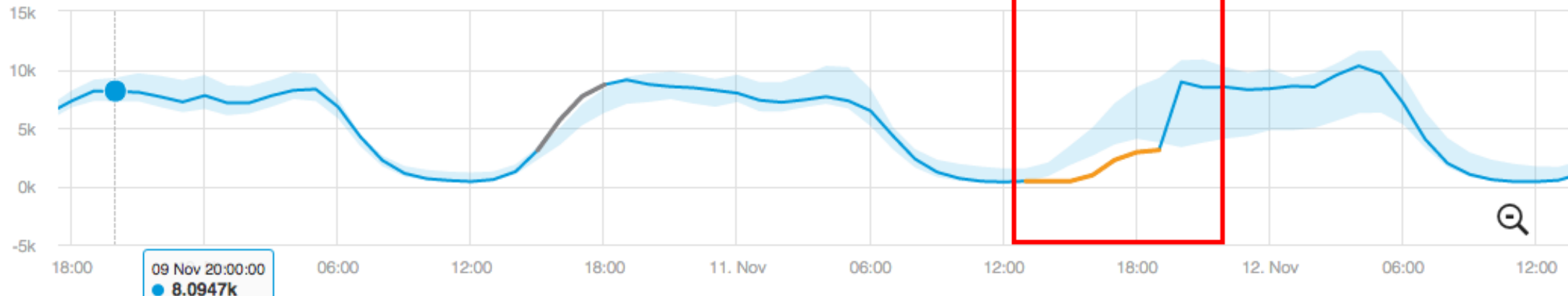
# Detecting Business Incidents: Anomaly Detection

gift\_cards.what=numPurchases



Price glitch – increase in purchases / decrease in revenue

gift\_cards.what=hourlyRevenue



# Anomaly detection: Detecting the Unknowns □ Saves Time + Money

## Web Services

Detecting business incidents + unknown business opportunities

## Industrial IoT

Proactive Maintenance  
Detecting issues in factories/machines

## Security

Detection of unknown breach/attack patterns

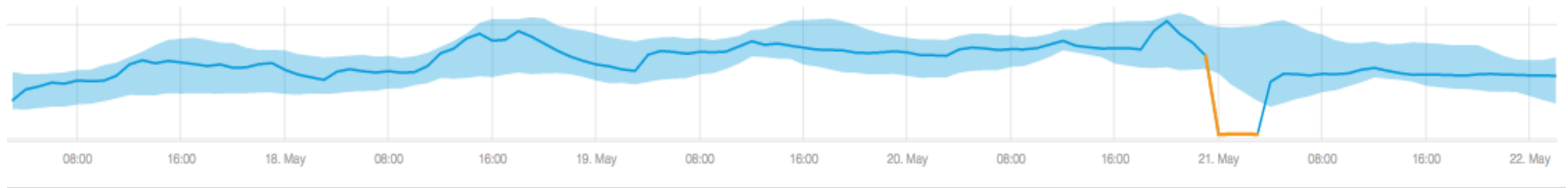
## Machine Learning

Closing the “Machine Learning” loop  
Tracking and detecting “unknowns” not modeled during training



# Detecting Unknowns of ML in Production: Anomaly Detection

Classification accuracy over time

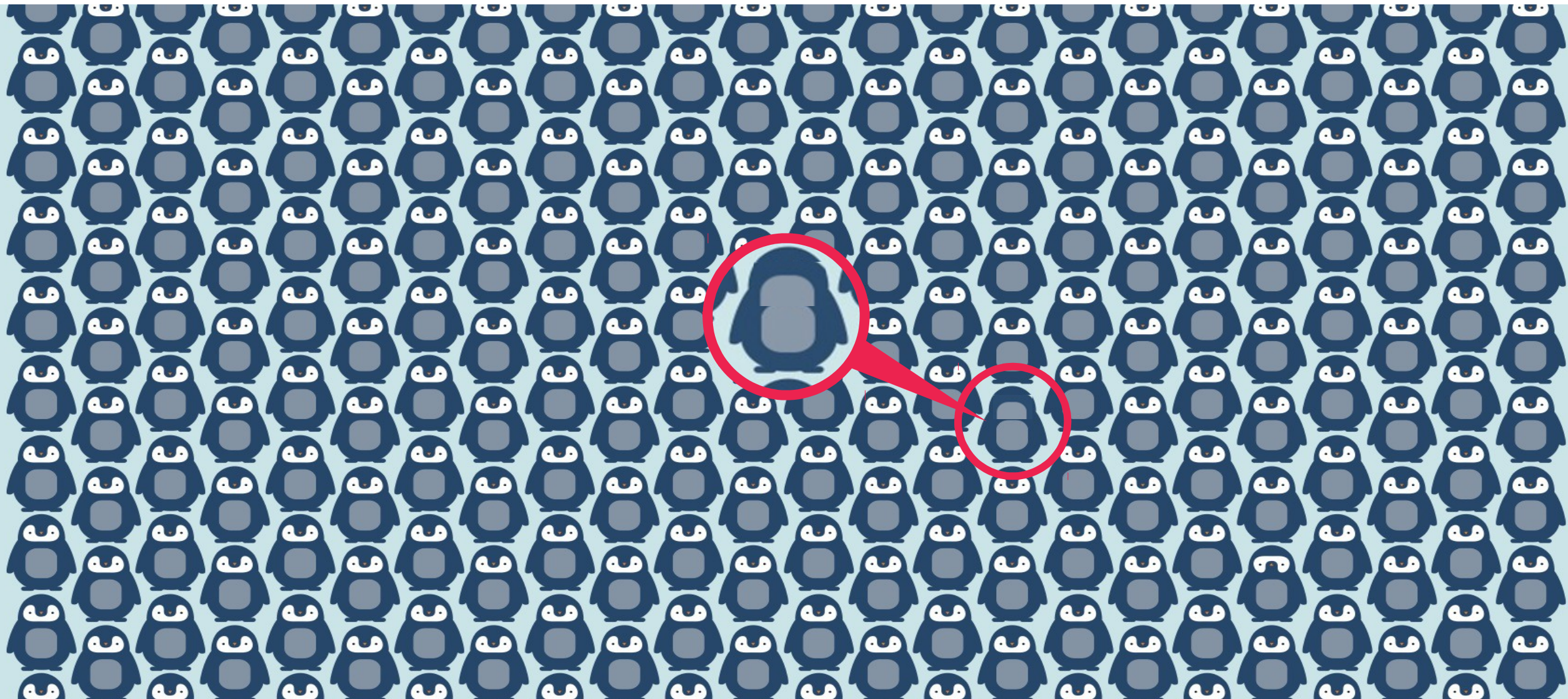




What is Anomaly Detection?



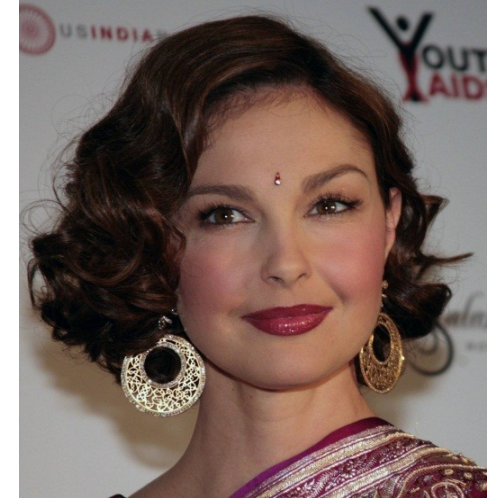
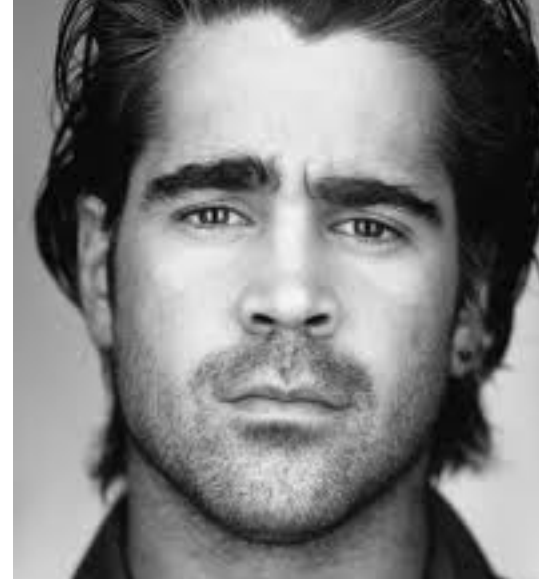
# Find the Anomaly



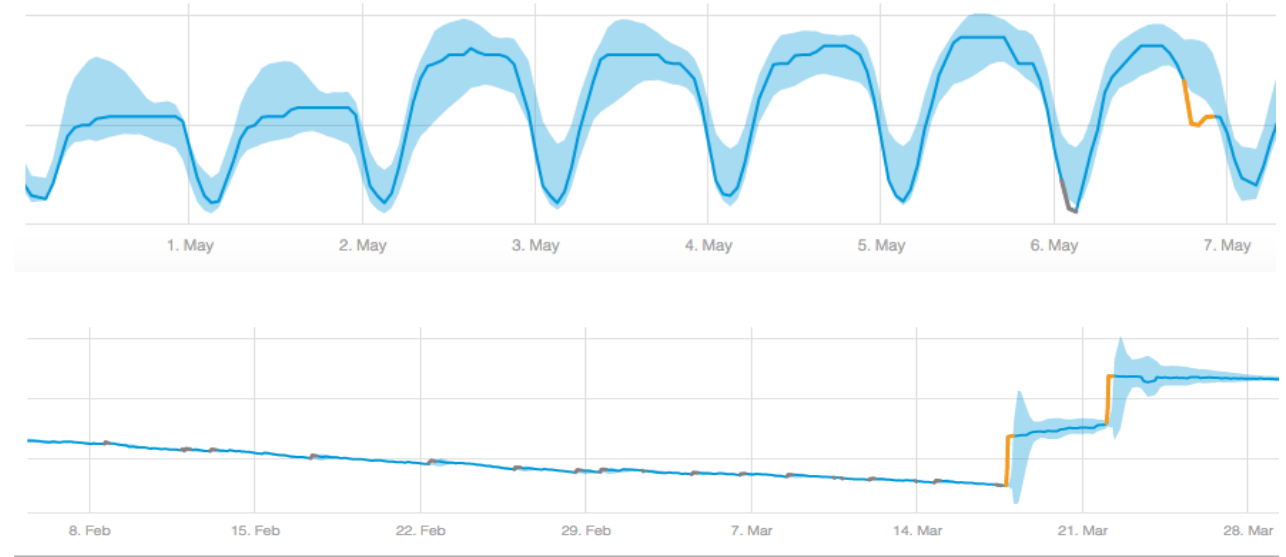
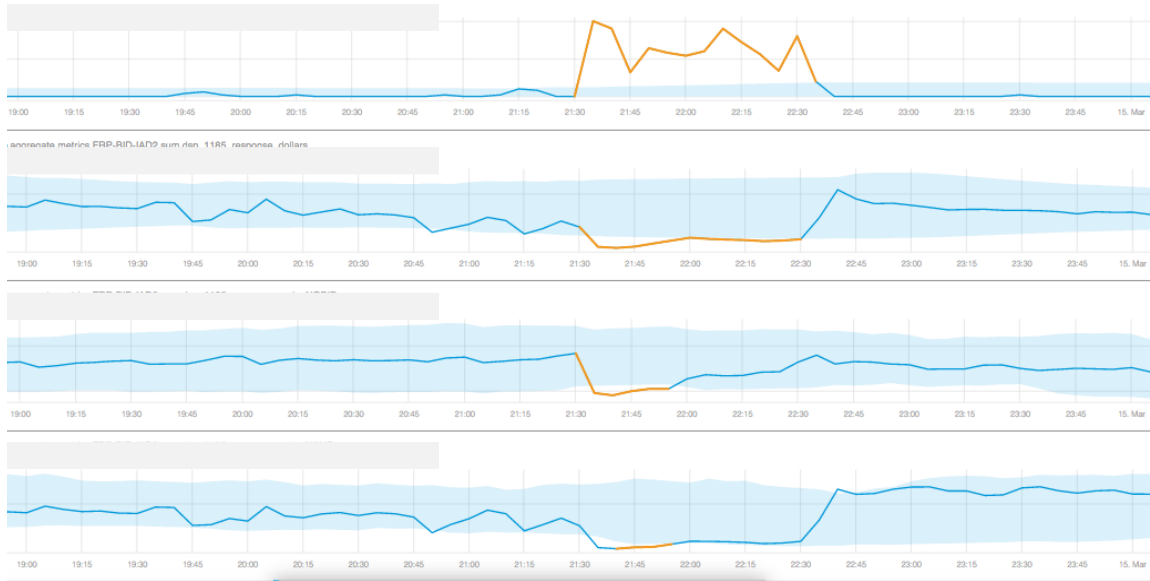


# Anomaly Detection

- Ill posed problem
- What is an anomaly?



# Anomaly Detection in Time Series Signals



Unexpected change of temporal pattern of one or more time series signals.

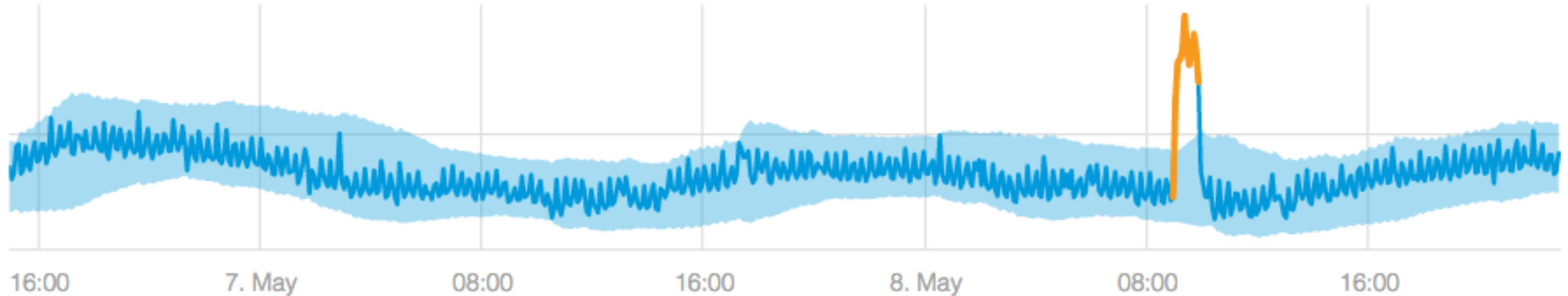




Anomaly Detection Methods



# Anomaly Detection: General Scheme



## General scheme

Step 1

Model the normal behavior of the metric(s) using a statistical model

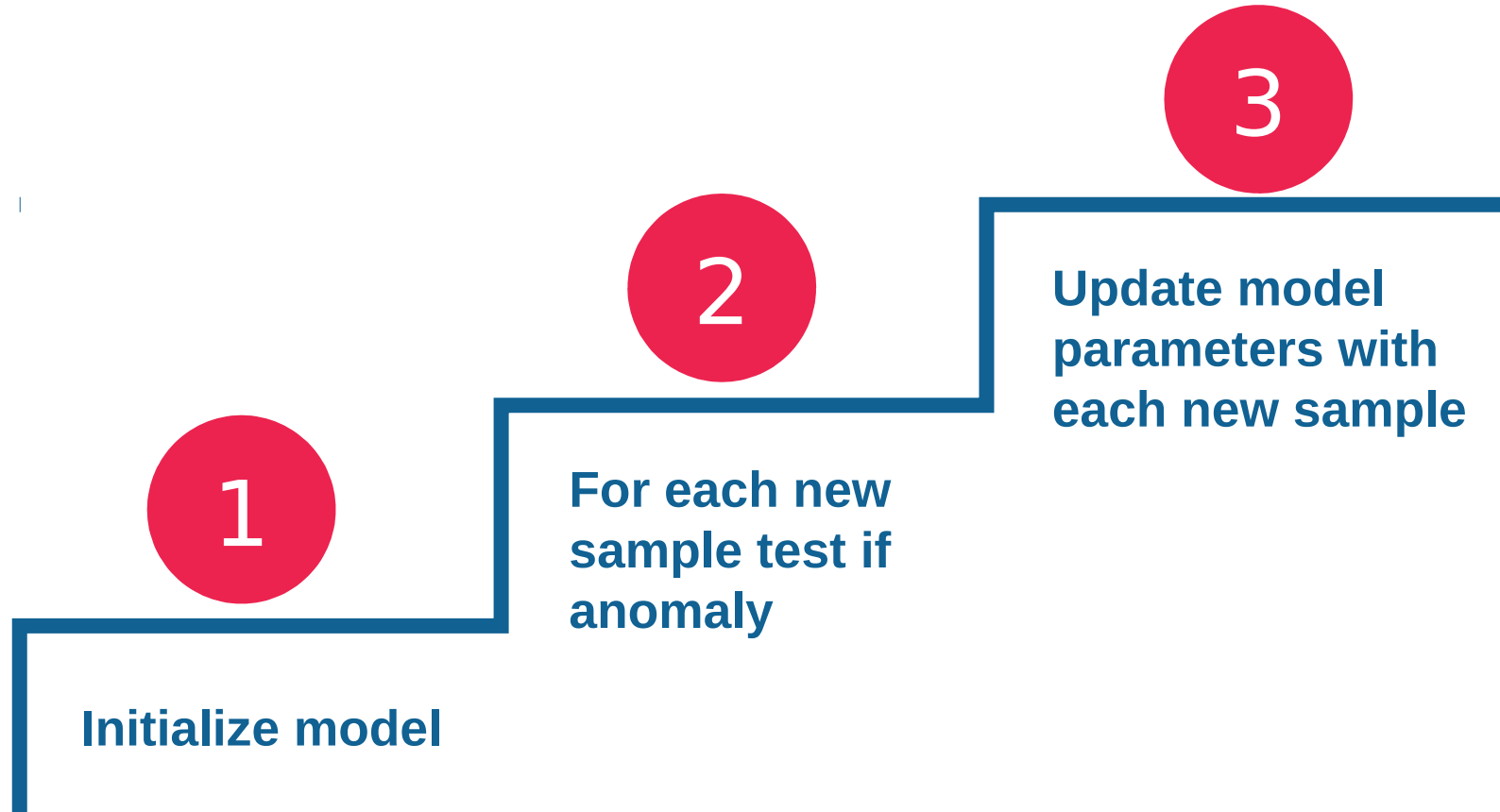
Step 2

Devise a statistical test to determine if samples are explained by the model.

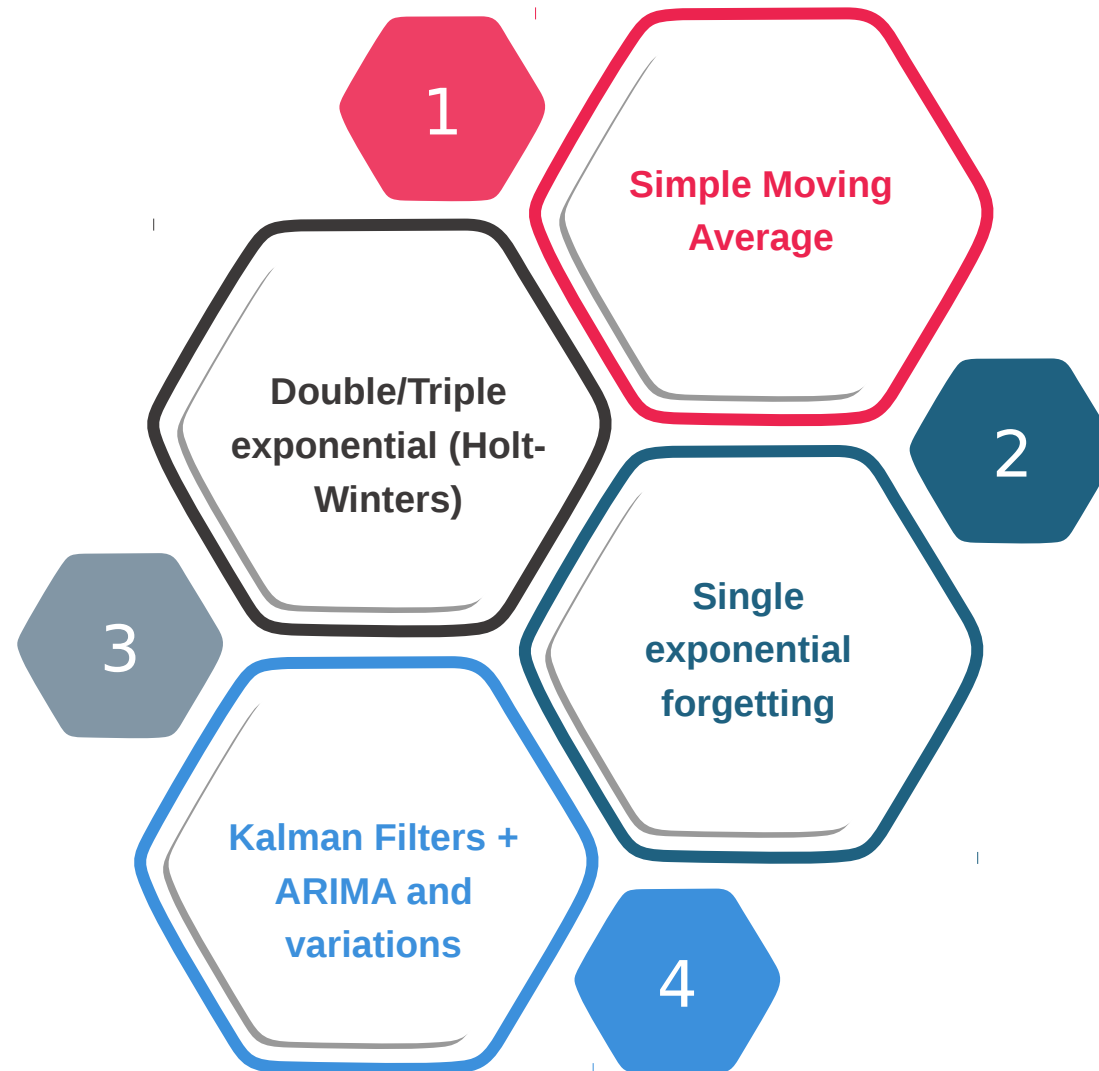
Step 3

Apply the test for each sample. Flag as anomaly if it does not pass the test

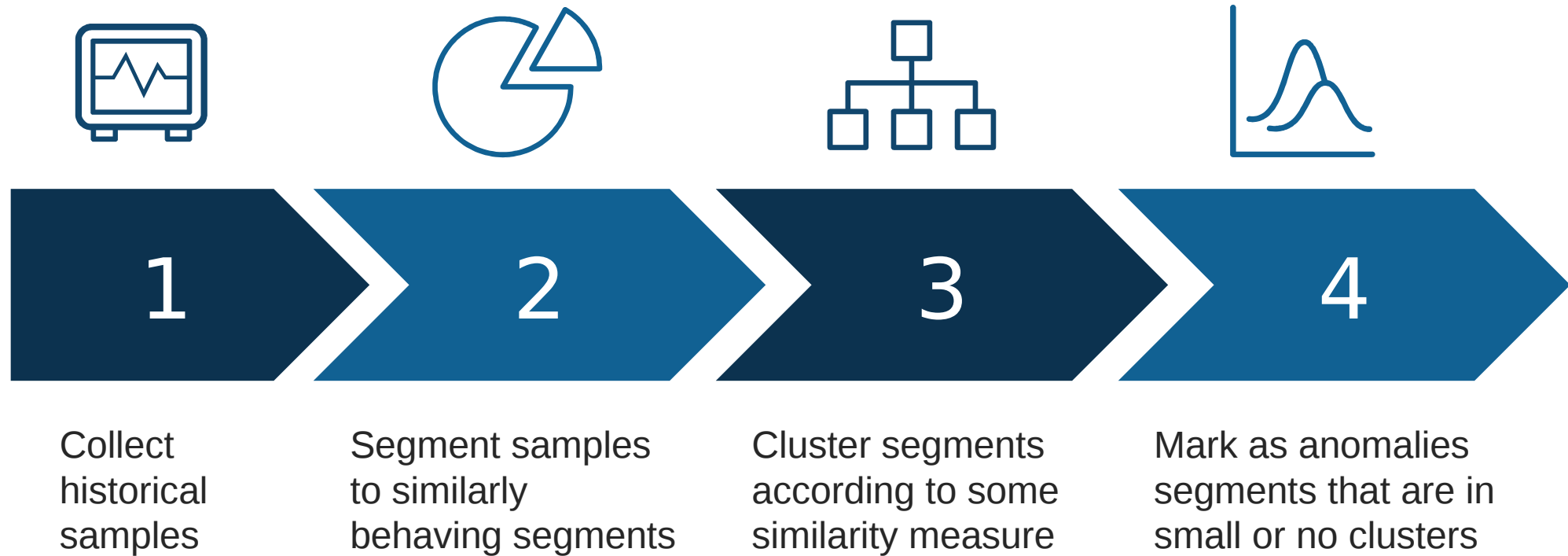
# Online Anomaly Detection Algorithms



# Example Online Models/Algorithms



# Batch Anomaly Detection





# Example Batch Anomaly Detection Methods

Multi-model distributions:

- Gaussian models
- Generalized mixture models

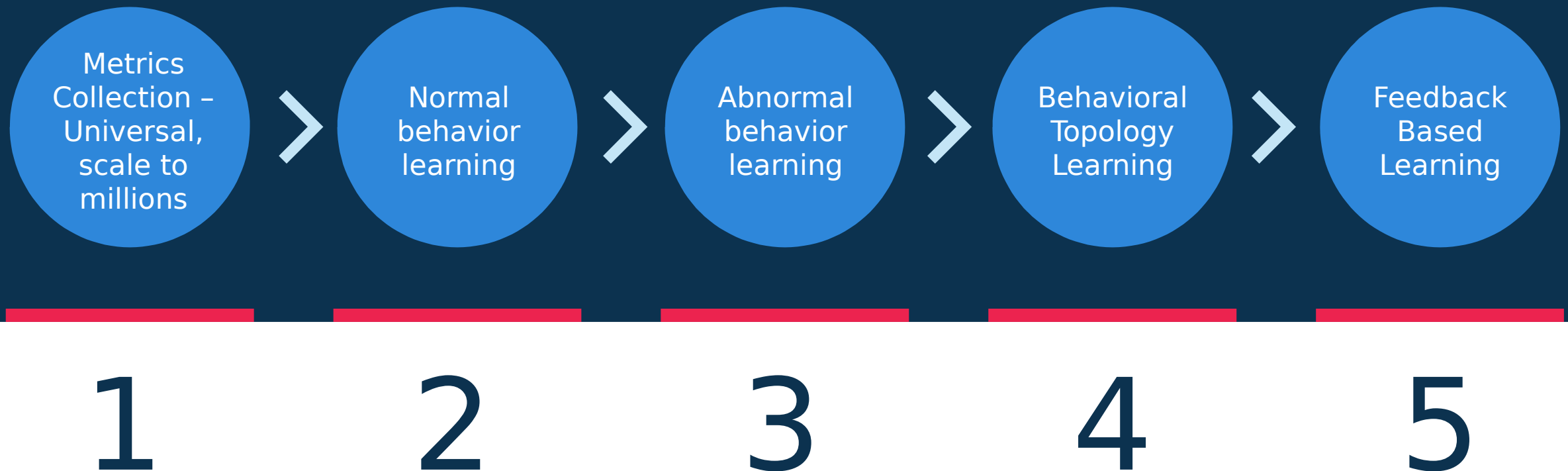
One sided SVM

Clustering methods  
(K-Means, DBScan, Mean-Shift)  
MOST COMMON IN USE

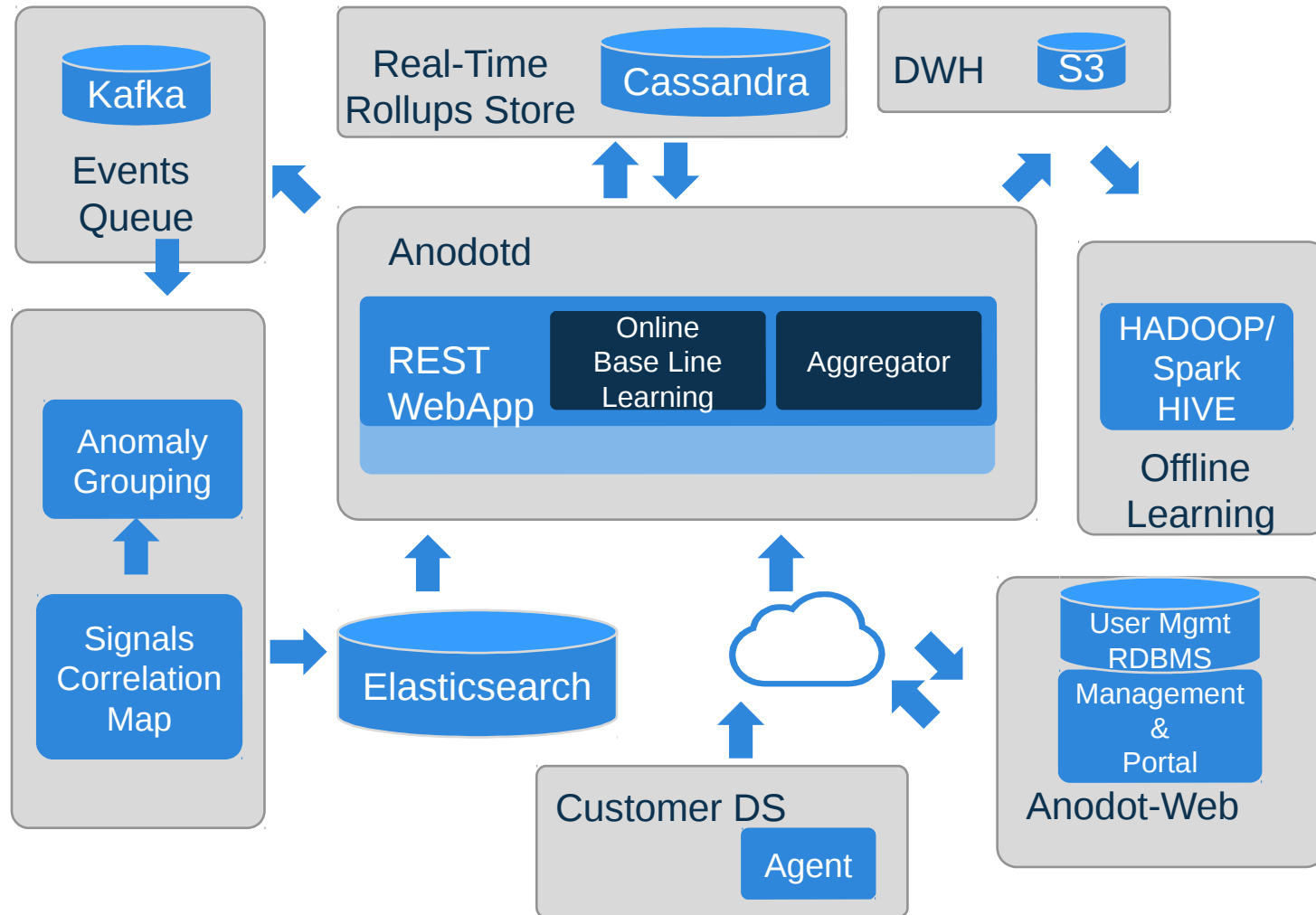
PCA

Hidden Markov Models

# Anodot's Automatic Anomaly Detection



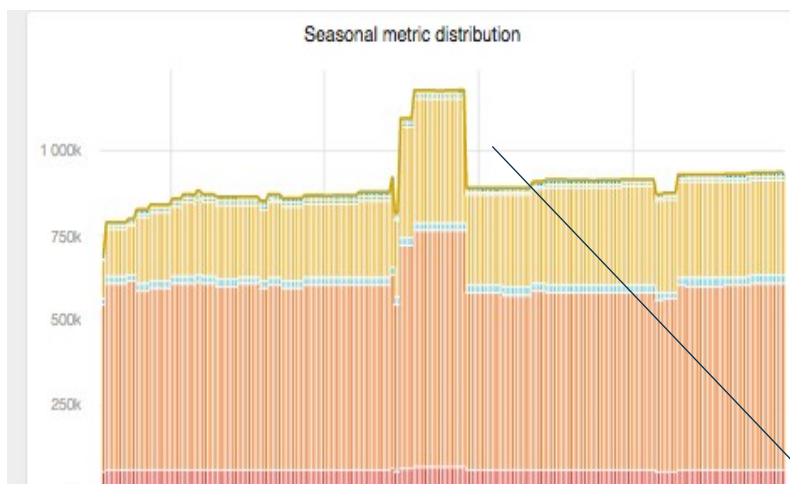
# Large Scale Anomaly Detection System Architecture



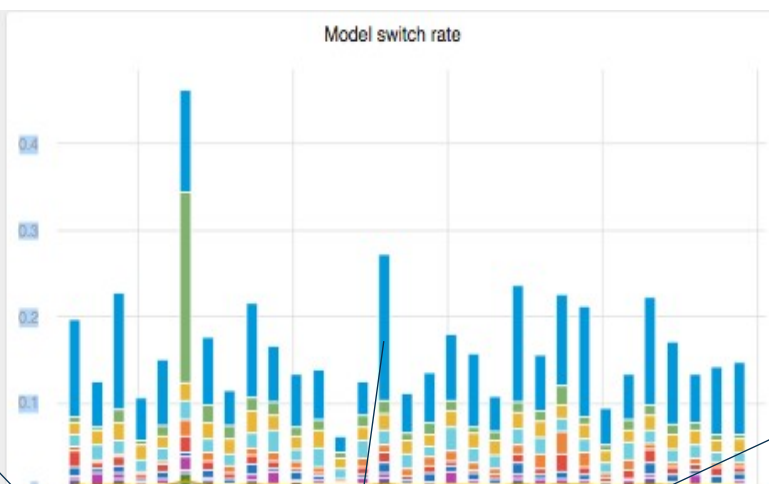
- 3.3 billion daily samples
- 75,000,000 metrics
- 150,000,000 models
  - updated with each sample
- 300,000,000 correlation links
  - Updated daily
- 7,000,000 seasonal models
  - Updated daily
- 30 types of learning algorithms
  - Metric classification, seasonality detection, trend, baseline models, clustering algos, LSH, ...
- And counting...

# Tracking the performance of the algorithms: With Metrics

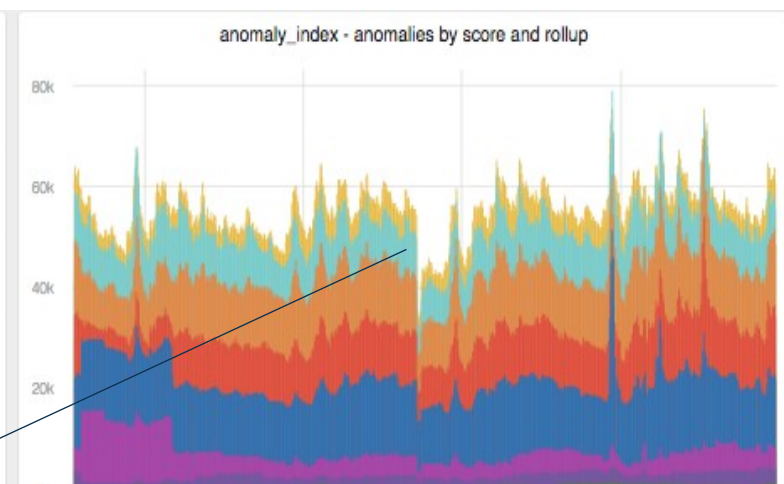
Seasonality detection distribution



Model switching rate and distribution



Anomaly quality scores



Anomaly as a result of deployment

# Alert when results are Abnormal: New type of model required

**[High]** [Redacted] Abnormal Increase in number of **anomal**

Anodot detected that 1 related alerts were triggered at 05/31/2016 07:00:00

[Investigate](#)

**[High]** [Redacted] Abnormal Increase in number of **anomalous metrics** [Alert Settings](#)

At least 50% increase in number of **anomalous** metrics for all of LivePerson's metrics.

Metric	Start (UTC)	Duration	State	Delta	Peak	Sig.
<span style="background-color: #00a0e3; color: white; padding: 2px 5px;">[Redacted]</span>	05/31/2016 15:00:00	2h	CLOSED	▲ 547%	22447.5714	62

[Investigate](#)

Provide feedback on this alert to improve detection

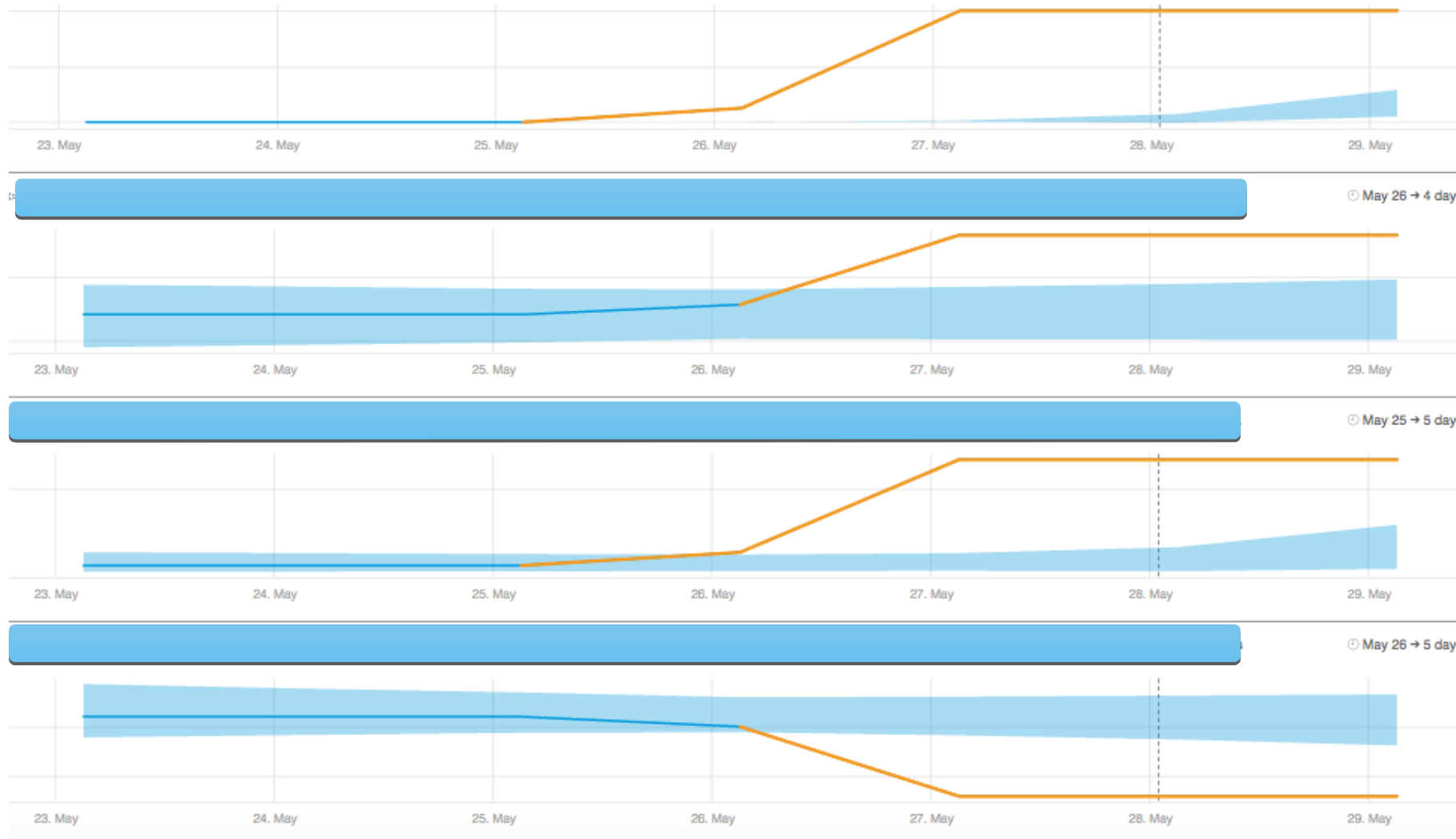
Good catch!

Not Interesting

Looks Wrong

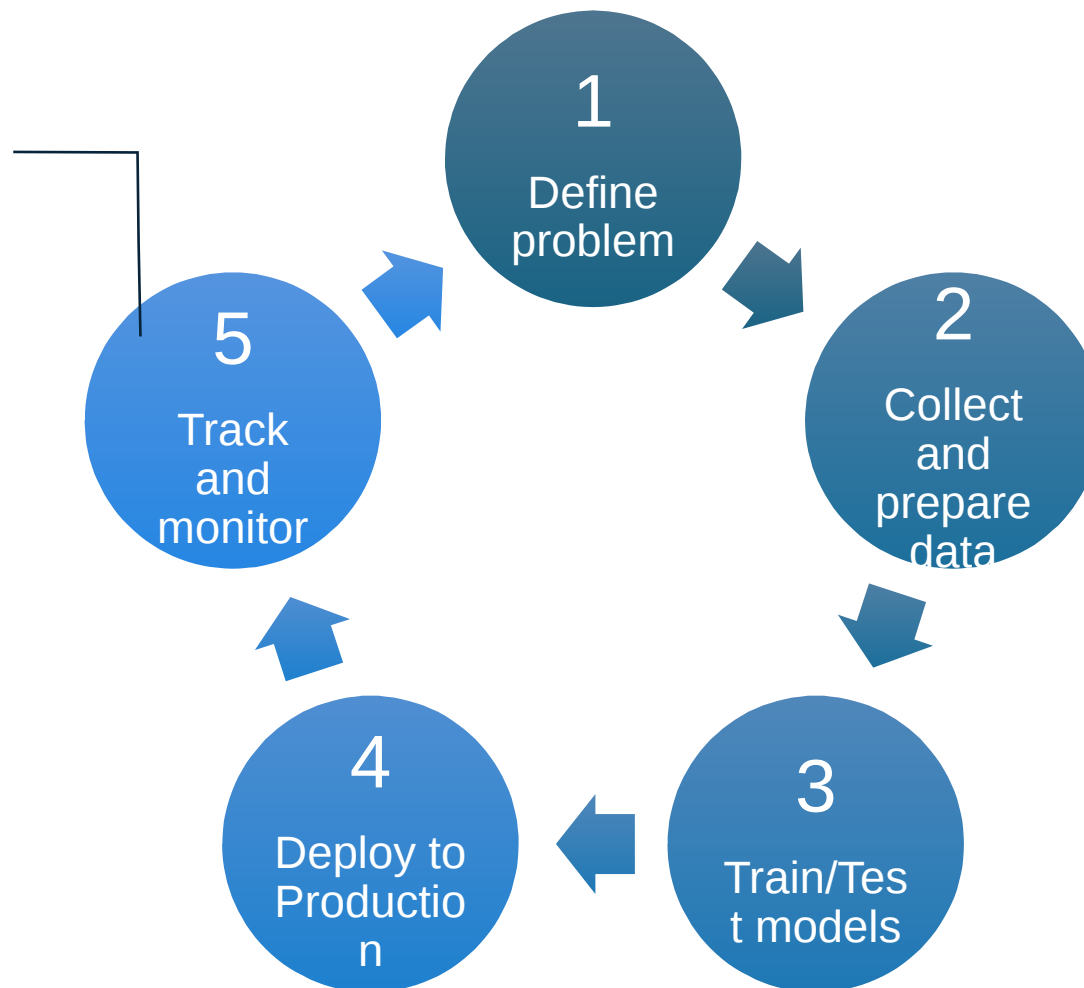


# Alert when results are Abnormal: Anomaly in Seasonality Detection Distribution



# Summary

- Automated anomaly detection
  - Closing the loop of the machine learning process
- The first step in full automation of the learning process





Thank  
you

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