

# Internet Measurement and Monitoring

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# Structure

- Part 1 – Basics of Measurement (35 min)
- Part 2 – Basic Statistics primer (35 min)
- Part 3 – Measurement Case Studies (20 min)
- Part 4 – Overview of Tools (20 min)
- Q&A – (10 min)

# Why are measurement needed ?

- Capacity planning and network design
- Finding anomalies and fault detection
- Defining a baseline for policy / pricing
- Measuring adoptions of technology
- Mapping the Internet
- Academic research
- Measuring QoS and SLAs

# What can you measure ?

- Latency
- Throughput
- Connectivity
- Periodicity

# Types of Measurements

- Active Measurements

The active approach relies on the capability to inject test packets into the network and follow them and measuring service obtained from the network/application.

# Types of Measurements

- Passive Measurements

The passive approach uses devices to watch the traffic as it passes by and collect data. Often they do not collect every data point but sample data

# Active Measurements

- Pros
  - More “objective” since you can control some parts the measurement environment
  - Easier to emulate scenarios by scheduling, mimicing traffic patterns
  - Better control over sampling
- Cons
  - Measurement could modify the test environment
  - Increases network traffic

# Passive Measurements

- Pros
  - Measures real traffic
  - Extremely valuable in network-debugging
  - Does not create extra traffic
- Cons
  - Can lead to processing lot of data. Proper sampling is crucial.
  - Can add extra devices to monitor live network
  - Privacy & Security issues



# Software

- Remote monitoring (RMON)
- SNMP
- Netflow
- RIPE Atlas
- M-lab

# Active Measurements

- One-way Measurements (OWAMP)
  - RFC 4656
- Two-way Measurements (TWAMP)
  - RFC 6038
- TCP Throughput Testing
  - RFC 6349
- Loss Episode Metrics
  - RFC 6534

# Passive Measurements

- IPPM Draft -  
<http://datatracker.ietf.org/doc/draft-morton-ippm-act>
- IPPM Draft -  
<http://datatracker.ietf.org/doc/draft-zheng-ippm-frame>
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# Challenges and Considerations

- Setting up the test environment
- Understanding Traffic patterns
- Removing “white noise”
- Understanding layers underneath
- Sampling correctly

# IETF WGs

- IPPM
- BMWG
- LMAP
- PMOL directorate

# Stats 101 for Measurements

# Basic terminology

- Distribution
- Mean
- Mode
- Median
- Variance
- Standard Deviation
- Population
- Sampling

# Distributions

- Normal Distributions
- Poission Distribution
- Binomial Distribution
- Bimodal Distribution
- Bernoulli Distribution
- Lognormal Distribution
- Zipf's law



# Sampling

- Process of Sampling
- Types of Sampling
  - Simple Sampling
  - Stratified Sampling
  - Systematic Sampling
  - Cluster Sampling
  - Opportunity Sampling

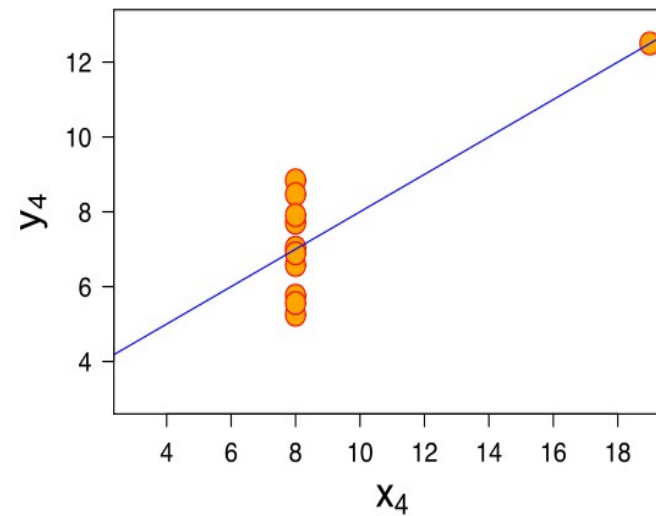
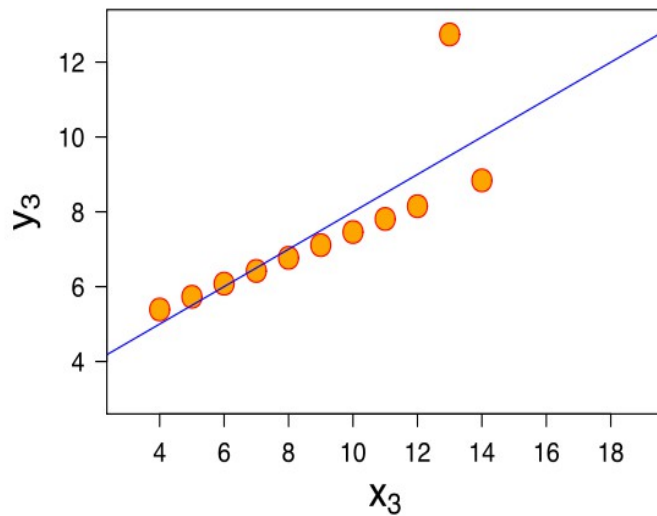
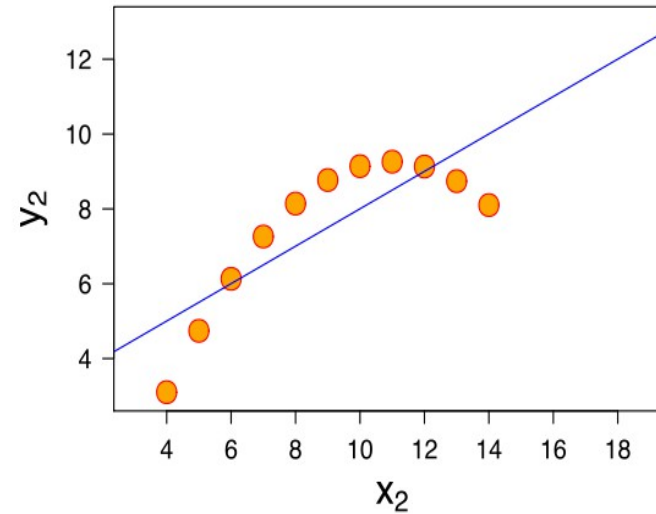
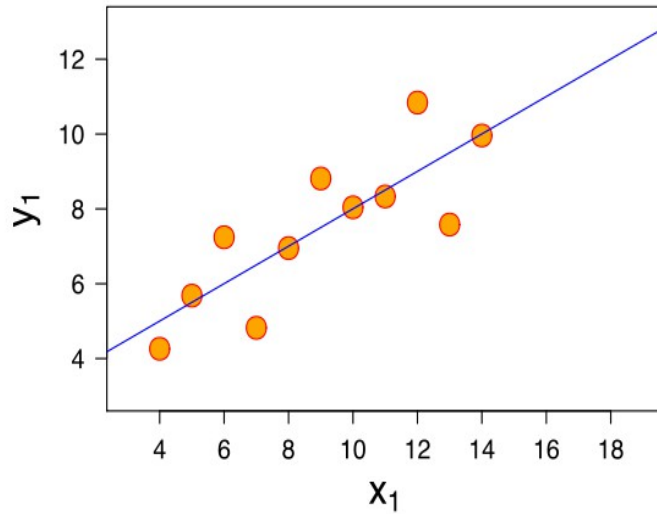
# More concepts

- Sampling Bias
- Outliers
- Margin of Error
- Sample Size
- Statistical significance
- A/B Testing
- Correlation
- Percentiles

# Gotchas & Traps

- Correlation is not causation
- Visualise your distribution (Anscombe Quartet)
- Confounding Variables

# Anscombe's Quartet



# Case Studies

# IPv6 Adoption Metrics

- <http://www.worldipv6launch.org/measurements/>

# Reachability of Anycast DNS K-Root Servers

- <https://www.ripe.net/publications/docs/ripe-393>

# Latency Analysis

- Cover one example from cable cut
  - <http://research.dyn.com/2008/01/mediterranean-cable-break/>
- Cover one example of blocking
  - <https://labs.ripe.net/Members/emileaben/a-ripe-atlas-view-of-internet-meddling-in-turkey>



# Tools Overview (demo)

# RIPE Atlas

# RIPE Stats

# Measurement Labs

# Q & A

- Thank you