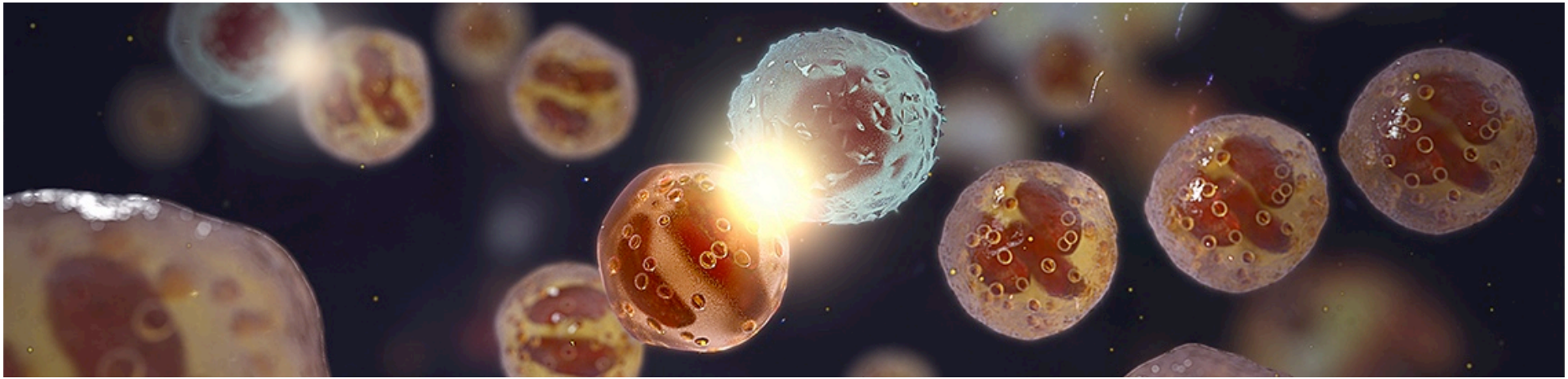
We saw it coming – review and trends in visual analytics

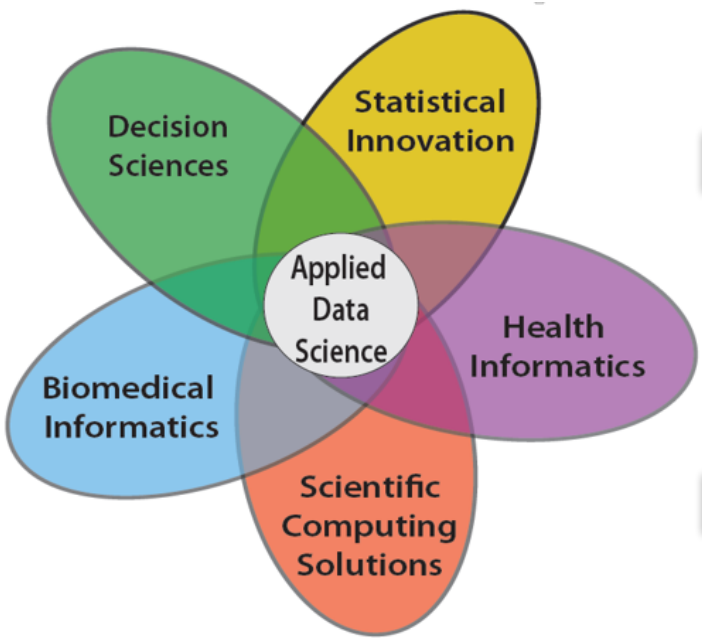
Nina Mian, Head of Biomedical Informatics AstraZeneca

PhUSE Single Day Event June 2017
Theme: Transforming Data Visualization – A Peek into the Future of Clinical Data Analysis



The AZ Advanced Analytics Centre (AAC)

Transforming drug development decision making through applied data science



Tactical impact

Advanced Analytical support to drug development:

- ✓Design options & simulations
- ✓Study data visualisation
- ✓Effect size benchmarking
- ✓Data mining
- ✓Real world data analytics

Strategic build

Focussed strategic projects:

- ✓Outcomes database
- ✓Predictive code and visualisations
- ✓Dynamic drug supply modelling
- ✓Structured exploratory analysis
- ✓Treatment pathway analytics

~30 clinical data scientists

Based in UK (Cambridge & Cheshire); Sweden (Gothenburg); US (Washington, DC)

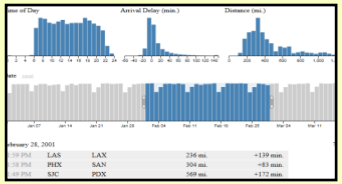
Clinical Trial Visual Analytics: An introduction

Applied computer based visualisation technologies alongside internal clinical knowledge to enhance clinical interpretation and decision making, enabling progression of the most successful drug candidates. More than simply graphs, charts and dashboards.

Question definition

Clinical Data

Visual Analysis Design



Interactive visual interfaces to facilitate analytical reasoning

Exploration, analysis, collaboration

Decision making

Make the right decisions based on the correct Clinical Data Interpretation

Tools: e.g. Commercial & opensource e.g. Spotfire, JReview, HighCharts, D3, R, Tableau, QlikView
Skills: e.g. Interaction design, concept elicitation, user experience, behavioral change

Let’s start out with the problems

Skills
Scale-up
Standards
Speed

Life in statistical science – final data analysis

Tables Figures and Listings "TFLs"

Statistical Analysis Plan

- Descriptive
- Efficacy measures
- Safety evaluation

Table 1.1.2: Demographics and Baseline Characteristics

Baseline Characteristics	Placebo N=28	Active Drug N=30
Age		
n	28	30
mean	42.6	45.2
sd	12.68	11.98
minimum	27	25
median	44	47
maximum	67	70
Sex		
F	12 (42.9)	14 (46.7)
M	16 (57.1)	16 (53.3)
Race		
CAUCASIAN	22 (78.6)	26 (86.7)
BLACK	2 (7.1)	2 (6.7)
ASIAN	3 (10.7)	1 (3.3)
OTHER	1 (3.6)	1 (3.3)

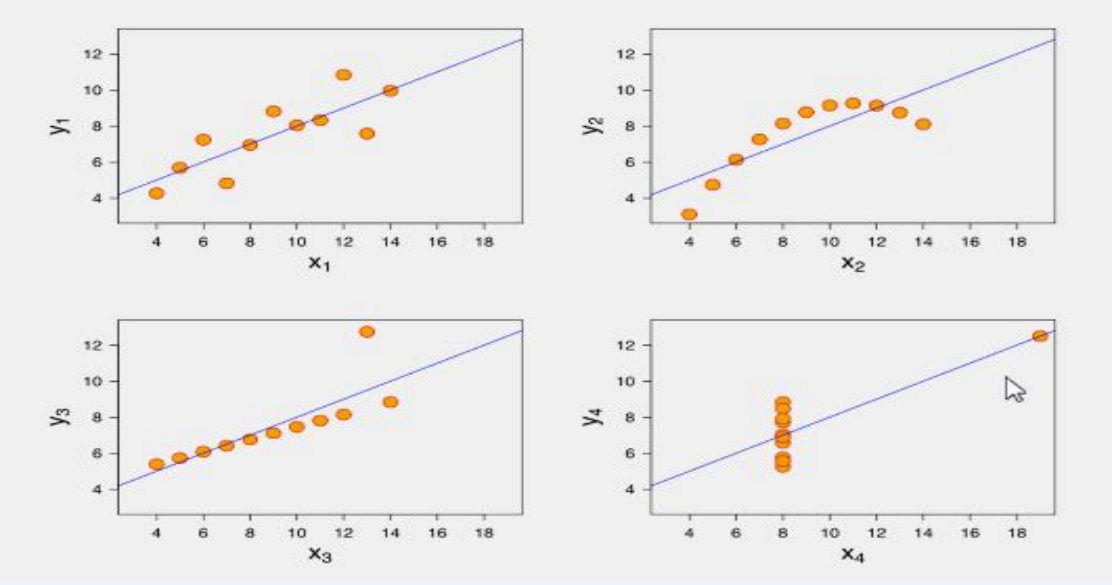
Source data : ADSL | Population: FASFL='Y'
The percentage for each categorical variable is calculated using N as the denominator

http://www.phusewiki.org/wiki/index.php?title=Clinical_Reporting_Summary

Anscombe's Quartet

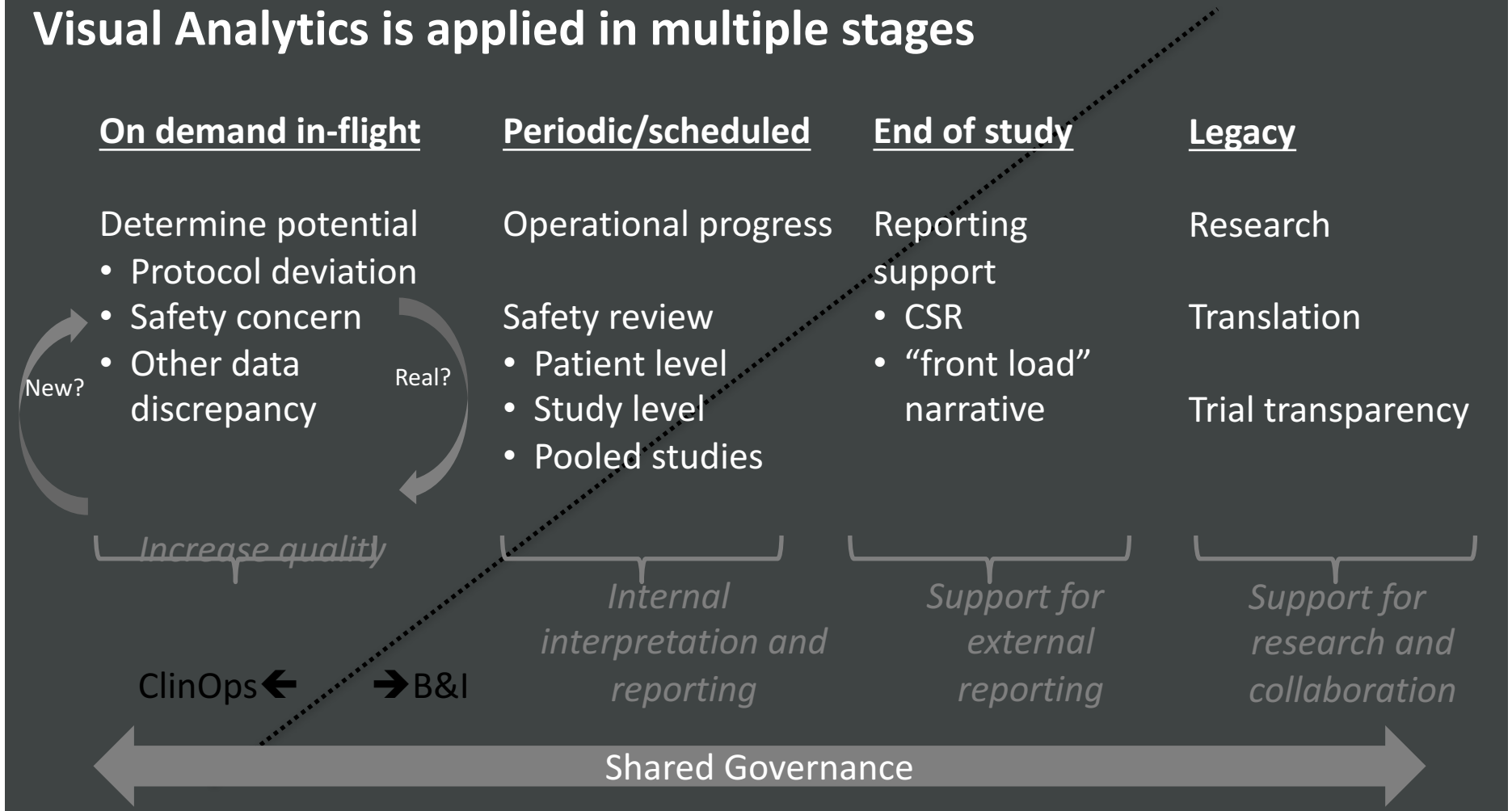
Property	Value
Mean of x	9
Sample variance of x	11
Mean of y	7.50
Sample variance of y	4.125
Correlation between x and y	0.816
Linear regression line	$y = 3.00 + 0.500x$

The case for graphics is made



https://en.wikipedia.org/wiki/Anscombe%27s_quartet

Visual Analytics is applied in multiple stages



Features of Clinical and Statistical sciences

Exploratory

Clinical sciences

Investigating

Hypothesis testing

Iterative

Just-in-time

Explanatory

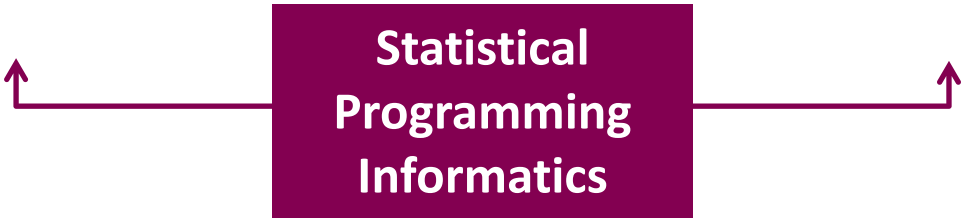
Statistical science

Regulatory reporting

Statistical significance

Robust

Pre-specified



Life in Clinical science

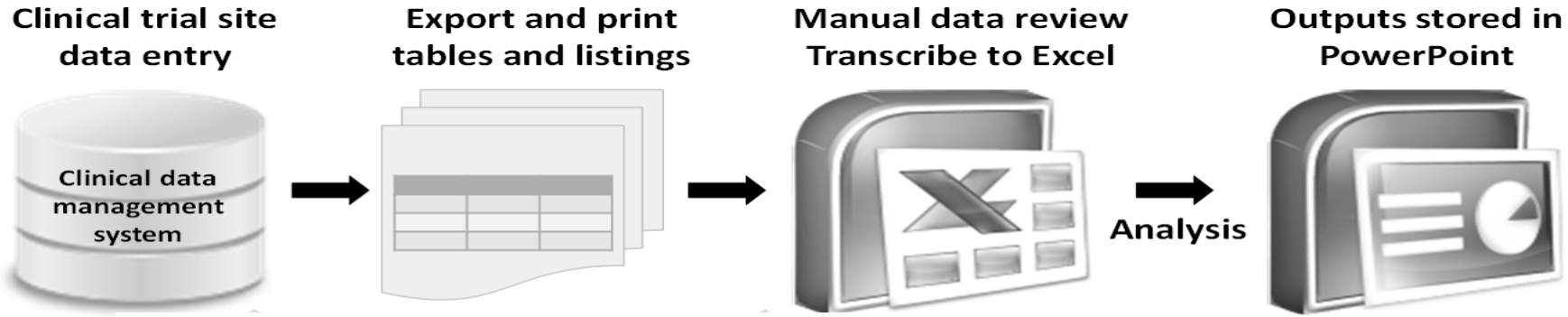
- Understanding of the drug effect in patients
- Improved patient tolerability
- Patient safety
- Management of complex AEs
- Development of treatment guidelines
-Improved communication and timely feedback to investigators

-Understanding relationships
-Hypothesis/Scenario testing
- Predictive analysis

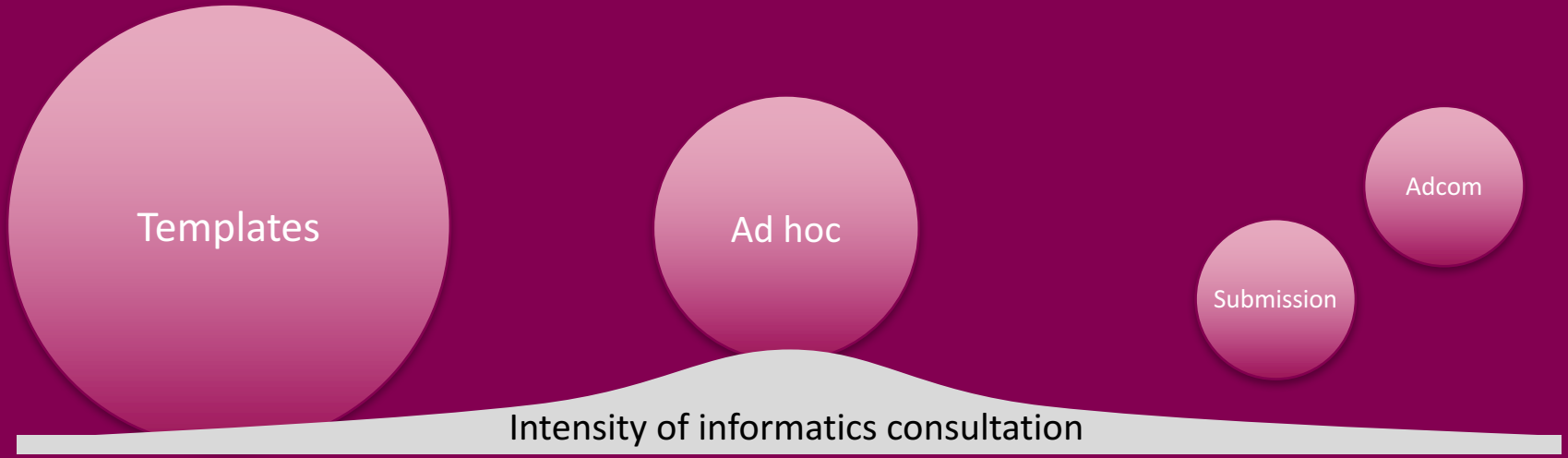
Clinical data management system

-Improved patient management
- Treatment guidelines
- Dynamic AE tracking
- Patient safety KPIs

Life in Clinical science



Clinical Trial Visual Analytics 'planets'



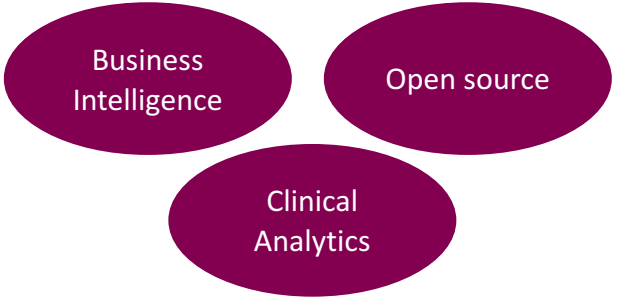
- **Standard, interactive visualizations**
- **Allow self-serve interpretation in a flexible pre-defined framework**
- **Best practice and governance model**
- **Scalable across multiple studies**
- **"the 80%" of questions**

- **Bespoke, interactive visualizations**
- **Tailored analytics, applicable to the specific study/question**
- **Live, informatics consultation model, within statistics guidelines**
- **"the 20%" of questions**

- **Static or interactive**
- **Reproducible, validated**
- **Informatics design consult; programmer implemented**

May inform further template development

How to make the magic happen



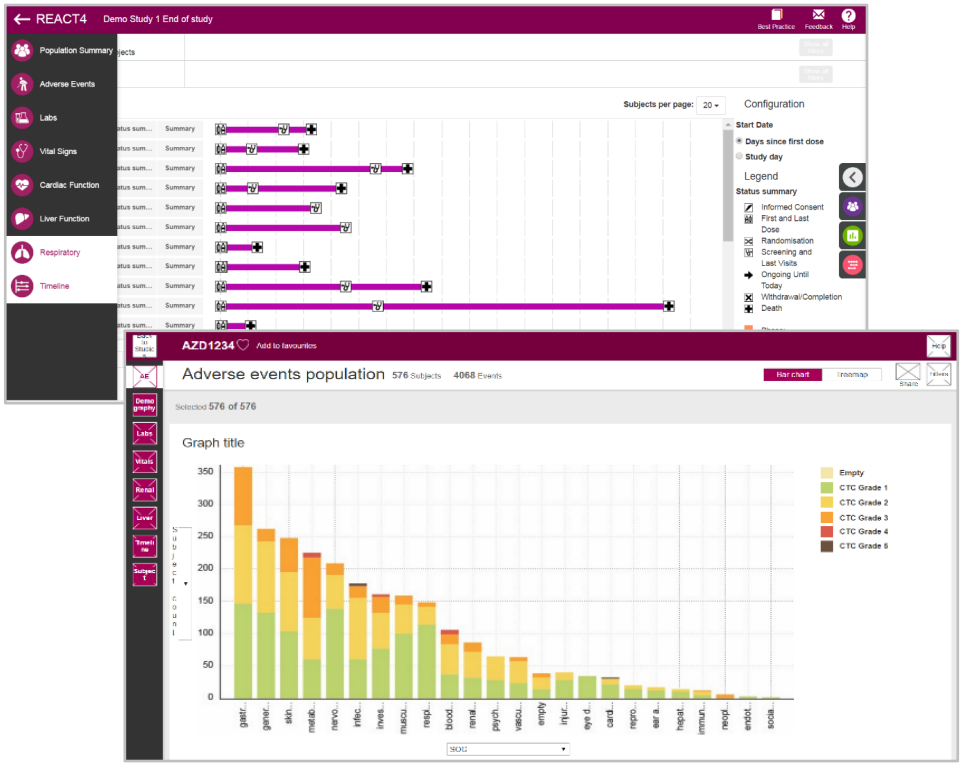
- Clinical analytics e.g. JMP Clinical*, JReview*
- Business Intelligence e.g. Tableau, Spotfire*, Micro, Qlikview*, Microstrategy*
- Open source e.g. R (ggplot)*, R Shiny*, D3*, HighCharts*

- Rapidly evolving market e.g. COVANCE, PerkinElmer

- Provisioned via different routes: CRO partners, or via internal development & deployment from analytics functions

**Available in the AZ/Medi estate – heterogeneity reflects using the right tool for the job, no single 'right' way though simplicity and rationalization is desirable.*

Surfacing data to the right users



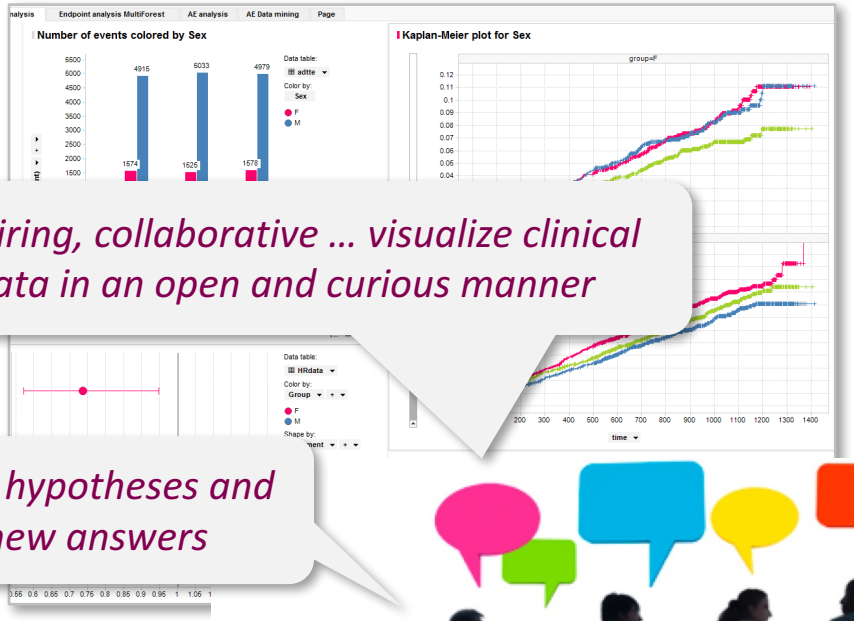
REACT
(Real-time analytics for Clinical Trials)

- Self-serve, Interactive visualizations
- Faster to find the right data
- Governance model

EventTracker

- Facilitate comments
- Team communication and collaboration

Multi-disciplinary collaboration



Inspiring, collaborative … visualize clinical data in an open and curious manner

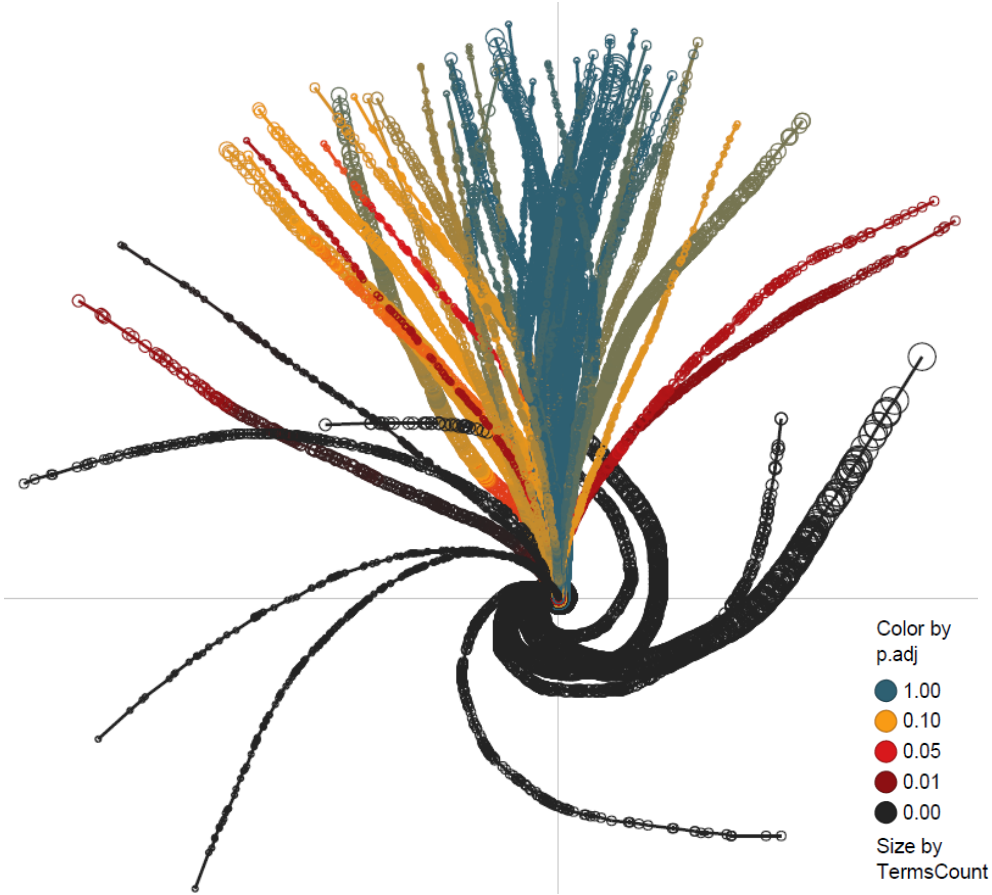
New hypotheses and new answers

"Data turned out to be very useful in regulatory interactions."

"Visualize/Explore" Workshops

- Medical & quant experts
- Build and test hypotheses

Visuals help derive insights from large data sets



Tendril Plots for Adverse Events

- Replace long summary tables
- Drill down on interesting trends
- Multi-dimensional

Acknowledgement:
Martin Karpefors, Biomedical Informatics

Business as Usual Process

Identify new studies	Support study teams in selecting the right visual analytics tool
Pre-study setup	Develop detailed requirements and establish governance (training)
Study setup	Data prep., mapping, QA/QC checks
Live study	User support. Interaction between users, stakeholders, BAU team
Post study	Close out, learning

Simple things matter

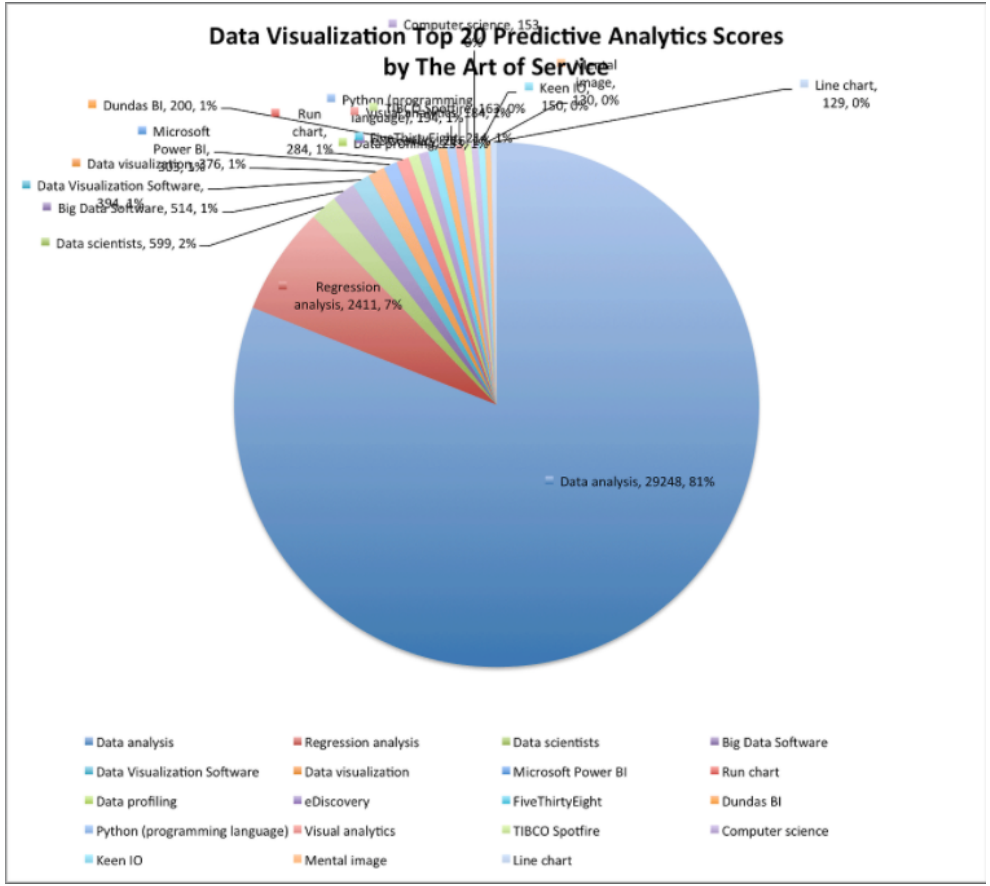
- Clear labels
- Correct chart types
- Care where colour has meaning
- Interactive – not distracting
- Filtering – always clear what's applied
- Laptop vs 8k collaboration screen
- Single sign on

Get training, get experience

- Tutorials

coursera

You searched for **data visualization.** 702 matches



http://viz.wtf/image/160340906457

What next?

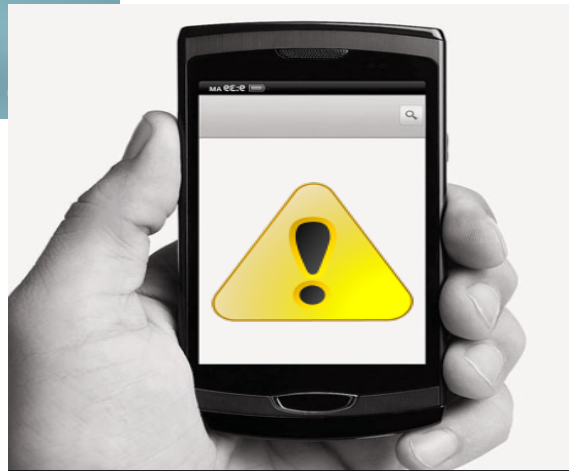
1. Dynamic

http://www.gapminder.org/

2. Video

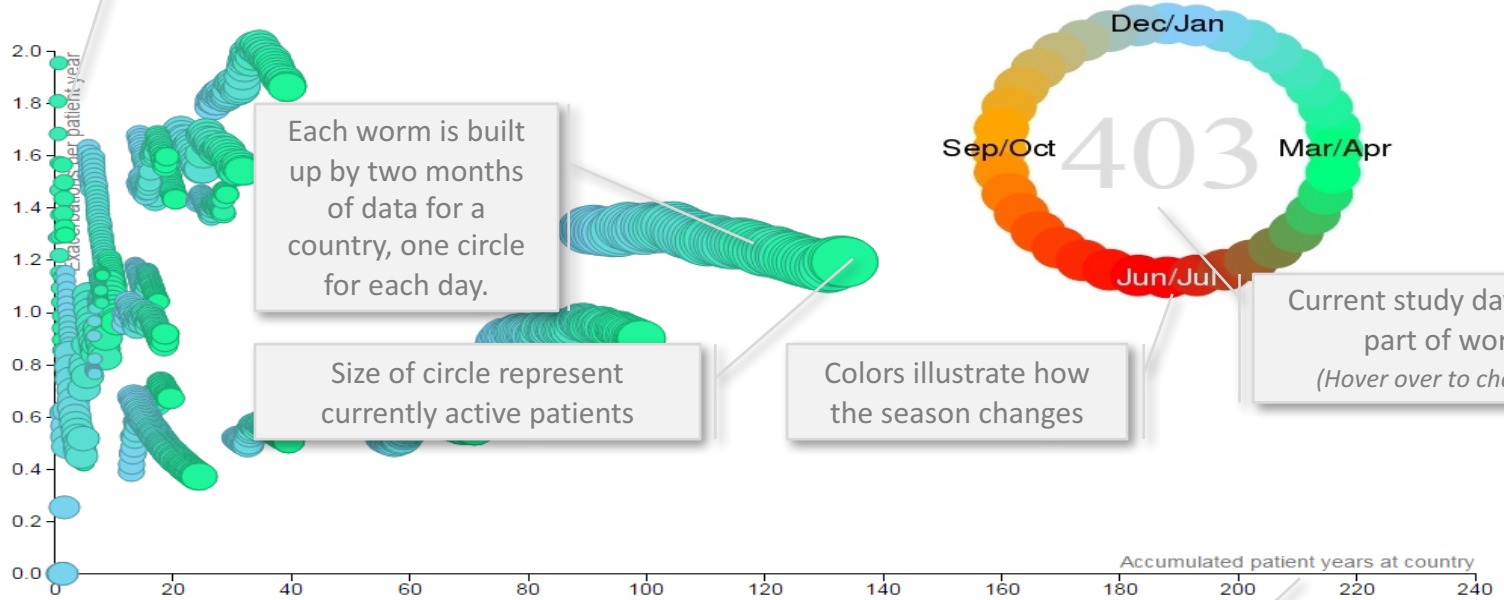
https://www.periscope.tv/

3. Small/mobile



Y axis: The cumulative exacerbation rate is defined as #exacerbations/#patient years in each country from study start until ”current study day”

Accumulated Exacerbations over time per country



Each worm is built up by two months of data for a country, one circle for each day.

Size of circle represent currently active patients

Colors illustrate how the season changes

Current study day for mid part of worm.
(Hover over to change it.)

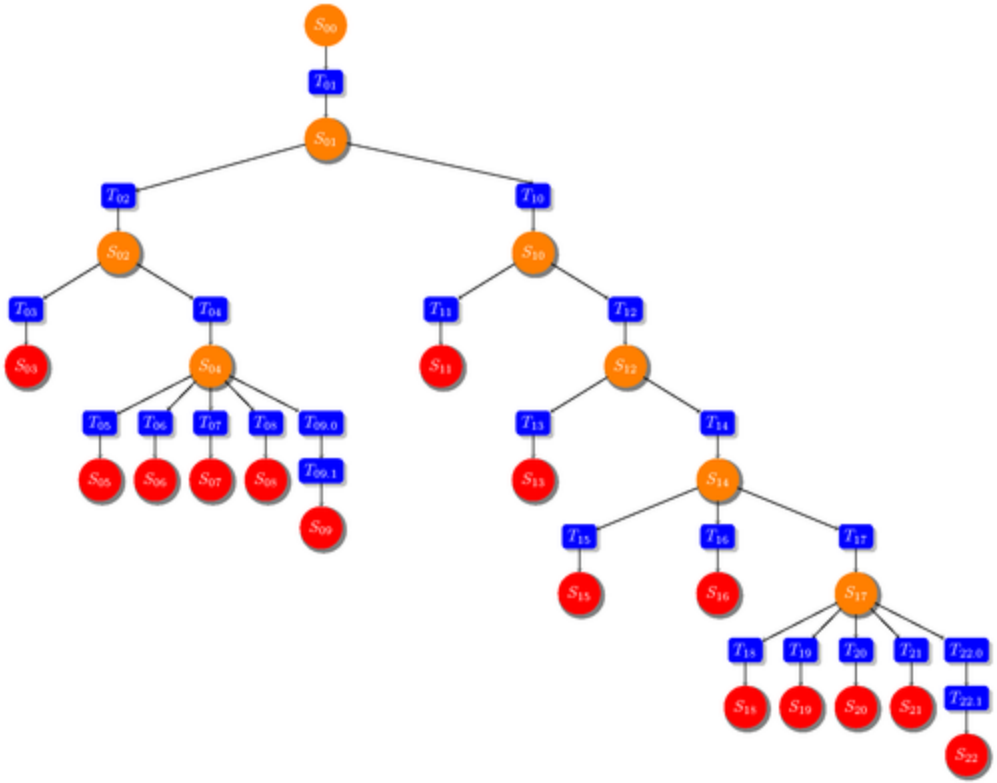
X axis: Accumulated patient years at the sites in a country

The need for Visual Analytics diminishes with smart application of logic and learning

“The power of a graph is its ability to enable one to take in the quantitative information, organize it, and see patterns and structure not readily revealed by other means of studying the data”

Graphical Perception: Theory, Experimentation, and Application to the Development of Graphical Methods
WS Cleveland, R McGill. Journal of the American Statistical Association, Sept 1984

Rules-based and learning-based



http://www.texample.net/tikz/examples/rule-based-diagram/

Summary

- Evolution
  - Tables
  - Static Graphs
  - Interactive filters
  - Dynamic, longitudinal
- Future
  - Automation – complex but repetitive
  - Learning – actions tracked becomes fertile training set
  - Dealing with new temporal source e.g. sensors and wearables

Some inspiration

Edward Tufte

Mike Bostock http://bost.ocks.org/mike/

Andy Kirk www.visualisingdata.com

Ben Fry http://benfry.com/projects/

David McCandless http://www.informationisbeautiful.net/blog/

Nathan Yau http://flowingdata.com

New York Times, The Guardian, The Economist

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