

Data Visualization

From Data to Decisions







Agenda

- Data Visualization Definition
- Visual Perception
- Making Efficient Charts
- Dashboard Design
- Improving Data Culture







Data Visualization



What is Data Visualization?

- Practice of translating information into a visual context
- To make data easier for the human brain to understand and pull insights from
 - Trends
 - Patterns
 - Outliers









5	2	8	3	6	1	9	3	6	2	5	3	7	4	3	8	3	8
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3	6	1	6	2	9	3	8	3	8	5	8	4	7	2	0	3	7
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6	5	2	4	9	1	0	2	7	5	2	8	3	6	1	6	2	9
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3	8	3	8	5	8	4	<u>7</u>	2	0	3	<u>7</u>	3	5	4	<u>7</u>	1	8
2	0	1	2	5	3	6	4	3	9	1	0	8	9	5	<u>7</u>	3	4
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6	2	1	4	4	3	9	3	6	5	2	4	9	1	0	2	5	2
8	3	6	1	6	2	9	3	8	3	8	5	8	4	2	0	3	3
5	4	1	8	2	0	1	2	5	3	6	4	3	9	1	0	8	9
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Number of times digit 7 appears: 17



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5	2	8	3	6	1	6	2	9	3	8	3	8	5	8	4	2	0
3	3	5	4	1	8	2	0	1	2	5	3	6	4	3	9	1	0
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6	2	1	4	4	3	9	3	6	5	2	4	9	1	0	2	5	2
8	3	6	1	6	2	9	3	8	3	8	5	8	4	2	0	3	3
5	4	1	8	2	0	1	2	5	3	6	4	3	9	1	0	8	9
5	3	4	5	3	2	5	2	8	3	6	1	6	2	4	6	2	5







Visual Perception



Visual Perception

- The brain is powerful... but working memory is limited
- Working memory limited to a small number of "chunks"
- Visualization allows us to consolidate complex statistics so we can process more data simultaneously























Visual Betrayal

- Eyes are easily fooled
- Ambiguity in images can make fun illusions
 - Do you really want your data visualization to be a fun illusion?
- Convey the data in a way that can be interpreted accurately and quickly























What color is the dress?

















Reasons Why I hate Pie Charts



.... GraphJam.com







Even Microsoft caught on...



Value

Thing 1 Thing 2 Thing 3 Thing 4

Office 2013



Thing 1 Thing 2 Thing 3 Thing 4







The Moiré Pattern







420 -												
405 -												
390 -												
375												
360												
3/15												
330												
215												
200 L												
200												
2/0												
235												*
240												
225							1					
210							/ /					
195 -												
180 -												
165 -												
150 –												
135 –												
120 –												
105 -												
90 -												
75 -												
60 -												
45 -												
30 -												
1 -												
12 -												
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0	1-Jan	1-Feb	1-Mar	1-Apr	1-May	1-Jun	1-Jul	1-Aug	1-Sep	1-Oct	1-Nov	1-Dec















Drinking age will remain 19 in Saskatchewan

CBC News Posted: Mar 4, 2013 11:59 AM CST | Last Updated: Mar 4, 2013 11:55 AM CST 🛄 25



Canadian Centre on Substance Abuse

You have to be 19 in Saskatchewan to have a drink, while in Alberta and Manitoba, the drinking age 18. (CBC)

The Saskatchewan Party government has ruled out lowering the drinking age, four months after party members put the issue in the public eye.







The Hermann Effect



FDOHEALTHCAREPRODUCTSRAPSCOLLABORATIVE













Bias in Thinking Systems

System 1 (Bottom Up)

 Operates automatically and quickly, with little or not effort and no sense of voluntary control

 System 1 generates impressions, intuitions, intentions, and feelings for System 2

System 2 (Top Down)

- Allocates attention to the effortful mental activities that demand it, including complex computations
- System 2 can be engaged as needed to solve more complex problems or where System 1 runs into difficulty







What is happening here?



System 1 informs. You get an automatic impression.







What is the answer?

19 x 23

System 2 shifts into gear to figure out the answer (437).







What happens now?



Impressions in System 1 affect the conclusions of System 2.

- Presentation impacts the way data is perceived
- Mood and emotions impact critical thinking







Making Efficient Charts

Count of Root Cause Categories



70

60												
50	_						_	_	_			
40									_			_
30												
20	_			_								
10		_		_		_					_	_
0												
	Requires user to cross reference multiple procedures/complexity	Inability to perform task (due to strength or dexterity	mproper storage, shutdown or cleaning of equipmen	Vendor/supplier or contractor performance problems	Inadequate inspection/material flaw not recognizec	Failure due to external emergency or act of nature	Calibration or certification frequency inadequate	Failure of contractor to manage their contracto	Ergonomically awkward/inconvenient/uncomfortable	Equipment records/manuals missing or incomplete	Material does not meet expected functionality	Not designed to work in provided environment











"Save the pies for the dessert." – Stephen Few

5	2	8	3	6	1	9	3	6	2	5	3	7	4	3	8	3	8
5	8	9	6	2	1	4	4	3	9	3	6	5	2	4	9	1	0
2	7	5	2	8	3	6	1	6	2	9	3	8	3	8	5	8	4
7	2	0	3	7	3	5	4	7	1	8	2	0	1	2	5	3	6
4	3	9	1	0	8	9	5	7	3	4	5	3	2	7	5	2	8
3	6	1	6	2	9	3	8	3	8	5	8	4	7	2	0	3	7
3	5	4	7	1	8	2	0	1	9	6	2	1	4	4	3	9	3
6	5	2	4	9	1	0	2	7	5	2	8	3	6	1	6	2	9
3	8	3	8	5	8	4	7	2	0	3	7	3	5	4	7	1	8
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5	3	2	7	5	2	8	3	6	1	6	2	4	6	2	7	5	9
1	5	2	6	3	6												







How Pie Chart represents data

3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2
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5	5	5	5	5	5	5	5	5	5	5	5	5	8	8	8	8	8
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	6
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	9
9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	0	0	0
0	0	0	0	0	0												







How Bar Chart represents data
























AFDO RAPS HEALTHCARE PRODUCTS COLLABORATIVE













General Rules for Pie Charts

1. Don't use Pie Charts

If you must break Rule #1, then:

- 2. Sums to 100%
- 3. Start at noon and move clockwise
- 4. Largest to smallest values
- 5. Add labels for %
- 6. No 3D

















Every few months
Every few weeks
Every few days
Daily
Never























Frequency









It seems that perfection is reached not when there is nothing to add, but when there is nothing left to take away.

-Antoine de Saint Exupéry









Pie Chart of Japan

















Last Month's Problem Solving



RAPS HEALTHCARE PRODUCTS COLLABORATIVE

















Poor Choices

- Wrong chart type for the data
- Overuse of gridlines
- Overuse of axis and data labels
- Bad color choices
- 3D chart
- Rotated text
- Hard to read













Poor Choice









Better Choice









Best Choice













Unemployment Rate Under President Obama









Unemployment Rate Under President Obama



AFDO RAPS HEALTHCARE PRODUCTS COLLABORATIVE



































Job Loss by Quarter









Job Loss by Quarter









Millions of Job Loss by Quarter









The problem with online graphs and charts Ice cream sales Fig 1. Problem Violent crime People who understand People who make the difference between graphs and charts correlation and causation Stop the cycle of violence! Jan Feb Mar Apr May Jun Jul Aug







Best Practices

- Who is the user? Know your audience!
- What are the business questions that need answered? Get input from the user!
- How can we answer the questions? What are the correct measurements?
- How will the data be viewed and used?







Record



Opened and Closed Deviations









Record	Due Date	Assigned To	Description	State	Leveling	Investigation	Review	Routing for Closure	Days Behind
13425	6-Jul	Investigator A	Dryer fault	Investigation	Complete	22	6	3	6
13503	9-Jul	Investigator C	Line Clearance	Review	Complete	Complete	2	6	1

	Leveling (3 days)	Investigation (20 days)	Review <mark>(</mark> 5 days)	Routing for Closure (3 days)
	2	22	6	3
Investigator A				
	1	15	4	1
Investigator B				
	2	16	2	6
Investigator C				
	Currently Assigned			
	9			
Investigator A				
	5			
Investigator B				
	6			
Investigator C				







Dashboard Design

Examples taken from Stephen Few's Visual Intelligence Blog, Now You See It, and Information Dashboard Design


Report Types

Executive	 Dashboard Interpret the story as quickly as possible Insights are focused, self-explanatory, and highly curated toward the audience
Analyst	 Analytical Report User discovers answers to broad array of questions by interacting with the report Many slicers, filters, and contain more complex visuals that expose in-depth detail
Worker	 Operational Report Monitors current or real-time data to make decisions then act on those decisions Includes buttons to navigate beyond the report to perform actions in external systems
	• Educational Reports

- •Assume the user is unfamiliar with the data
- Must provide clear narrative and guidance
- •Used to disseminate information to large audiences with varying levels of understanding





Execut

General



Dashboards / Scorecards

- Provides an "at a glance" view of vital signs
- Contain critical information that is easily monitored, clearly understood, and indicates where attention may be needed
- Typically viewed as a single page
- Show historical trends as well as "right now"
- Provide figures along with graphical targets
- Add links to detailed data









Dashboards / Scorecards

- Content position and size should match its importance and frequency of use
- Consider how the eye scans the page when deciding placement
- Use color and formatting to draw attention where needed
- Visually associate data and content that is related
- Use the needs of the user to drive the layout

Latest Network ERP Data Warehouse Web Site Email II Dashboard for D. Smith (CIO)	8/	1/2007 11:0
Major System Availability (Last 30 days) (Actual Not Acceptable Acceptable) Key Non-System Metrics (Actual Go	od 📗 Excessi	ve 📗 Critica
Last 12 Months ! System Availability % Year-To-Date ! Metric % of Target		Actus
Network 98.5% Expenses YTD KS	- 1	2,345.
ERP 97.9% Customer Satisfaction		3.25 of
O Data Warehouse 93.2% Everel I Problems		5
Web Site 98.5% 0% 50%	100% 150%	
Email 99.7% Major Project Milestones		Daves Unit
HR 96.7% ! Project Milestone	Due Date	Past Du
Problem Tracking 98.0% ERP Uperade Full System test	01/08/07	
90% 95% 100% Add services data to Datawarehouse ETL Coding	02/08/07	-
Upgrade Mainframe OS Prepare Plan	03/07/07	
Hardware % of Capacity (Actual Good Excessive Critical) DR Site Upgrade Install Hardware	04/08/07	
CPU Last 7 days Overall 81% Budgeting System Hire PM resource	23/07/07	
Storage Last 12 Mo. OA review	06/08/07	
Monthly Network Traffic (Klobytes) Out New for ktr Senets Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Let Month Daily Man for ktr 7 days Daily Man for ktr 3 month Daily Man for ktr 7 days Daily Man for ktr 3 month Daily Man for ktr 7 days Daily Man for ktr 3 month Daily Man for ktr 7 days Daily Man for ktr 3 month Daily Man for ktr 7 days Daily Man for ktr 3 month Daily Man for ktr 7 days Daily Man for ktr 3 month Daily Man for ktr 7 days Daily Man for ktr 3 month Daily Man for ktr 7 days Daily Man for ktr 3 month Daily Man for ktr 7 days Daily Man for ktr 3 month Daily Man for ktr	Funding Approved X	Sched. Sta 01/10/0 01/09/0 12/09/0 05/08/0 01/09/0
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Present Hardware Upgrde Proposal to CEO	Self	03/08/0
Present Hardware Upgrde Propositio CLO ERP Asia IT Management forsteen for DW Re Present Relaxe Management forsteen for DW	Self Self PDP	03/08/0 04/08/0 05/08/0







Emphasis Guidelines

Most emphasis	Neutral
Neutral	Least emphasis







Overall Rep Performance	Individual Rep Performance
% of Target Actual Today (compared to target)	Orders: Calls
	Name PerHr PerHr Call Duration (minutes)
Poid Time 27	
CallDuration 4,796	18006, 5 5 10
	Sector V S 17
Most omphasis	
0% 50% 100% 150% 200% 250% (Sparilines acaiad as % of target)	
	Singes 8 10 16
Rep Utilization	Newman, A 11 15
Reps Online: 20 = 87%	Bailey, S 11 16
Reps Today: 23	Barclay, T 11 17
75% 80% 85% 90% 10%	Jimenez, J 12 16
Volume The Hair Today The Hearth Dec Hair Today	X Chou, A 12 17
	5a(a, H 12 17 -
Call/Count 373 1,322 25,934	Schuster,P 13 18
Order Count 234 925 17,834	Silverman, C 13 18
(Sparklines acalesiae % of target)	Truman, N 13 19
Reps Reps 124 124	X Pierce,8 14 19
	Pisher,J 14 20
10-	Jung,T 14 20
8- Blackert	English, S 15 21
	welleast emphasis
	Johnson, N 15 21
	X Lucas, J 18 22
2 2	Forester, R 17 23
	0 3 6 9 12 15 18 21
Mean Hourly Calls per Rep Today Nean Hourly Orders per Rep Today	(X = Currently offine) Call Duration (minutes)
Telesales Dashboard Reset Alerts Untreeze Data	HCIP Click rep to sensiinstant message (IIICoost, IIIExcessive; IICritical)







Avoid Useless Bling

- Software provides visualizations that are glitzy but unhelpful
- Require disproportionate amount of room for the information presented
- Hard to read and understand
- Little actionable information













As at 2007 11:02	8/1/	(CIO)	D. Smith (Cl	rd for	IT Dashboar	Veb Site Email	Warehouse	ERP Dati	Network	Latest
e 📗 Critical)	ood 📗 Excessive	(Actual Go		Metrics	Key Non-System N	cceptable Accepta	(Actual N	ility (Last 30 days)	stem Availab	Major Sy
Actual		% of Target	! Metric		Year-To-Date	Availabilit			onths	Last 12 M
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3.25 of 4		isfaction	Customer Satisfactio	~ (~~~~	• 97			~	~
56		ems	Level I Problems	_ (\sim	93		3	$\sim \sim$	\sim
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Days Until				estones	Major Project Mile	• 99		-	\sim	\sim
Past Due	Due Date	ilestone	Mileston		! Project	- 96	<u> </u>	12	\sim	\searrow
0	01/08/07	ull System test	Full Syste		ERP Upgrade	• 98			~~_	~
1	02/08/07	TL Coding	rehouse ETL Cod	ta to Datawa	Add services data	95% 100%				
-29	03/07/07	repare Plan	Prepare	ime OS	Upgrade Mainfran				1	
3	04/08/07	stall Hardware	Install Ha		DR Site Upgrade	d 📗 Excessive 📕 Crit	(Actual	ity	e % of Capa	Hardwar
-9	23/07/07	ire PM resource	Hire PM	m	Budgeting System		Overali 🗧	$\sim \sim \sim$	Last 7 days	CPU
5	06/08/07	A review	QA revie	2n	Web site redesign		Today 🖷	$\sim \sim$	Last 12 Mo.	Storage

Monthly Network Traffic (Kilobytes)



Response Time (Distribution in seconds)



56 ntil Due 0 1 -29 3 -9 5 c n. in the day of Eurodia

10	p 5 Projects in the Queue (Sorted	by priority)	Funding	
#	Project	Status	Approved	Sched. Start
1	Timesheet and Expense System	Project Manger awaited	×	01/10/07
2	Upgrade Office to 2007	Cost benefit Analysis		01/09/07
3	Failover for ERP	Gate I preparation		12/09/07
-4	Updgrade DW hardware	Evaluating Options		05/08/07
5	Executive Dashboard	Vendor XLCubed Selected	×	01/09/07

Critical Events (Next 14 days)	Manager	
Event	Responsible	Date
Full System maintenance putage from 11 - 1130 pm	CGJ	03/08/07
Present Hardware Upgrde Proposal to CEO	Self	04/08/07
Asia IT Management Team visting CIO	Self	05/08/07
Prepare Release Management Strategy for DW	PDP	06/08/07
Deliver TDWI Dashboard Best Practises Presentation	Self	07/08/07























































Few's Steps to Dashboards

- 1. Begin with a definition
- 2. Focus on the goals, not on the means
- 3. Get into people's heads
- 4. Ask the right questions
- 5. Identify information that really matters
- 6. Identify useful context for measures







Last updated 2 days ago

02

Q3

Q1

02

Q3

QTD

Last updated 1 day ago

Q4



Last updated 2 days ago













Planning Completed	Design Completed	Develo 6	opment	Testing Waiting	Pro Lau Mon Frida	ojected nch Date 07 Days y, December 15
Proje	ect Budget			Overdue -	Tasks	
60К			Overdu	ue Task	Deadline	Employee
540К	Total Budget 💲	52,000	1 Day	Update facebook prof	ile 2017-08-15	5 Paula
	Remaining	\$8.770	4 Day	S Update testing plan	2017-08-0	6 Kate
320К		0 10/	10 Day	S Configure desktop	2017-08-0	1 Nancy
\$OK Total Budget Budget Amount Used Target Amount Used	Currently O	O.I /o Iver Target	🔵 24 Day	ys Set up new databas	e 2017-07-18	3 Georg
W	orkload		Upcoming D	eadlines		
67 %			Employee	Task	Deadline	Workload
55 %	48 %		Kate	Update twitter profile	2017-08-15	349
	45 %	30 %	Georg	E-Commerce Dashboard	2017-08-06	569
		55 78	Nancy	Set up dev environment	2017-08-01	15%
Georg Nancy	Richard Kate	Paula	Paula	Hire Data Scientist	2017-07-18	• 119







Data Culture



Data Culture

- Data culture is the collective beliefs and behaviors of the people in the organization for leveraging data for improved busines performance. – Forbes
- Data culture is the collective behaviors and beliefs of people who value, practice, and encourage the use of data to improve decision-making. – Tableau

• Gartner's third CDO Survey lists data cultures as the number one challenge for realizing benefits of data and analytics







Data Culture

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Data Culture

• Data culture is the **behaviors** of the **people** using **data** for **improved** decision making. – Schmucki









Hurdles to Data Culture

- Executives lack a clear vision for advanced analytics
- Goals are driven by tools and not business problems
- Analytic capabilities are isolated from the business
- Ignoring Lean Principles











McKinsey's Model

Defining roles is an important first step in sourcing and integrating the right talent for your data culture.



- Business leaders lead analytics transformation across organization
- 2 **Delivery managers** deliver dataand analytics-driven insights and interface with end users
- 3 Workflow integrators build interactive decision-support tools and implement solutions

4

Visualization analysts visualize data and build reports and dashboards

- 5 **Data engineers** collect, structure, and analyze data
- 6 Data architects ensure quality and consistency of present and future data flows
- 7 Analytics translators ensure analytics solve critical business problems
- Data scientists develop statistical models and algorithms







Steps to Data Culture

- 1. Create a service culture as it relates to data
- 2. Move away from Consensus and Hierarchy Cu
- 3. Leverage technology
- 4. Invest in both people and technology
- 5. Fix basic data-access issues quickly
- 6. Question analytical choices











"In God we trust, all others bring data."

W. Edwards Deming