

C4M — COMPUTING FOR MEDICINE

# INFORMATION VISUALIZATION

---

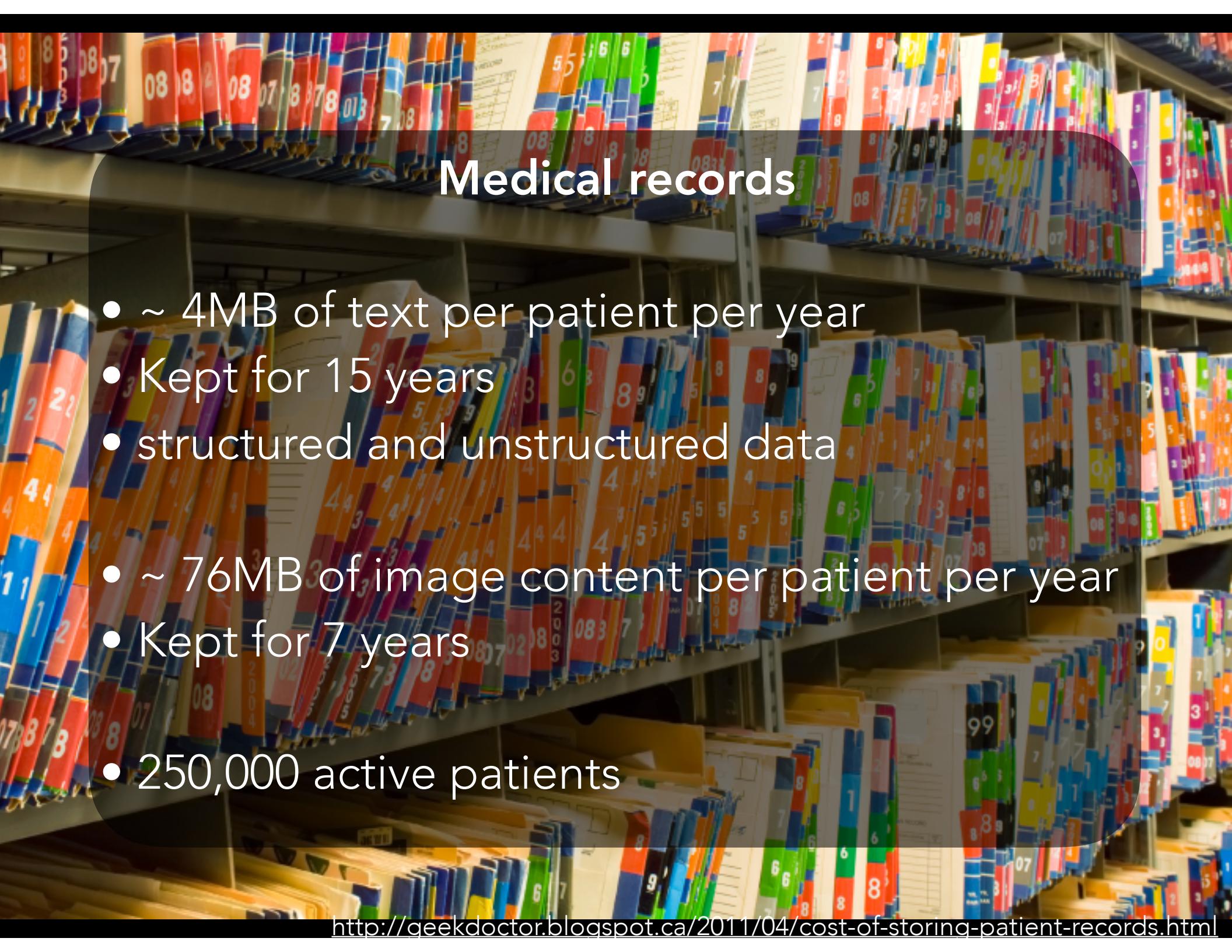
Nicole Sultanum

based on slides by Fanny CHEVALIER



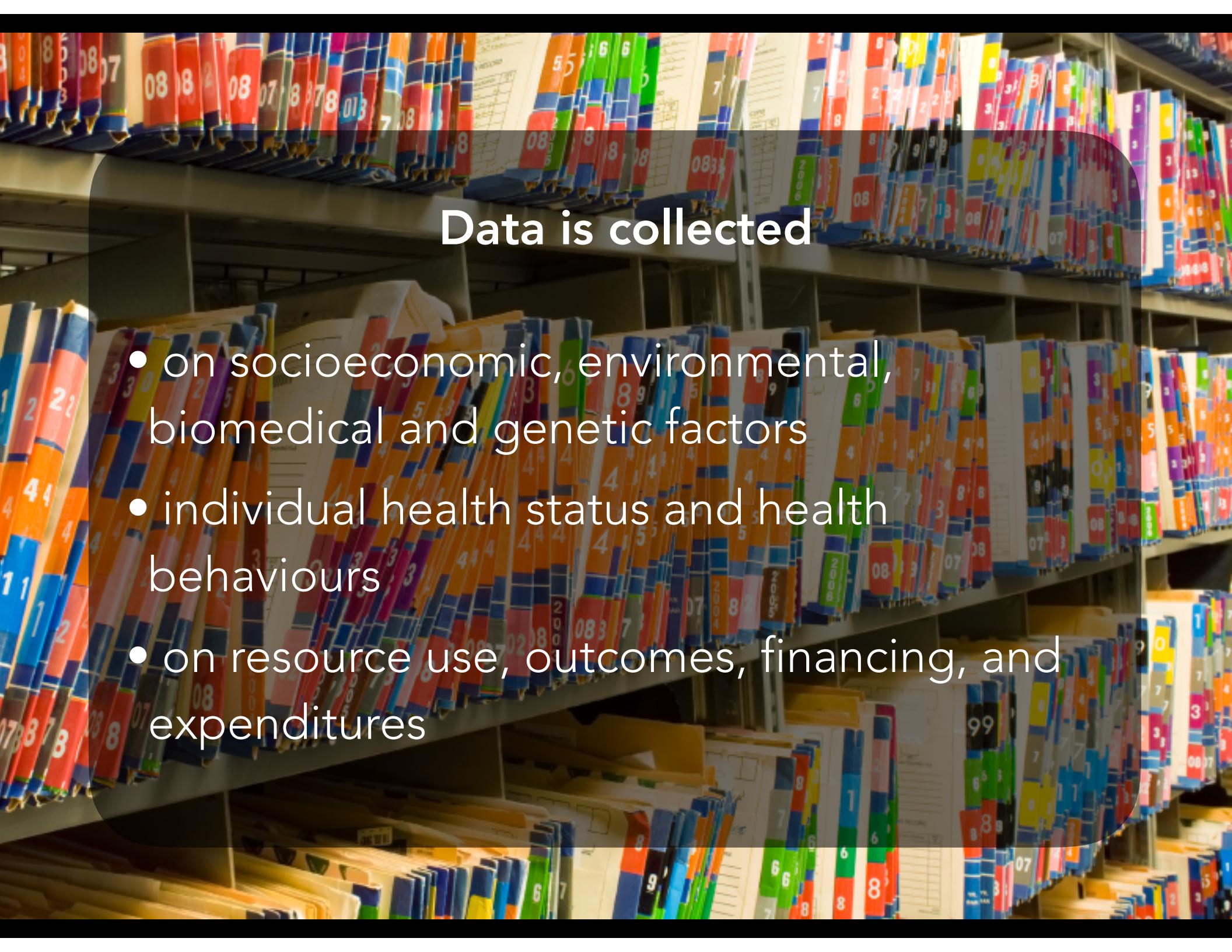


Data



# Medical records

- ~ 4MB of text per patient per year
- Kept for 15 years
- structured and unstructured data
- ~ 76MB of image content per patient per year
- Kept for 7 years
- 250,000 active patients



## Data is collected

- on socioeconomic, environmental, biomedical and genetic factors
- individual health status and health behaviours
- on resource use, outcomes, financing, and expenditures

DATA != INSIGHTS

**Connectedness**

**Wisdom**

**Knowledge**

**Information**

**Data**

**Understanding**

*Understand  
Relations*

*Understand  
Patterns*

*Understand  
Principles*

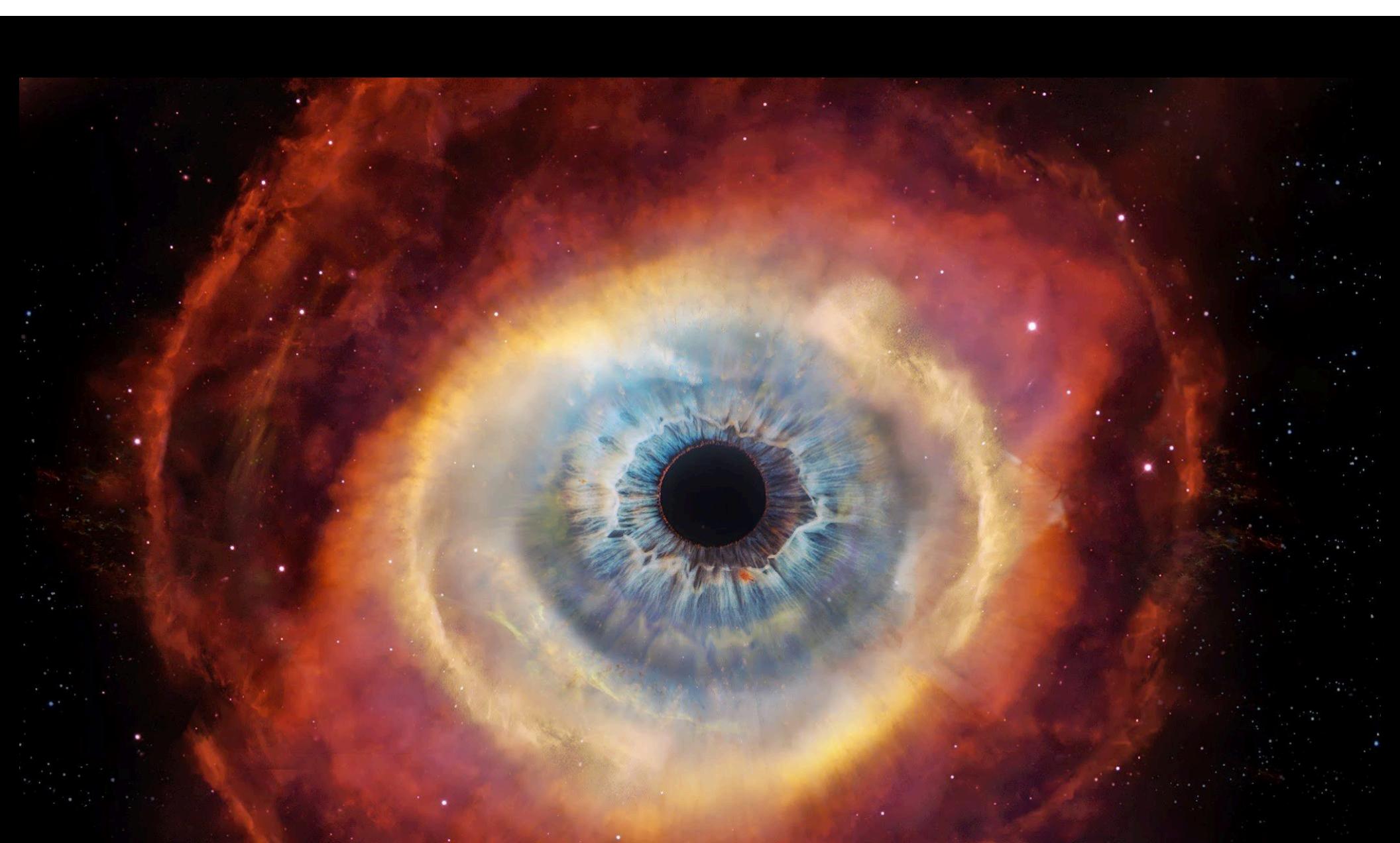


[ source: Data, Information, Knowledge, and Wisdom by Gene Bellinger, Durval Castro, Anthony Mills]

ANALYSIS IS NEEDED

How can we ...

- effectively access to the information?
- understand the data structure?
- make comparisons?
- make decisions?
- discover new insights?
- communicate to others?
- convince?
- ...



VISION

## Sub-conscious Bandwidth

(millions of bits per second)



## Conscious Bandwidth

(bits per second)



# WHY VISUAL REPRESENTATIONS?

- **Vision** is the sense with the **highest bandwidth** ( $\approx 100\text{MB/s}$ , then ears  $<100\text{b/s}$ );
- **Vision extends** memory and cognition
- people **think visually**

# BRITISH CASUALTIES IN THE CRIMEAN WAR

DATA	WOUND	FIELD	DISEASE
05/1854	0	95	105
06/1854	0	40	95
07/1854	0	140	520
08/1854	20	150	800
09/1854	220	230	740
10/1854	305	310	600
11/1854	480	290	820
12/1854	295	310	1100
01/1855	230	460	1440
02/1855	180	520	1270
03/1855	155	350	935
04/1855	195	195	560
05/1855	180	155	550
06/1855	330	130	650
07/1855	260	130	430
08/1855	290	110	490
09/1855	355	100	290
10/1855	135	95	245
11/1855	100	140	325
12/1855	40	120	215
01/1856	0	160	160
02/1856	0	100	100
03/1856	0	125	90

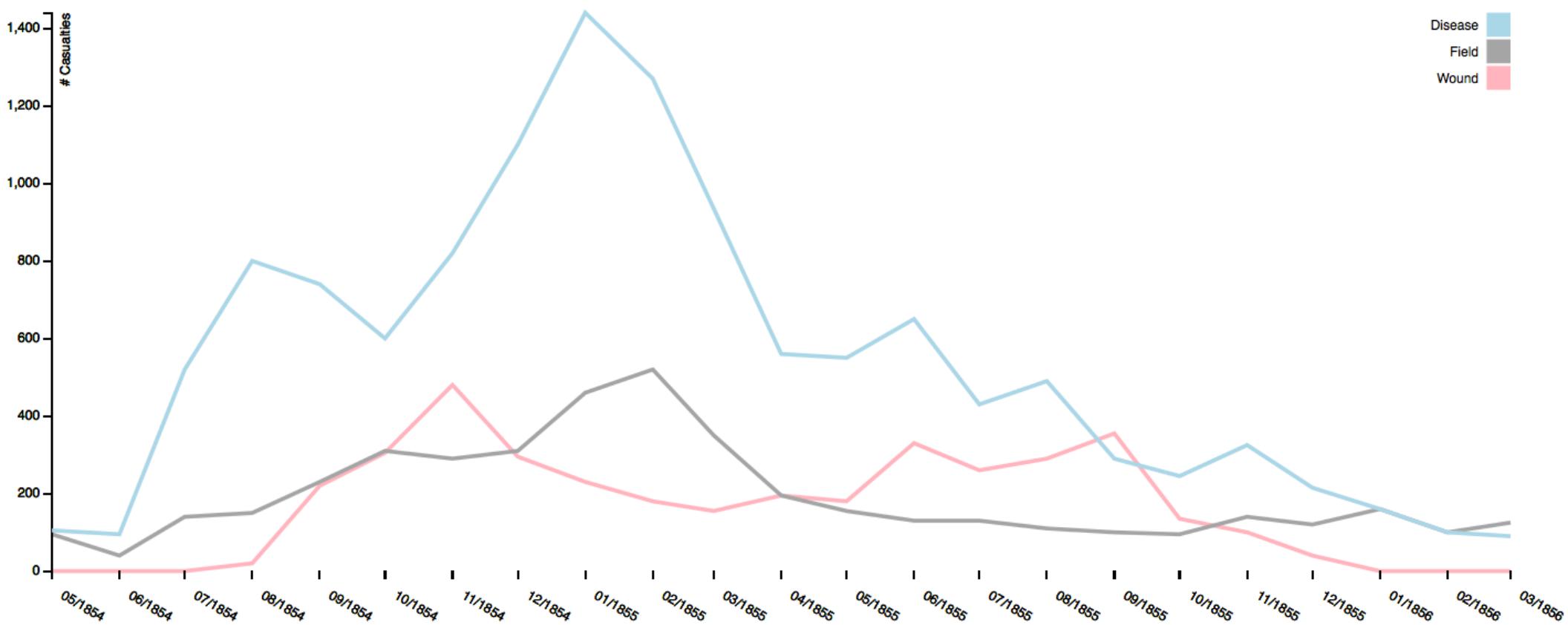
Month with **highest casualty rates** in the **field**?

Month with **highest total casualty rate**?

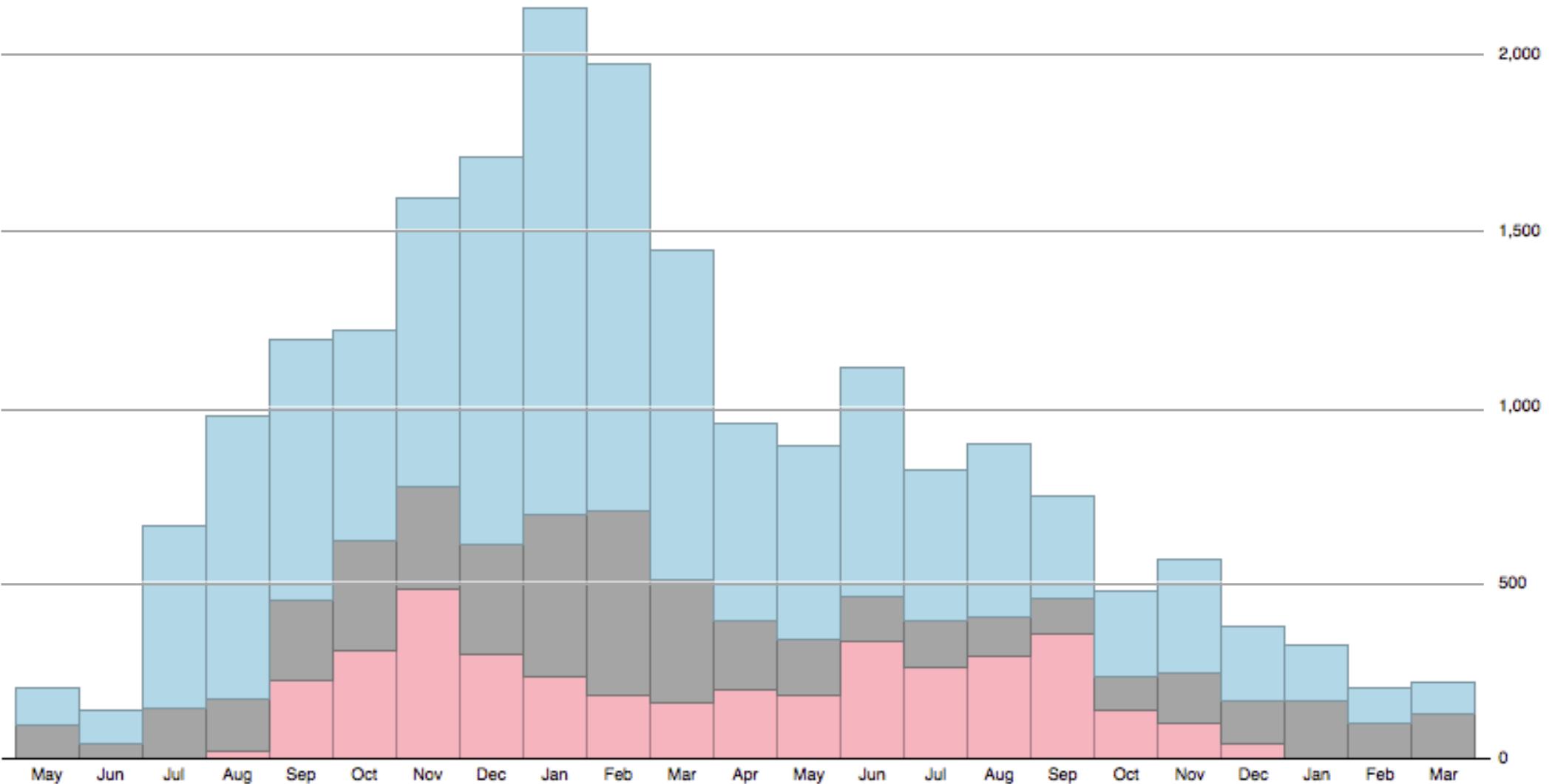
# months in which deaths by **wound** exceeds deaths in the **field**?

Months in which **% of deaths** by disease was **below 50%**?

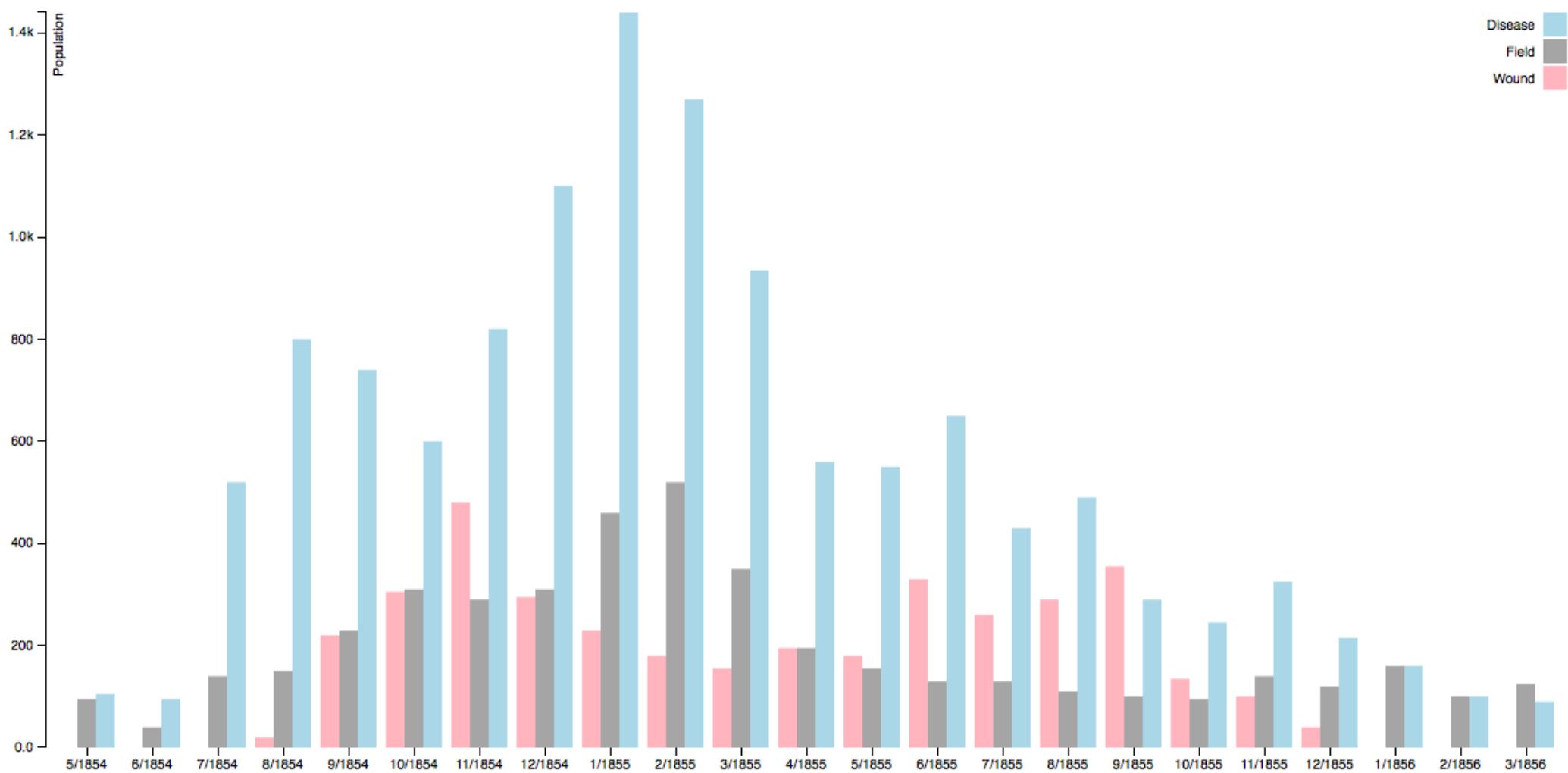
# Month with **highest casualty rates** in the field?



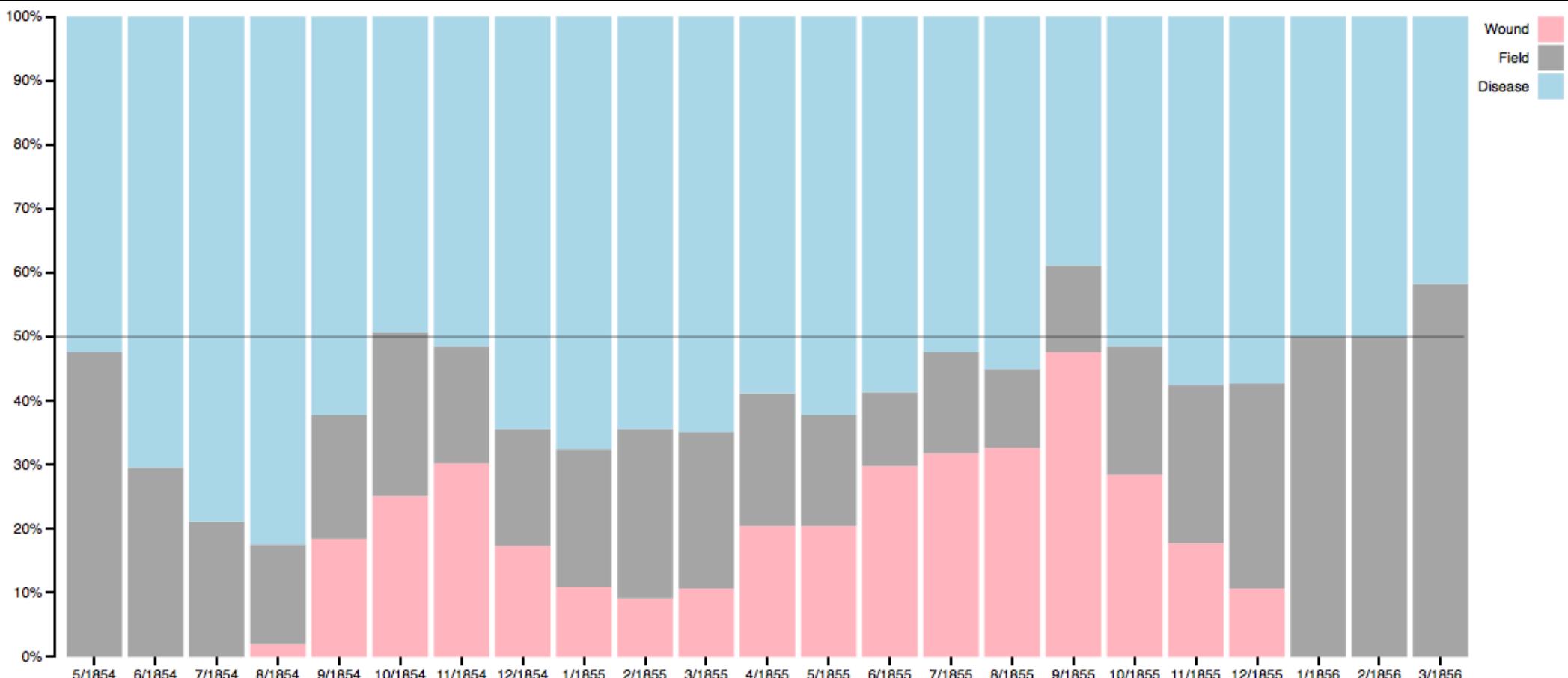
# Month with **highest total** casualty rate?



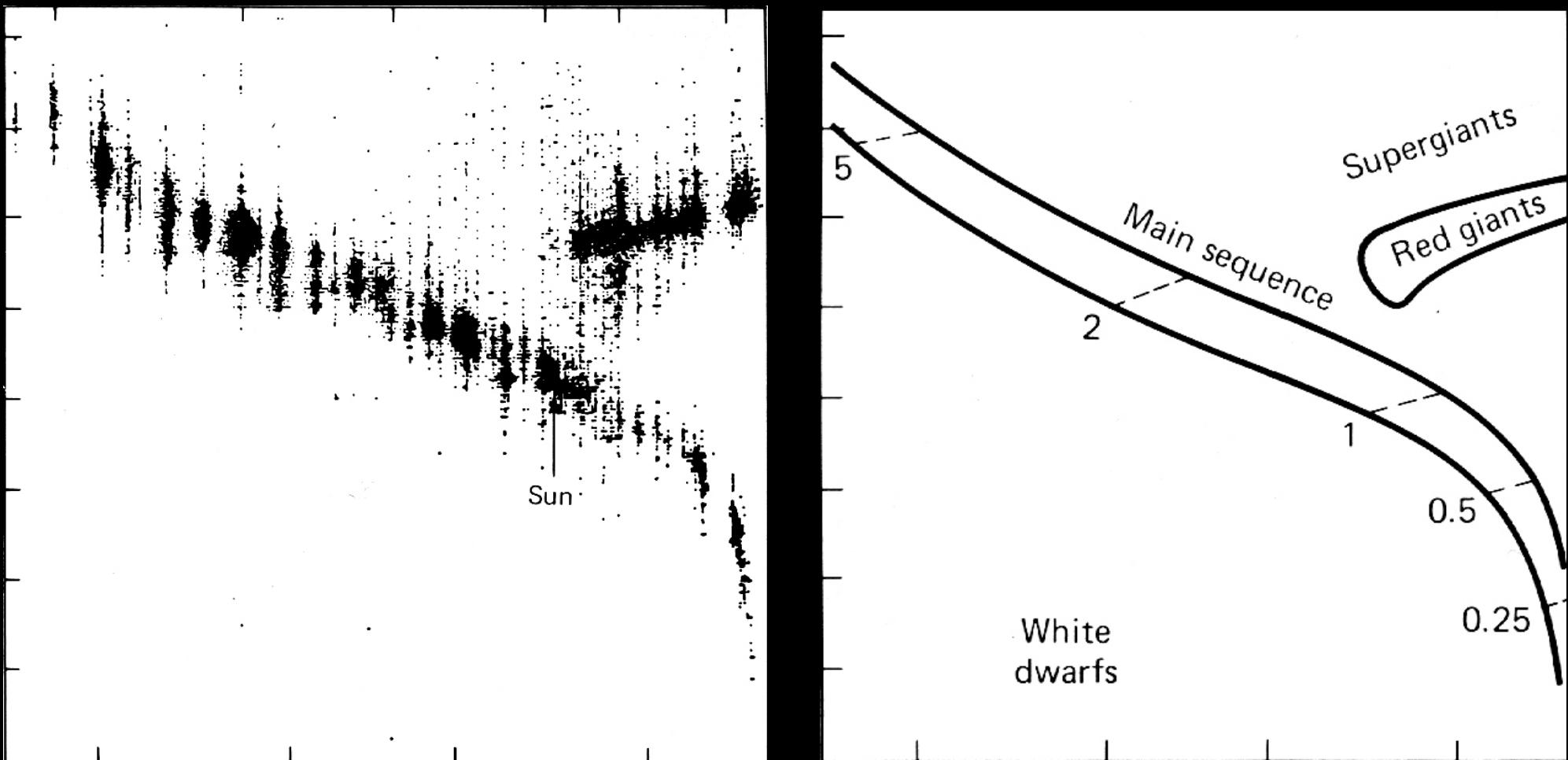
# # months in which deaths by **wound** exceeds deaths in the **field**?



# Months in which **% of deaths** by disease was **below 50%**?



# AUTOMATIC ABSTRACTION CAPABILITY



Hertzsprung Russell Diagram and its interpretation

# Anscombe's Quartet

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Source: Anscombe's Quartet, Wikipedia

# STATISTICAL ANALYSIS

suggests that all datasets are equivalent w.r.t. some metrics

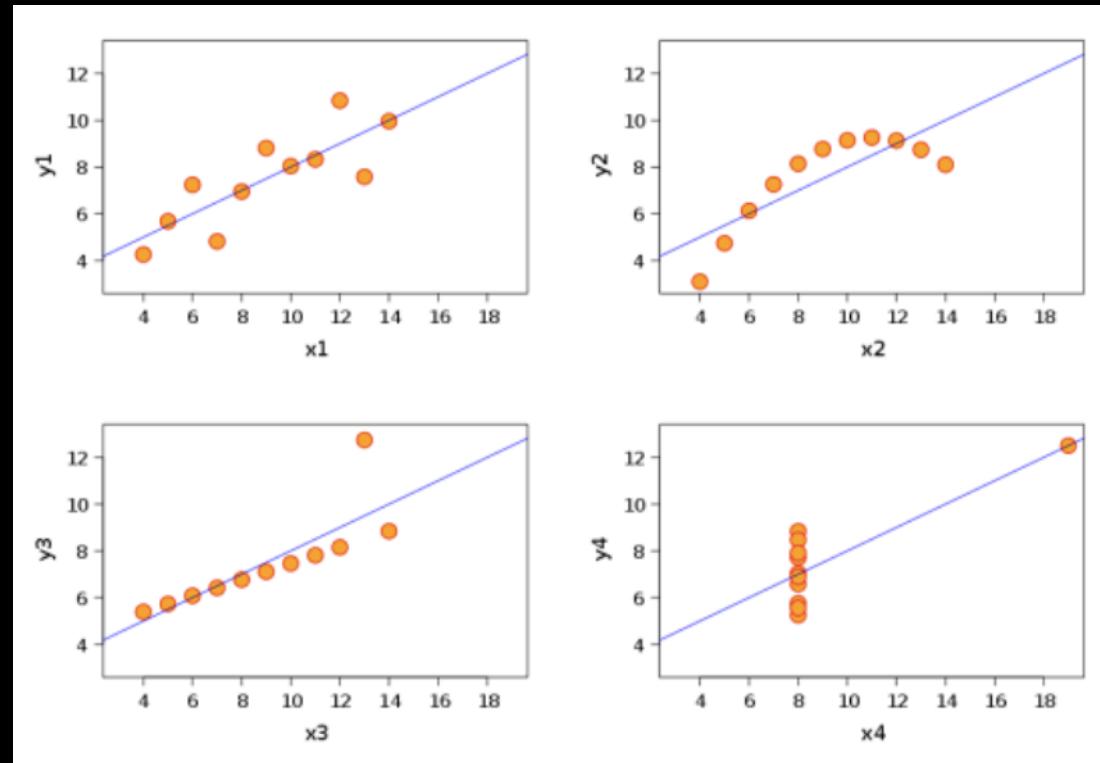
I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89

Mean of x	9
Sample variance of x	11
Mean of y	7.50
Sample variance of y	4.12
Correlation between x and y	0.816
Linear regression line	$y = 3.00 + 0.500x$

# VISUALIZATION

the visual representations tell a complete different story...

I		II		III		IV	
x	y	x	y	x	y	x	y
10.0	8.04	10.0	9.14	10.0	7.46	8.0	6.58
8.0	6.95	8.0	8.14	8.0	6.77	8.0	5.76
13.0	7.58	13.0	8.74	13.0	12.74	8.0	7.71
9.0	8.81	9.0	8.77	9.0	7.11	8.0	8.84
11.0	8.33	11.0	9.26	11.0	7.81	8.0	8.47
14.0	9.96	14.0	8.10	14.0	8.84	8.0	7.04
6.0	7.24	6.0	6.13	6.0	6.08	8.0	5.25
4.0	4.26	4.0	3.10	4.0	5.39	19.0	12.50
12.0	10.84	12.0	9.13	12.0	8.15	8.0	5.56
7.0	4.82	7.0	7.26	7.0	6.42	8.0	7.91
5.0	5.68	5.0	4.74	5.0	5.73	8.0	6.89



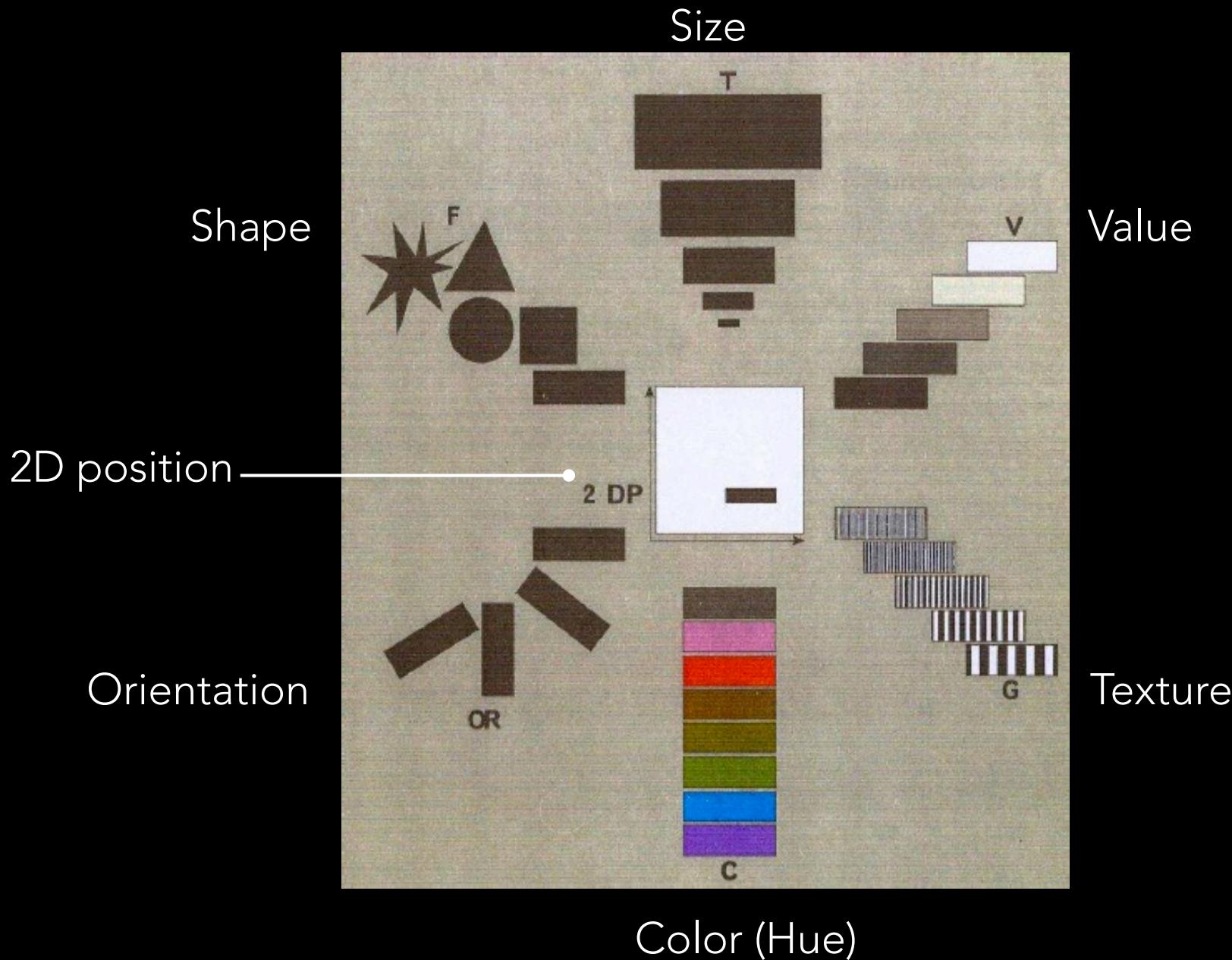
Source: Anascombe's Quartet, Wikipedia

# HUMAN IN THE LOOP

- it is sometimes dangerous to rely on purely automated analyses
- **human judgment** and **intervention** often needed
  - for: background information, flexible analysis (unintended directions), creativity
  - because: data can be incomplete, inconsistent, or deceptive
  - also: an excellent communication tool

HOW?

# VISUAL VARIABLES (aka Retinal variables)

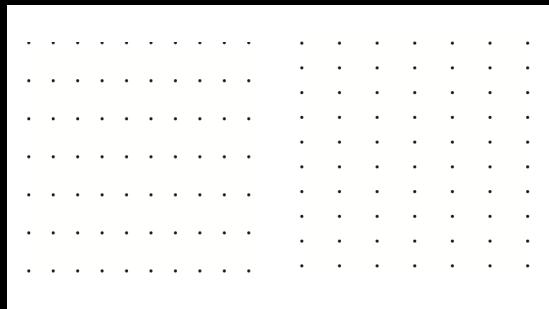


# EFFECTIVENESS AND EFFICIENCY

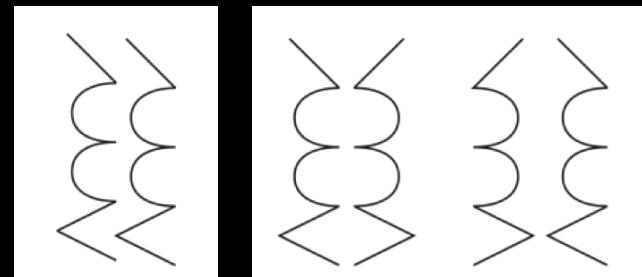
- Some visualizations are objectively better than others, based on:
  - Perceptual principles
  - Task to be solved
  - Underlying data
  - Domain/context knowledge

# GESTALT LAWS & ORGANIZATIONAL PRINCIPLES

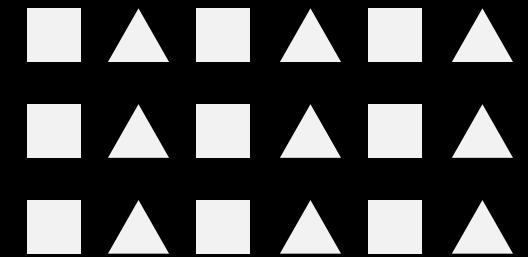
Proximity



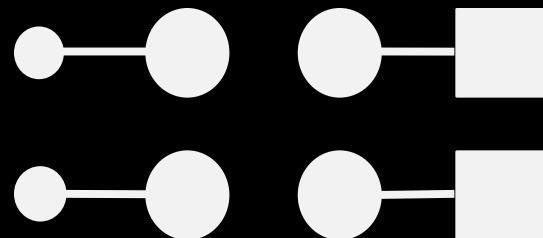
Symmetry



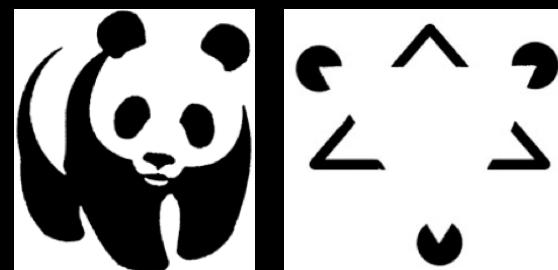
Similarity



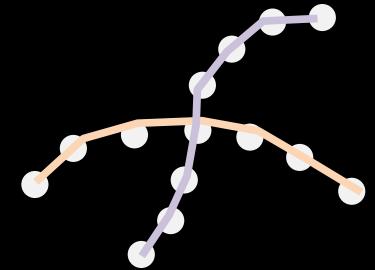
Connectivity



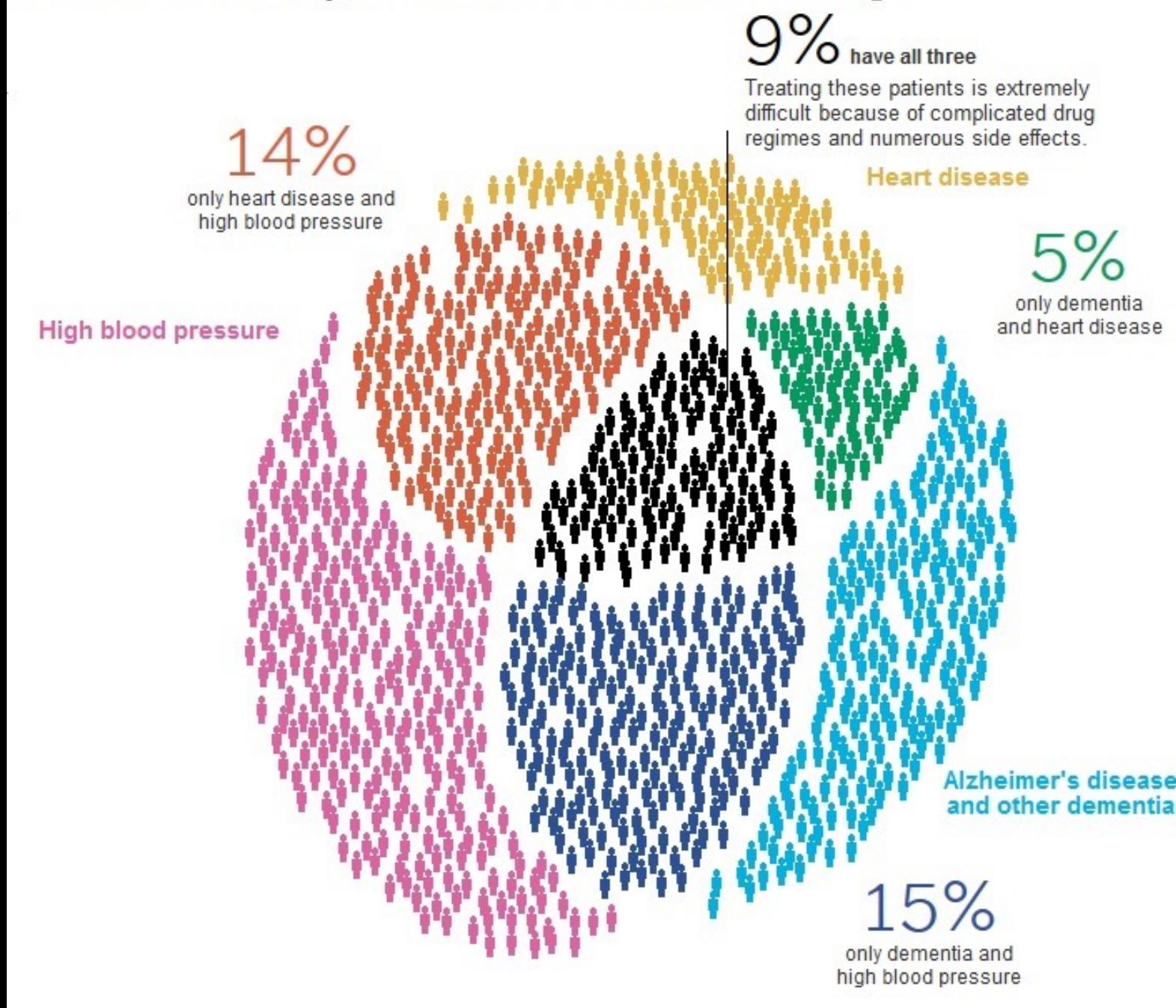
Closure



Continuity



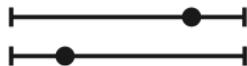
# For the Elderly, Diseases That Overlap



# EFFECTIVENESS PRINCIPLE

## → Magnitude Channels: Ordered Attributes

Position on common scale



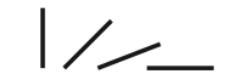
Position on unaligned scale



Length (1D size)



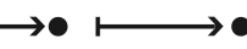
Tilt/angle



Area (2D size)



Depth (3D position)



Color luminance



Color saturation



Curvature



Volume (3D size)



Same

## → Identity Channels: Categorical Attributes

Spatial region



Color hue



Motion



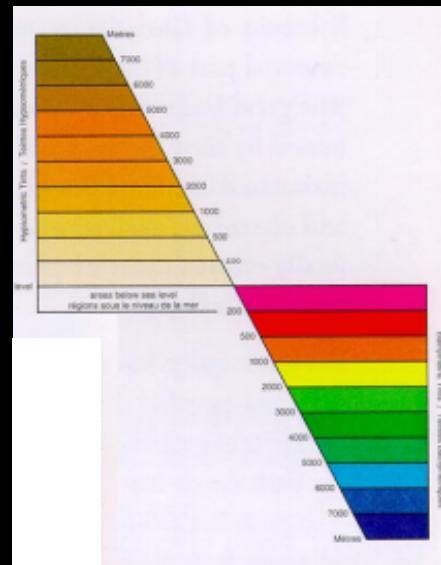
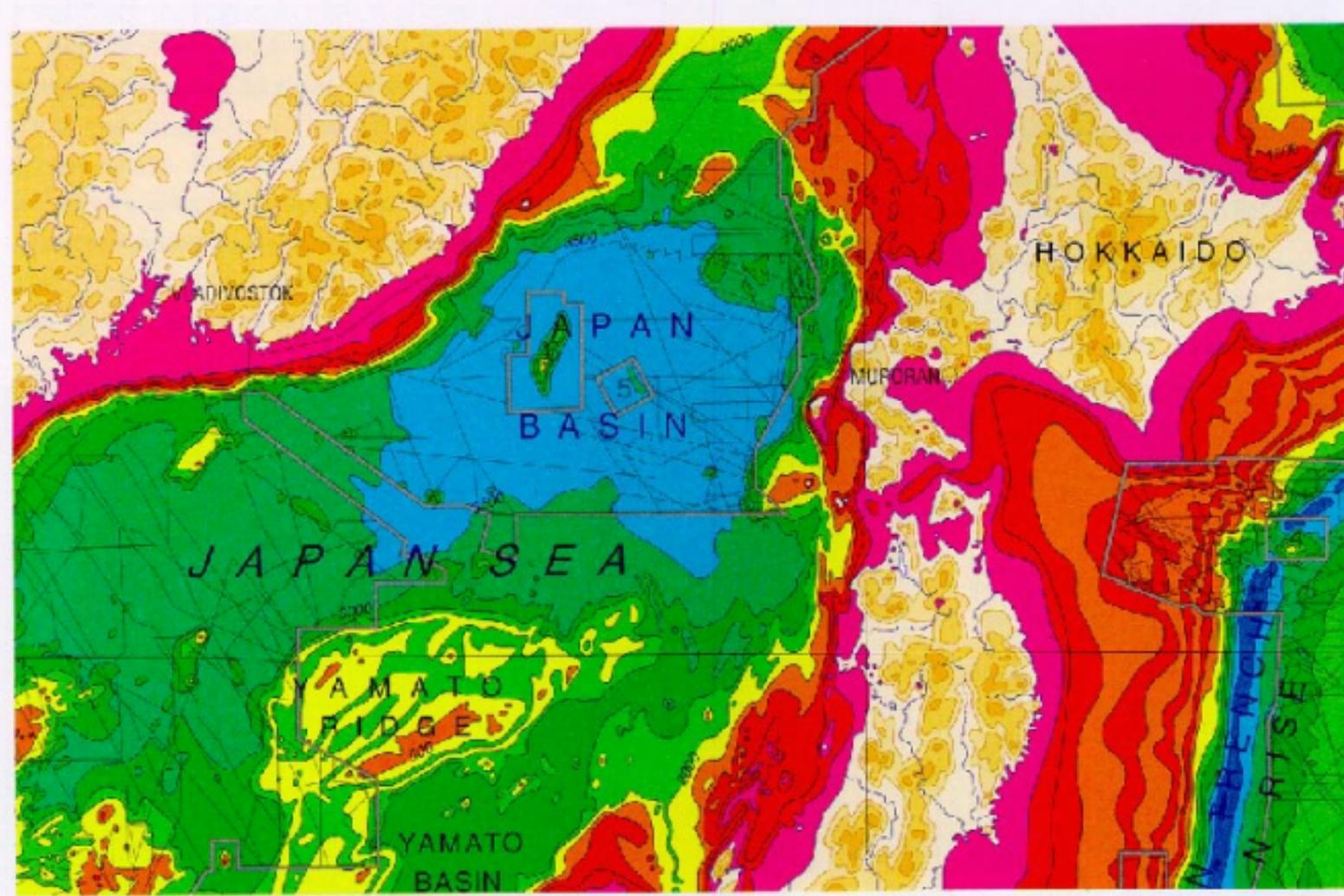
Shape



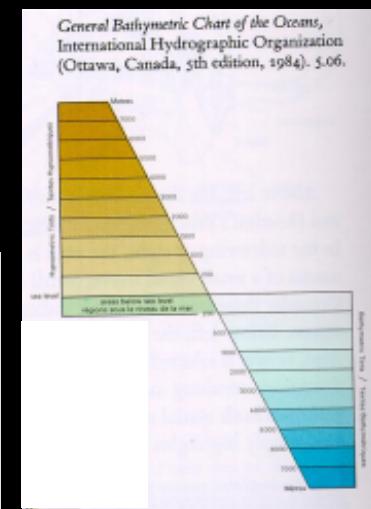
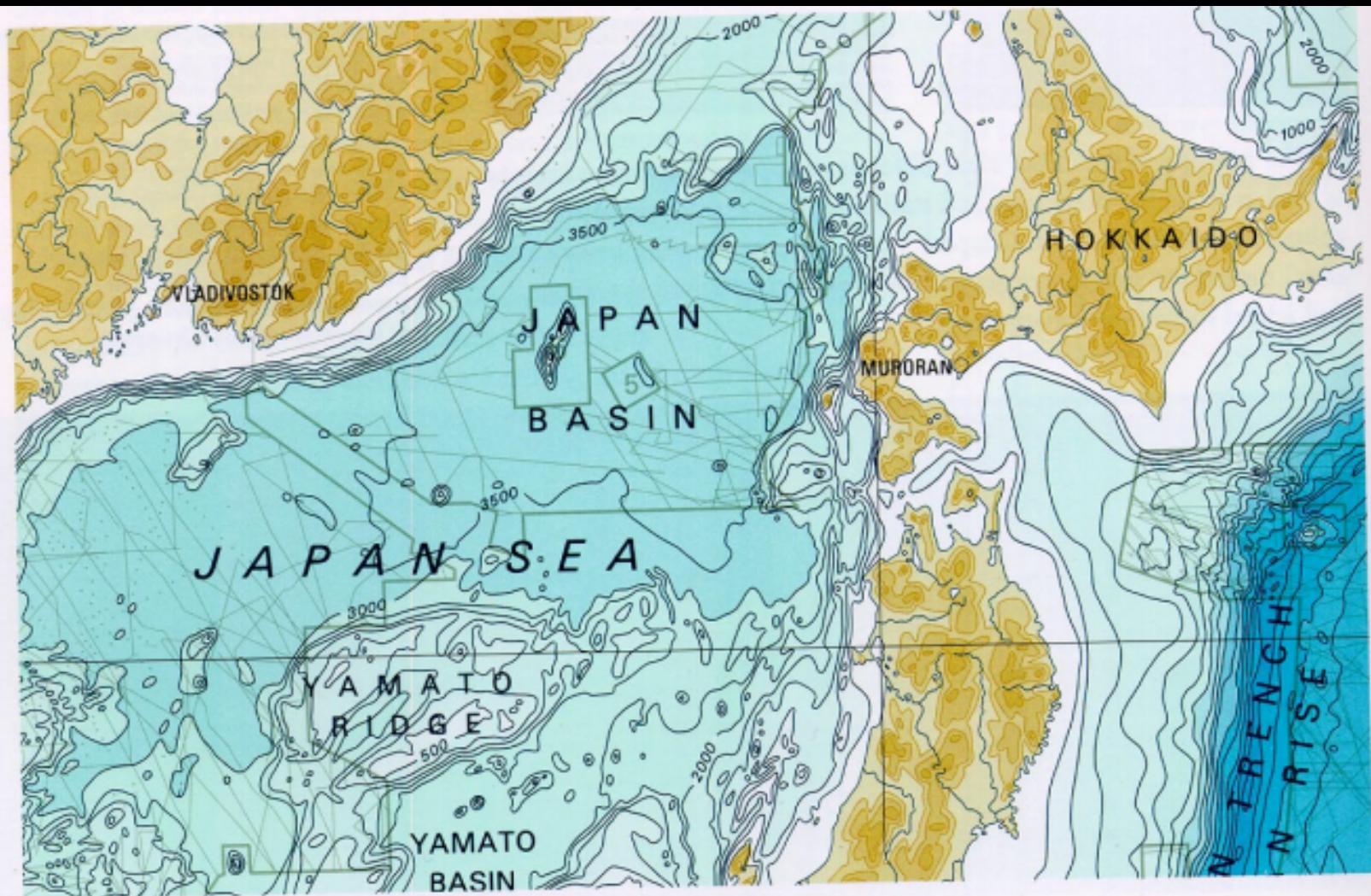
Most

Effectiveness

Least



General Bathymetric Chart of the Oceans,  
International Hydrographic Organization  
(Ottawa, Canada, 5th edition, 1984). 5.06.



# INFORMATION VISUALIZATION

Graphics should reveal the data

- show the data
- not get in the way of the message
- avoid distortion
- present many numbers in a small space
- make large data sets coherent
- encourage comparison between data
- supply both a broad overview and fine detail
- serve a clear purpose

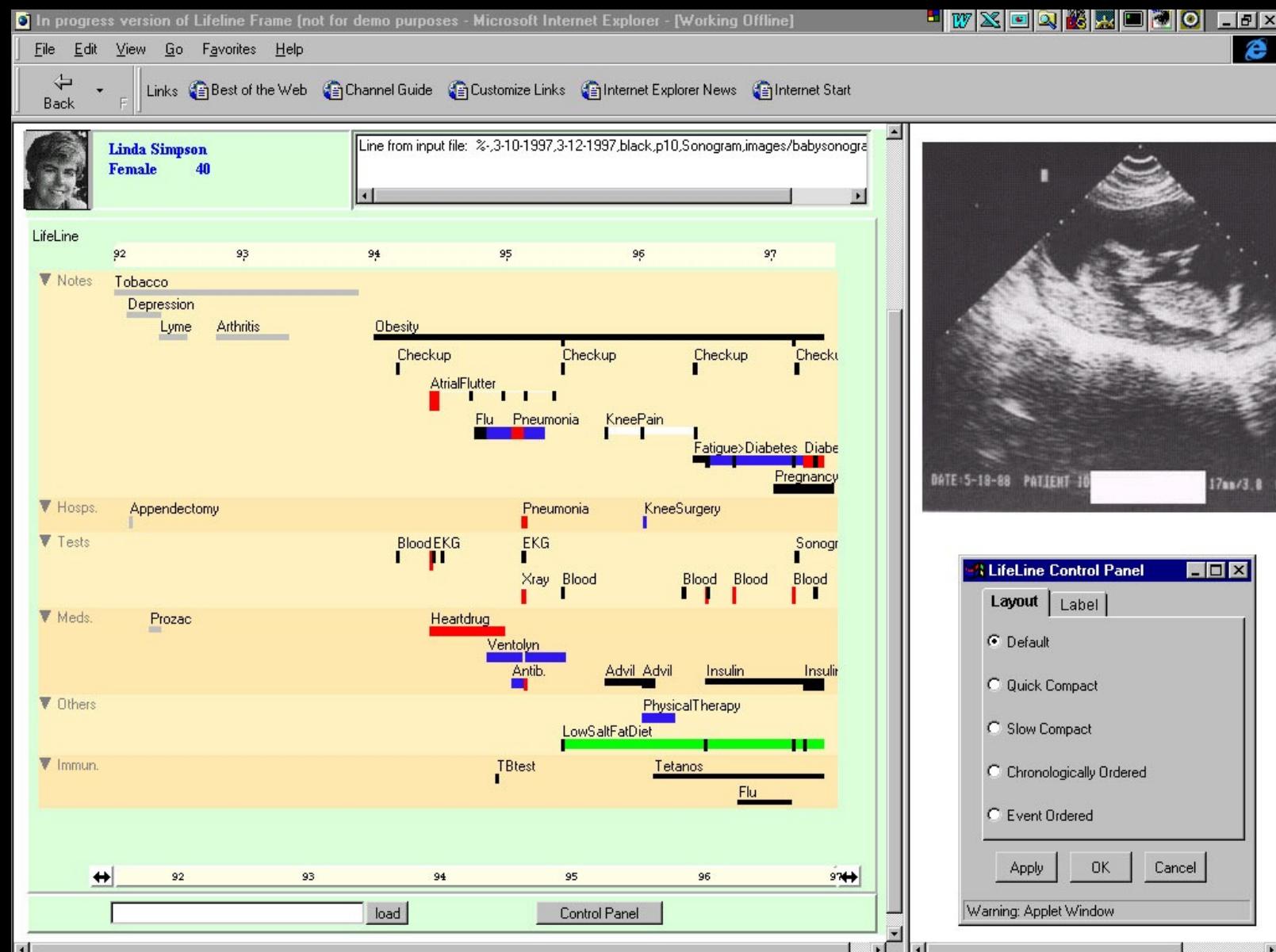
*E. Tufte  
Visual Display of Quantitative Information*

# VISUALIZATION IN MEDICINE



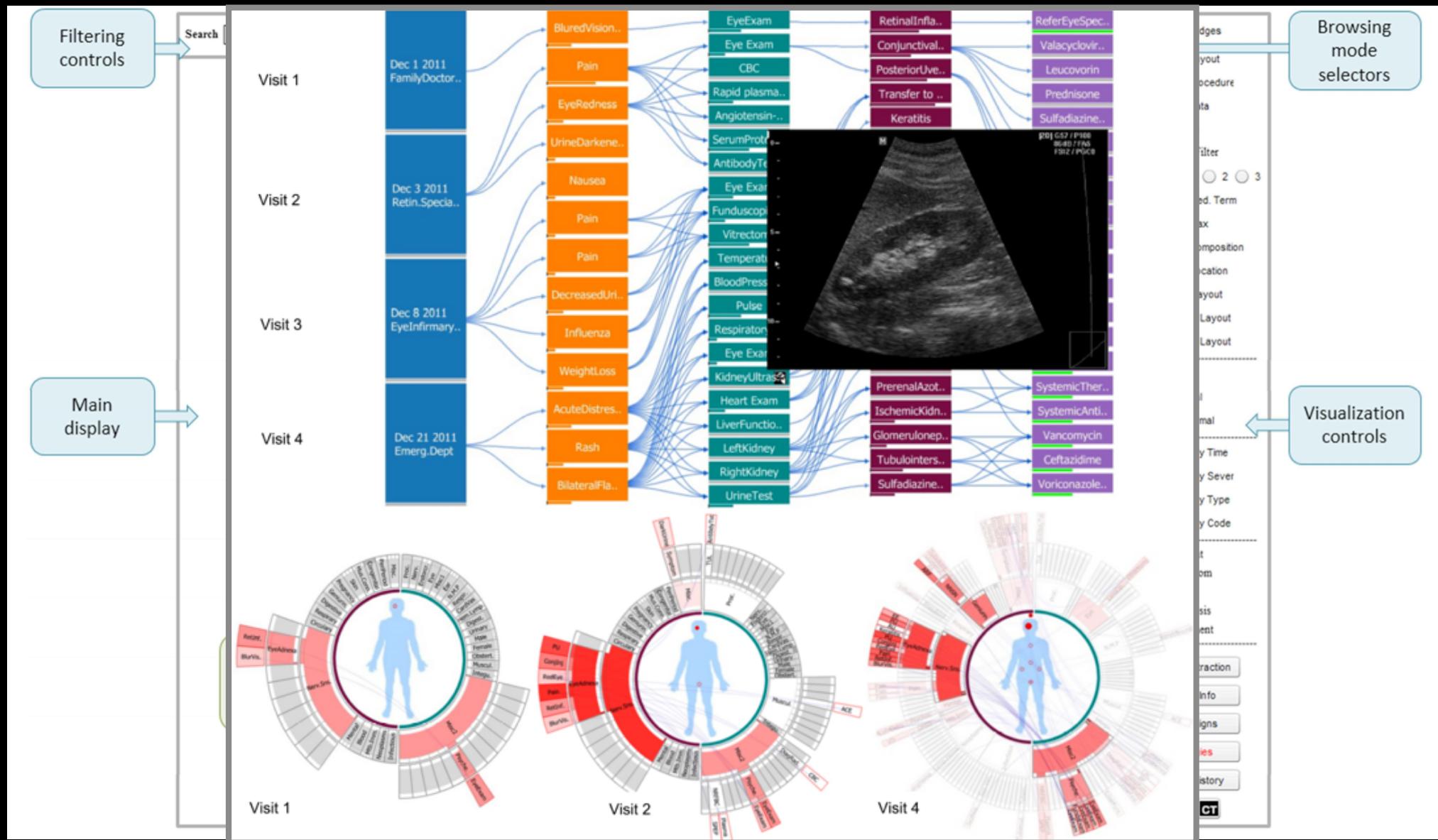
# VISUALIZATION FOR CLINICAL PRACTICE

# LifeLines [Shneiderman & Plaisant, 1996]



<http://www.cs.umd.edu/hcil/lifelines/>

# AnamneVis [Zhang et al., VIS 2013]



Z. Zhang, B. Wang, F. Ahmed, I. V. Ramakrishnan, R. Zhao, A. Viccellio, and K. Mueller, "The five Ws for information visualization with application to healthcare informatics," *IEEE Trans. Vis. Comput. Graph.*, vol. 19, no. 11, pp. 1895–1910, 2013.

# HARVEST [Hirsh et al., JAMIA 2015]

**INY** Patient List Registry Patient Data

Profile History/Timelines Data Review Research

EMR NYU/CU CMC

Filter [ ] Save Pg# Order

Epilepsy Note - Columbia University (20 - 10-17-20 - 05-08)

Cardiology Consult Follow-Up Free Text Note  
Procedure Note, Time Out Not Required  
Medicine Follow-Up Free Text Note  
Transfusion Nursing Note  
Nursing Adult Admission History  
Critical Care Values Reporting  
Milstein Hospitalist Attending Follow-Up Free Text Note  
Milstein Hospitalist Admitting Follow-Up Free Text Note  
Cardiology Consult Follow-Up Free Text Note  
Milstein Hospitalist Resident/PA Follow-Up Free Text Note  
Milstein Hospitalist Attending Follow-Up Free Text Note  
Cardiology Consult Free Text Note  
Medicine Follow-Up Free Text Note  
Case Manager Plan Of Care  
Milstein Hospitalist Attending Assessment  
Milstein Hospitalist Resident/PA Follow-Up Free Text Note  
Milstein Hospitalist Attending Follow-Up Free Text Note  
Cardiology Free Text Note  
Nursing Adult Admission History  
Medicine Admission Free Text Note  
Transfusion Nursing Note  
Emergency Department Disposition Note  
Emergency Resident / Nurse Practitioner / Attending Note (Milstein)

Admit Add Discharge Sum Admit Admin Operative Operative Report Add Neurophys Cardiology GI Endo HEMAT Pulmonary Dem Path Endocrinol Allergy Pharmacy Billing Diagnosis All Data

Filter [ ] Save Pg# Order

Cardiology Consult Free Text Note • 20 - 10-10 14:14

Cardiology Consult  
Requested by: [ ]  
Reason: Fluid overload  
  
HPI: 57 yo woman with a pmhx significant for morbid obesity, HTN, HLD, CKD. CAD stage VI in resting and making urine. CAD s/p mLAD DES in 7/2005, and pulmonary HTN (based on RHC on 7/2005) with signs and symptoms of fluid overload. Cardiology is being asked to consult for further management. In regards to the patient's functional status, the patient lives a sedentary lifestyle and is now on disability. Over the course of the past month, she has had increasing fluid accumulation with a weight gain of over 25 kg, with worsening LE edema and facial puffiness. Prior to 1 month ago, her ET was 2 blocks, but has now decreased to 15 feet limited by SOB and occasionally with CP. Furthermore, she has a 6 pillow orthopnea that has been stable for 4 years but has worsened PND this past month. The patient also reports 3 months of intermittent chest pain, located in the center of the chest, lasting 5 minutes with 1-2 episodes per week. These episodes occur at rest, and improved by sitting up and taking an aspirin.  
PtRx:  
1. Morbid obesity  
2. HTN  
3. HLD  
4. DM2  
5. CAD (stage VI) not on RRT and making urine  
6. CAD s/p mLAD DES in 7/2005

Timeline: 8/1/20 to 10/24/20

Admitted: 8/2/20 Visit Type: Clinic Attending: Dx: CHEST PAIN NOS  
Admitted: 9/21/20 Visit Type: REFERRED AMBULATORY SERVICE Attending: Dx: PERFORATION GALLBLADDER  
Admitted: 9/27/20 Visit Type: Clinic Attending: Dx: ACUTE DIASTOLIC HEART FAILURE  
Admitted: 10/6/20 Visit Type: Inpatient Attending: Dx: ACUTE CHRNIC DIASTOLIC HRT FAIL

stable angina pulmonary hypertension ESRD dyspnea influenza abdominal pain DM CAD  
edema volume overload obese OSA chest pain lymphadenopathy morbid obesity pruritis weight gain hypertension DM2 LVH  
leg cramps chest discomfort vitamin D deficiency CKD hyponatremia agitation fistula nausea facial swelling hypoglycemia ischemia  
CHF Dyslipidemia abdominal mass scar hyperphosphatemia anasarca angina hypoventilation \*\*\*

More

**Notes about dyspnea 8/1/20 - 10/24/20**

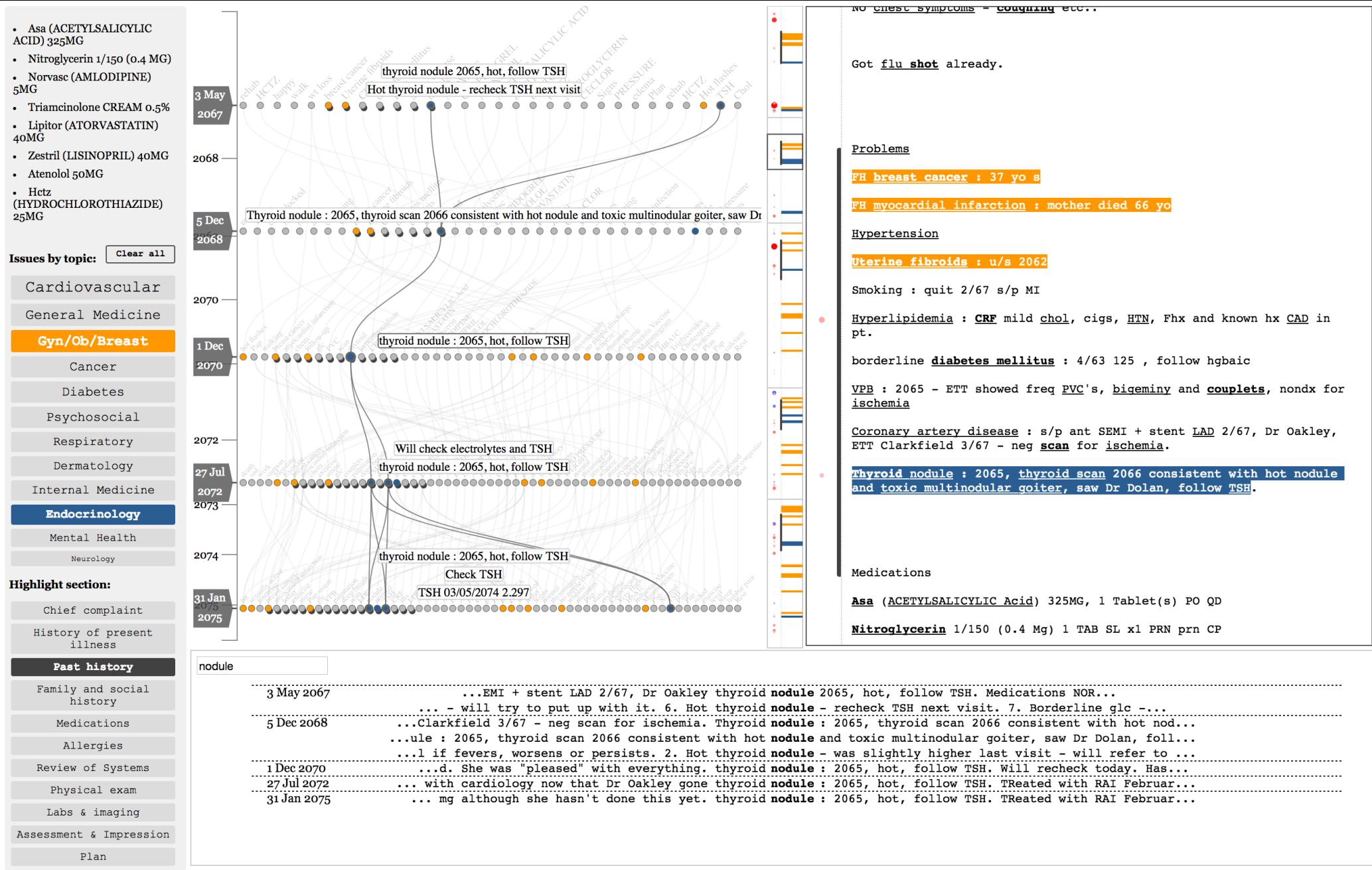
Cardiology Consult Follow-up Free Text Note	10/15/20	1:32 PM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/15/20	7:00 AM
Medicine Follow-Up Free Text Note	10/14/20	4:06 AM
Nephrology Consult Free Text Note	10/13/20	2:52 PM
Milstein Hospitalist Attending Follow-up Free Text Note	10/13/20	11:27 AM
Cardiology Consult Follow-up Free Text Note	10/12/20	11:40 AM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/12/20	7:02 AM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/11/20	12:43 PM
<b>Cardiology Consult Free Text Note</b>	<b>10/10/20</b>	<b>10:14 AM</b>
Medicine Follow-Up Free Text Note	10/10/20	10:10 AM
Case Manager Plan of Care	10/10/20	5:31 AM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/09/20	7:58 AM
Milstein Hospitalist Resident/PA Follow-up Free Text Note	10/08/20	7:21 AM
Nursing Adult Admission History	10/07/20	2:24 AM
Medicine Admission Free Text Note	10/06/20	11:30 PM
ED Resident/NP/Attending Note (Milstein)	10/06/20	3:04 PM

**Cardiology Consult Free Text Note**

Cardiology Consult  
Requested by: Dr. [ ]  
Reason: Fluid overload  
  
HPI: 57 yo woman with a pmhx significant for morbid obesity, HTN, HLD, CKD (stage V) not on RRT and making urine, CAD s/p mLAD DES in 7/2005, and pulmonary HTN (based on RHC on 7/2005) who presents with signs and symptoms of fluid overload. Cardiology is being asked to consult for further management. In regards to the patient's functional status, the patient lives a sedentary lifestyle and is now on disability. Over the course of the past month, she has had increasing fluid accumulation with a weight gain of over 25 kg, with worsening LE edema and facial puffiness. Prior to 1 month ago, her ET was 2 blocks, but has now decreased to 15 feet limited by SOB and occasionally with CP. Furthermore, she has a 6 pillow orthopnea that has been stable for 4 years but has worsened PND this past month. The patient also reports 3 months of intermittent chest pain, located in the center of the chest, lasting 5 minutes with 1-2 episodes per week. These episodes occur at rest, and improved by sitting up and taking an aspirin.  
PtRx:  
1. Morbid obesity  
2. HTN  
3. HLD  
4. DM2

J. S. Hirsch, J. S. Tanenbaum, S. Lipsky Gorman, C. Liu, E. Schmitz, D. Hashorva, A. Ervits, D. Vawdrey, M. Sturm, and N. Elhadad, "HARVEST, a longitudinal patient record summarizer," *J. Am. Med. Inform. Assoc.*, vol. 22, no. 2, pp. 263–74, 2015.

# MedStory [Sultani et al., CHI 2018]



# Doccurate [Sultani et al. 2018]

**Current date:** 26 Sep 2183 Psychosocial X

**Name:** Walker Peery  
**Birth (Age):** 28 Sep 2144 (38)  
**Sex:** M

Binning Interval	Document Type
3d	ECG
1w	Nur/O.
2w	Disch.
3w	Rad.
1m	Nur.
3m	Phys
	Soc.W.

**Filter Collections**

- Other
- Psychosocial**
- Mental Health
- Orthopaedics
- Gastroenterology
- Cardiovascular
- Neurology
- Note Sections
- Respiratory
- Medications
- Dermatology
- General Medicine
- Diabetes
- Endocrinology
- Cancer
- Gyn/Ob/Breast
- Nephrology

**Medical Taxonomy Codes (UMLS/SNOMED)**

- (364665006) Ability to perform function / activity
- (129025006) Activity of daily living
- (191480000) Alcohol withdrawal syndrome
- (365448001) Social and personal history finding

Search... Add

- (29212009) Alcohol-induced organic mental disorder
- (363101005) Drug withdrawal
- (191480000) Alcohol withdrawal syndrome** OK

Search... Add

**Keywords**

- abusive X
- smoking X
- smoker X
- etoh X

urine Benzos, Barbs, Upates, Cocaine, Ampmet, Methane negative  
[\[image002.jpg\]](#)

Other labs: Lactic Acid:3.1 mmol/L

Assessment and Plan

36M with **ETOH dependence** and frequent admissions for **ETOH intoxication** presents with **ETOH withdrawal**.

# **Alcohol withdrawal**: Currently with **signs** of withdrawal with **agitation**, **hypertension**, **tachycardia**, and slight tremor of upper **ext** bilat. Has gait unsteadiness which is likely [\*3-10\*\*] acute intox but appears to be chronic based on records. Can consider cerebellar degeneration [\*3-10\*\*] **etoh**.  
- given that he has hx of DTs and w/d **seizures**, will need to rx with **valium** aggressively in ICU.  
- diazepam 20mg PO 15m prn CIWA>10  
- then diazepam 20mg PO q1-2h prn CIWA>10  
- MVI, **folate**, **thiamine**  
- Aggressively replete lytes  
- social wk and/or psych c/s in am as per OMR recs; especially given high **valium** need.  
- reassess gait once over acute withdrawal

# Psych: No current SI, psych/social **work** have followed in previous admissions  
- can discuss section 12 vs. section 35 with psych in am

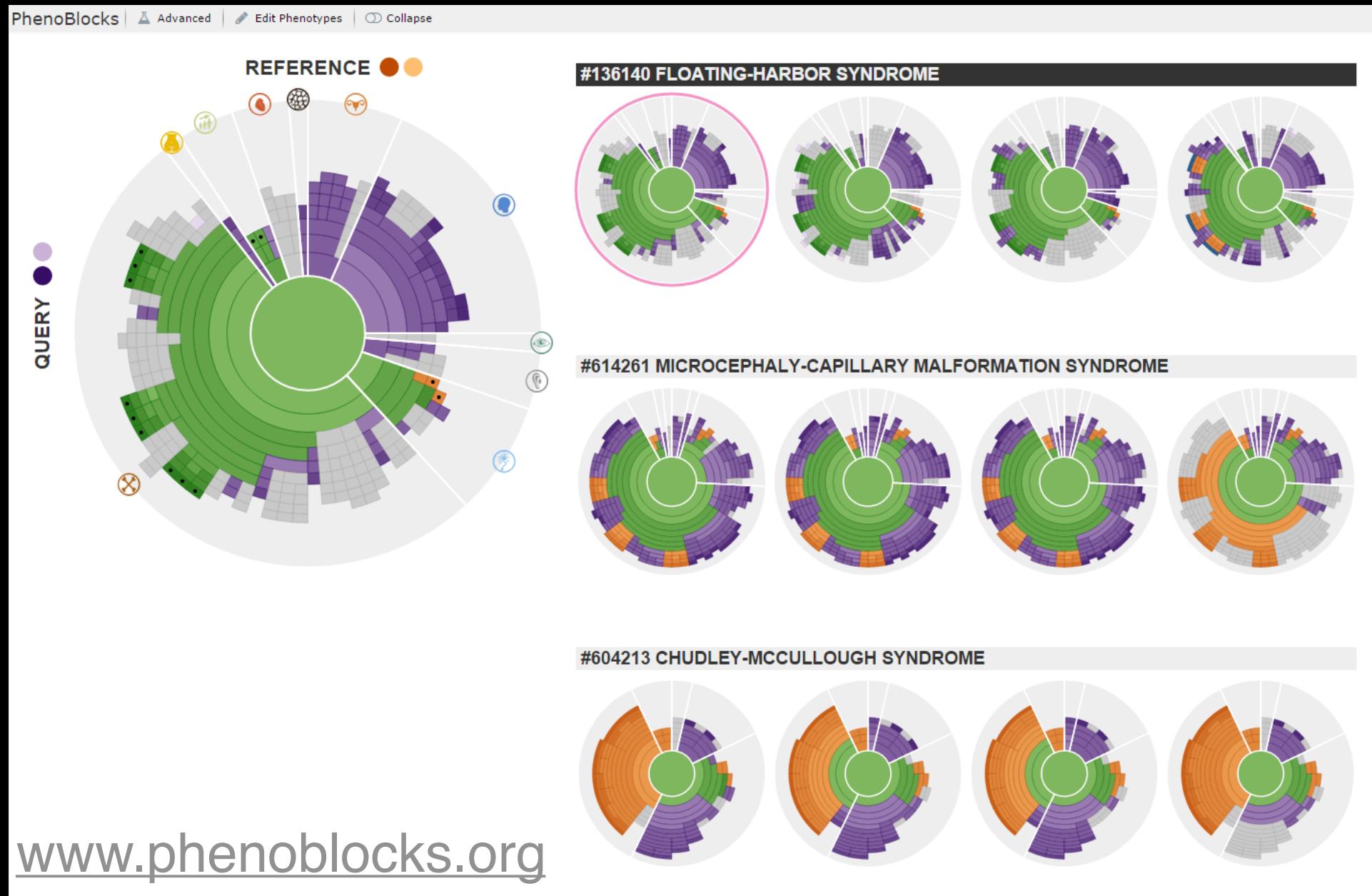
# **chest pain**: EKG without ischemic changes. CP was reproducible on **palpation**. Suspect MSK pain. Highly doubt ACS or acute pulm process such as PE or PNA.  
- consider CXR in am if persists  
- in meantime, received one dose of **morphine** for cp. will avoid narcotics for now on given his hx.  
- use toradol then motrin/tylenol for CP  
- patient also reports having **leg/back pain** which is **burning**, bilat, and ongoing. Will try neurontin as has been tried previously

# elevated lactate: ddx includes **dehydration**, **infection**, **liver disease**, **hypovolemia**, poor sample. **Lactic acidosis** not likely given the alklosis seen on VBG. Consider dehydration vs poor quality sample. Infection less likely given no **fever** or **hypotension** or any localizing signs of infection  
- repeat **lactate** with next set of labs  
- IVF **hydration**

# Anion gap: AG 18 in the ED with a normal HCO3 and **alkalosis** on VBG. ASA negative as were other toxins. Difficult to interpret but wonder

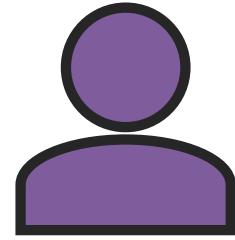
Save Filter Collection:  
Psychosocial Save

# PhenoBlocks [Glueck et al., VAST'15]

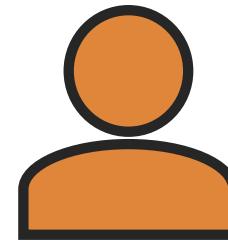
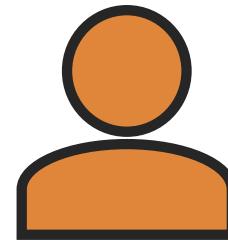
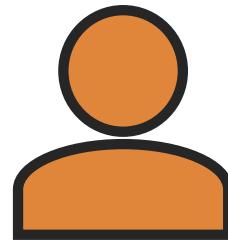
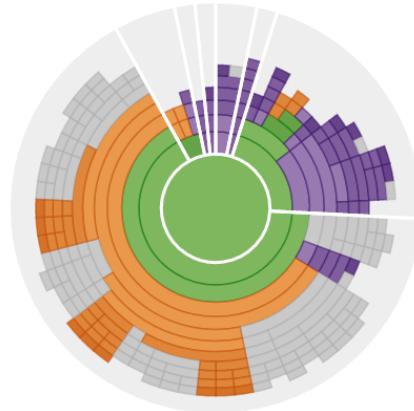
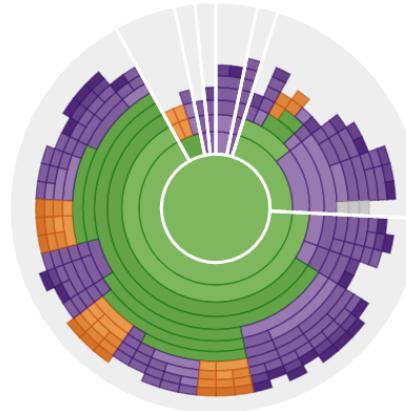


Glueck, Michael, et al. "PhenoBlocks: Phenotype Comparison Visualizations." IEEE transactions on visualization and computer graphics 22.1 (2016): 101-110.

# PhenoBlocks [Glueck et al., VAST'15]



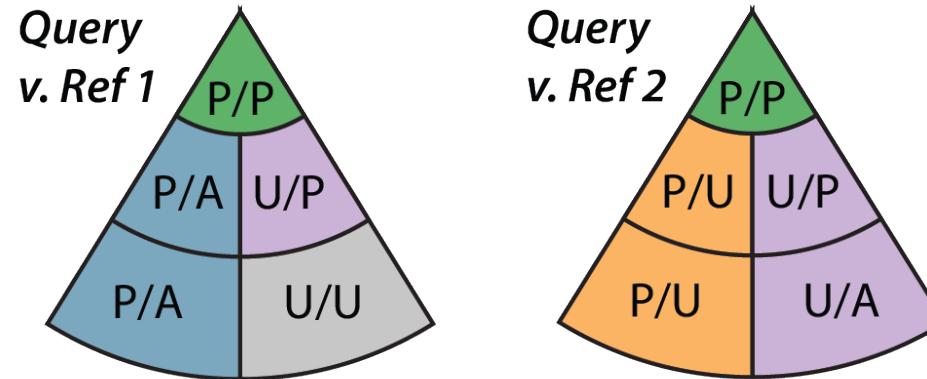
**QUERY**  
*undiagnosed*



**REFERENCES**  
*diagnosed*

Glueck, Michael, et al. "PhenoBlocks: Phenotype Comparison Visualizations." IEEE transactions on visualization and computer graphics 22.1 (2016): 101-110.

# PhenoBlocks [Glueck et al., VAST'15]

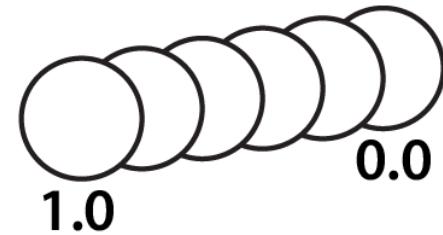


Nine States		Reference			
		Present	Absent	Unknown	
Query	Present	P/P	P/A	P/U	Shared in Both
	Absent	A/P	A/A	A/U	Divergent in Both
	Unknown	U/P	U/A	U/U	Missing in Query

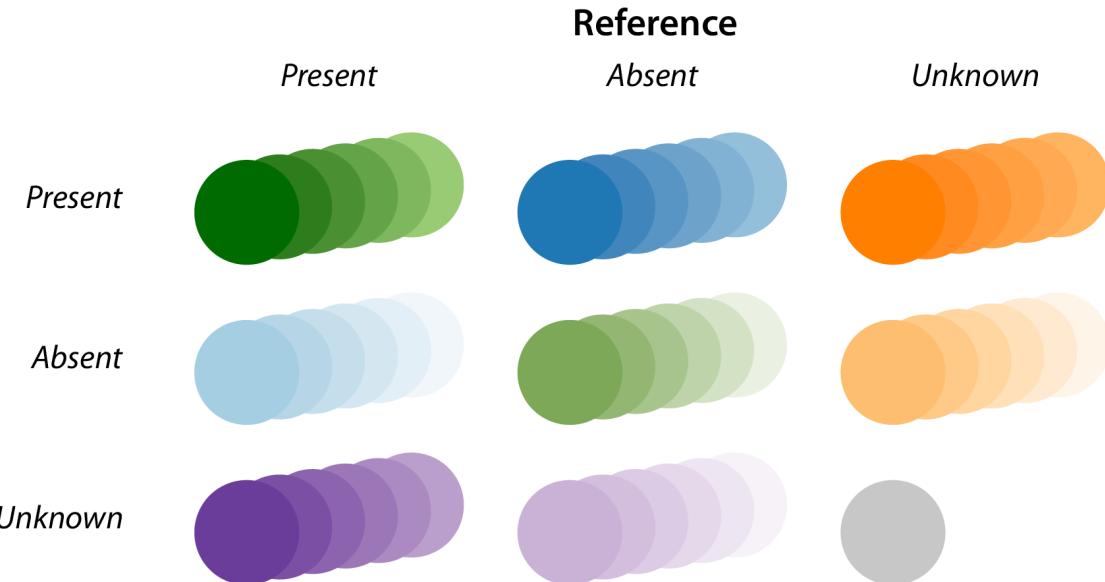
**Missing in Reference**

**Unknown in Both**

# PhenoBlocks [Glueck et al., VAST'15]

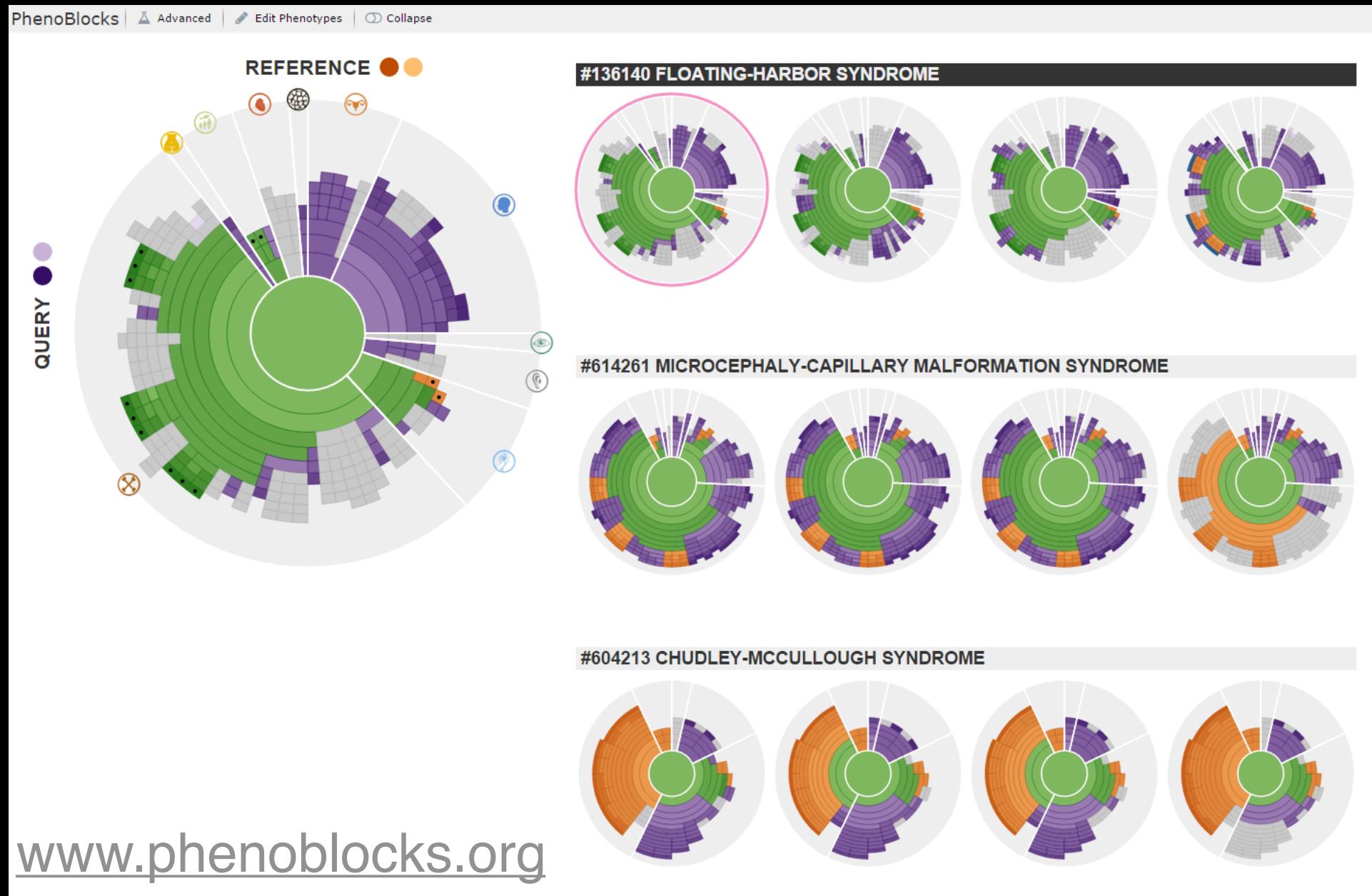


*Hard Handle Score*



Glueck, Michael, et al. "PhenoBlocks: Phenotype Comparison Visualizations." IEEE transactions on visualization and computer graphics 22.1 (2016): 101-110.

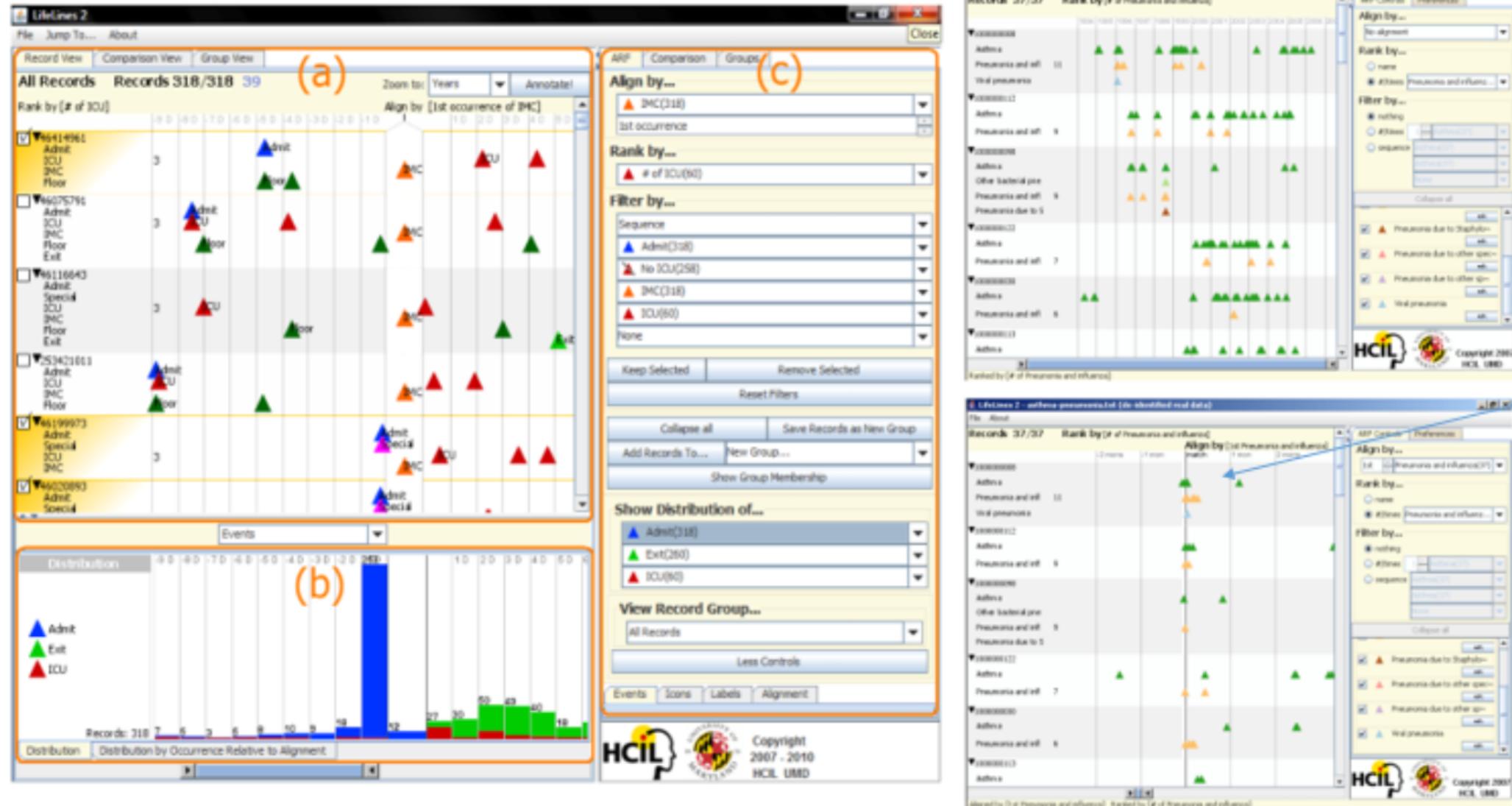
# PhenoBlocks [Glueck et al., VAST'15]



Glueck, Michael, et al. "PhenoBlocks: Phenotype Comparison Visualizations." IEEE transactions on visualization and computer graphics 22.1 (2016): 101-110.

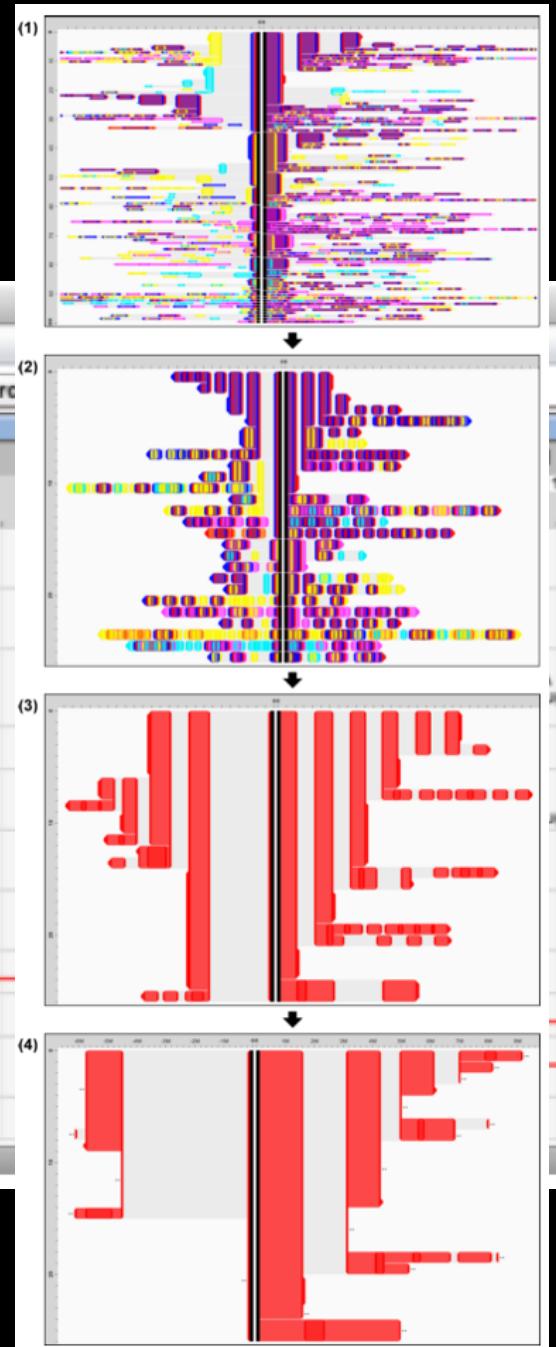
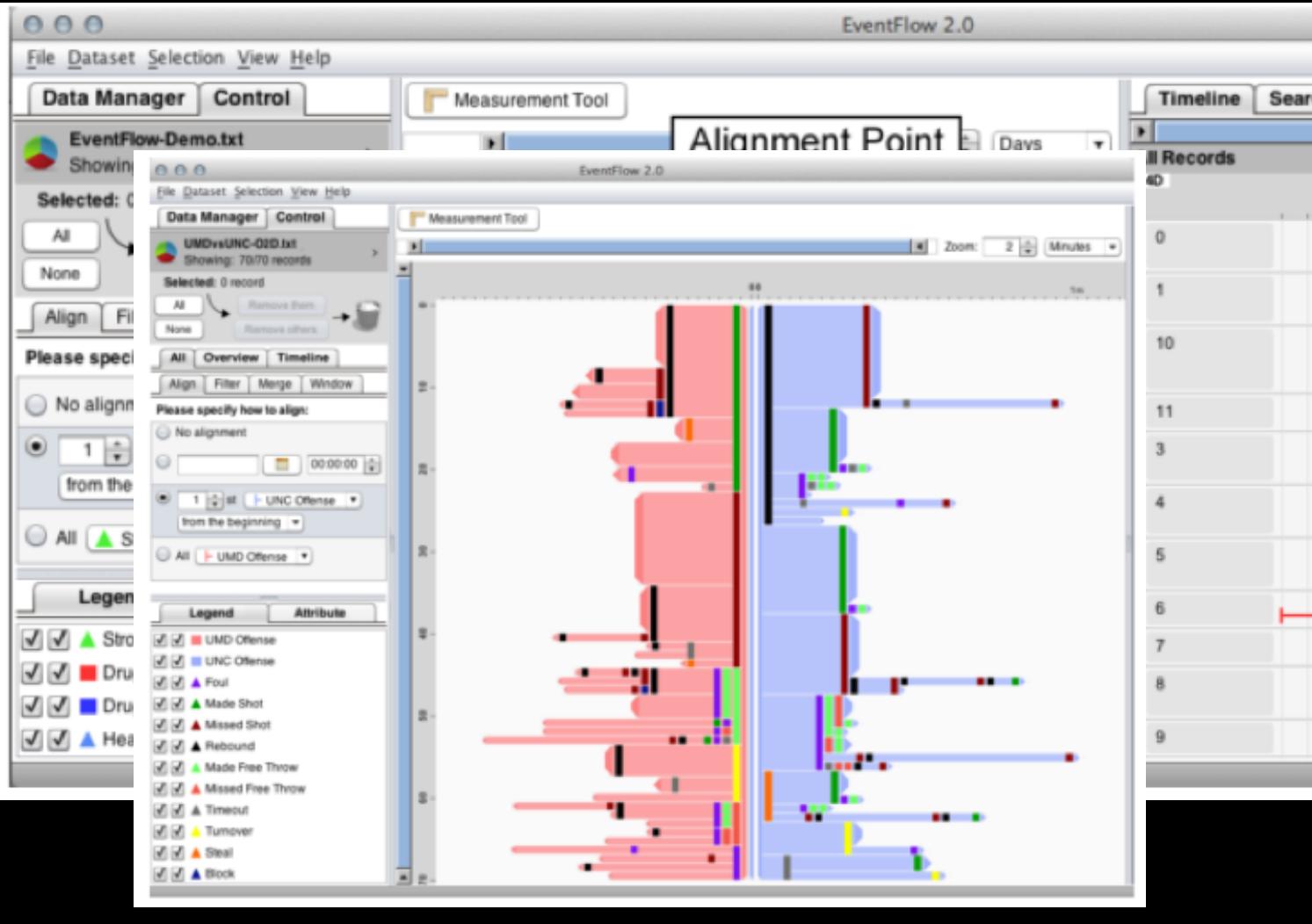
# VISUALIZATION FOR MEDICAL RESEARCH

# LifeLines2 [Wang et al., 2008]



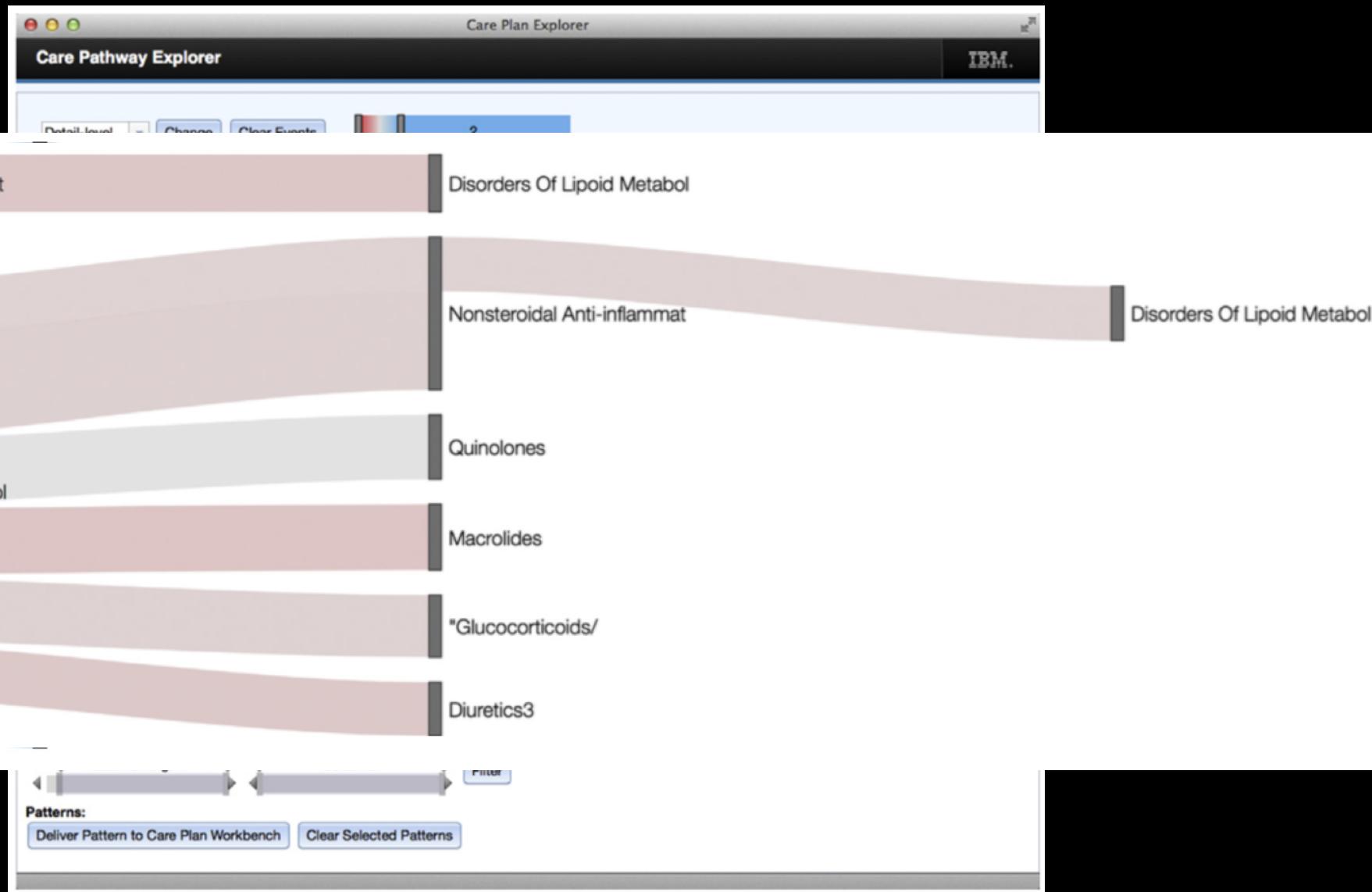
<http://www.cs.umd.edu/hcil/lifelines/>

# EventFlow [Monroe et al., 2013]



M. Monroe, R. Lan, H. Lee, C. Plaisant, and B. Shneiderman, "Temporal event sequence simplification," *IEEE Trans. Vis. Comput. Graph.*, vol. 19, no. 12, pp. 2227–2236, 2013.

# Care Pathway Explorer [Perer et al, J. Biomed Inform. 2015]



Perer, Adam, Fei Wang, and Jianying Hu. 2015. "Mining and Exploring Care Pathways from Electronic Medical Records with Visual Analytics." *Journal of Biomedical Informatics* 56:369–78.

VISUALIZATION FOR COMMUNICATION

## Motor & Sensory Homunculus



LabCorp San Diego  
13112 Evening Creek Dr So Ste 200  
San Diego, CA 92128-4108

Phone: 858-668

PATIENT: DONAIRE, NONITO				Specimen Number: 333-086-0655	
Specimen Number	Patient ID	Date and Time Collected	Date Reported	Sex	Age (Y/M/D)
M304481191	22247228	11/29/10 10:52	12/02/10	M	28/06/13

TESTS	RESULT	FLAG	UNITS	REFERENCE INTERVAL
BUN/Creatinine Ratio	12			8 - 27
Sodium, Serum	140		mmol/L	135 - 145
Potassium, Serum	4.2		mmol/L	3.5 - 5.2
Chloride, Serum	101		mmol/L	97 - 108
Carbon Dioxide, Total	26		mmol/L	20 - 32
Calcium, Serum	9.4		mg/dL	8.7 - 10.2
Protein, Total, Serum	7.1		g/dL	6.0 - 8.5
Albumin, Serum	4.6		g/dL	3.5 - 5.5
Globulin, Total	2.5		g/dL	1.5 - 4.5
A/G Ratio	1.8			1.1 - 2.5
Bilirubin, Total	1.1		mg/dL	0.0 - 1.2
Alkaline Phosphatase, S	83		IU/L	25 - 150
AST (SGOT)	20		IU/L	0 - 40
ALT (SGPT)	20		IU/L	0 - 55
IGF-1				
Insulin-Like Growth Factor I	242		ng/mL	117 - 329
Testosterone, Serum	691		ng/dL	280 - 800
**Effective December 13, 2010, Testosterone reference*, interval will be changing to:				
MALE TANNER STAGE				
1	<3		1	<3 - 6
2	<3 - 432		2	<3 - 10
3	65 - 778		3	<3 - 24
4	180 - 763		4	<3 - 27
5	188 - 882		5	5 - 38
MALE ADULT				
20-49 years	249 - 836		20-49 years	8 - 48
>49 years	193 - 740		>49 years	3 - 41
LDH	151		IU/L	100 - 250
Creatine Kinase, Total, Serum	204		U/L	24 - 204
Magnesium, Serum	2.4		mg/dL	1.6 - 2.6
Zinc, Plasma or Serum	109		ug/dL	70 - 150
Detection Limit = 5				
Ferritin, Serum	185		ng/mL	30 - 400
01 SO	LabCorp San Diego	Dir: Kelli Hanson, MD		
	13112 Evening Creek Dr Sc Ste 200, San Diego, CA 92128-4108			
02 BN	LabCorp Burlington	Dir: William F Hancock, MD		
	1447 York Court, Burlington, NC 27215-3361			
For inquiries, the physician may contact Branch: 800-762-4344 Lab: 858-668-3700				

DONAIRE, NONITO 22247228 333-086-0655-0

#### FINAL REPORT

Page 2 of

This document contains private and confidential health information protected by state and federal law.  
If you have received this document in error, please call 800-542-7708.

# Your Test Results

Your results at a glance:

Questions?

- YOUR GLUCOSE LEVELS ARE TOO HIGH, WHICH INDICATES PREDIABETES.
- YOUR VITAMIN D LEVEL IS TOO LOW.
- YOUR CHOLESTEROL LEVELS ARE BORDERLINE HIGH.
- YOUR KIDNEY, LIVER, AND THYROID FUNCTION ARE ALL NORMAL.

Contact the physician who ordered this test for further interpretation of the results:

DR. PICO DUVAL  
(212) 555-8253

PATIENT: Cora Peterson

GENDER: Female

AGE: 41

DOB: August 12, 1969

ORDERED BY: Dr. Pico Duval

COLLECTED: November 13,

2010, 8:40 a.m.

RECEIVED: November 13,

2010, 8:12 p.m.

#### RESULTS:

##### Comprehensive Metabolic Panel

Glucose (fasting): 125 mg/dL



##### Vitamin D

Total vitamin D: 22 ng/mL



**Complete Blood Cell Count (CBC)** Normal for all 20 values, including white blood cell count (a high count can indicate infection).

##### Urinalysis

Normal for all 20 values, including color, appearance, and protein.

**Endocrinology** Normal for TSH, which is an indicator of thyroid function, and for microalbumin and creatinine, measures of kidney function.

**Chemistry** Normal for iron, transferrin saturation, and ferritin. (Abnormal levels could indicate anemia, hepatitis, or other problems.)

#### WHAT DO YOUR RESULTS MEAN?

  **ELEVATED GLUCOSE:** The relatively high amount of sugar in your blood is typical of a patient with prediabetes, which can double your risk for heart disease, depending on other risk factors. See diabetes.org for more information.

  **ELEVATED CHOLESTEROL:** Your relatively high cholesterol (a waxy substance produced in the liver) may also increase your risk of heart disease, depending on other risk factors. See heart.org for more information.

  **LOWER LEVELS OF VITAMIN D:** Your results suggest insufficient vitamin D, which promotes bone density and immune-system function. Women who fit your profile can become deficient within five months if no action is taken. Vitamin D deficiency may increase your risk for osteoporosis, high blood pressure, and certain cancers.

##### Lipid Profile

Total cholesterol: 211 mg/dL



HDL ("good" cholesterol): 46 mg/dL



LDL ("bad" cholesterol): 165 mg/dL



Triglycerides: 160 mg/dL



#### WHAT CAN YOU DO?

**CONSIDER YOUR LIFESTYLE.** If you are inactive, overweight, and/or a smoker, your risk for diabetes and heart disease rises. Exercising regularly (30 minutes/day) and reducing your weight by 5 to 10 percent lowers your risk of diabetes by 58 percent.

**ADDRESS OTHER RISK FACTORS FOR DIABETES AND HEART DISEASE.** Dietary changes, like reducing alcohol consumption and increasing fruit and vegetable intake, can decrease your cholesterol and triglyceride levels.

**ASK YOUR DOCTOR ABOUT REDUCING YOUR HEART DISEASE RISK.** Medications like statins can lower cholesterol and delay the onset of heart disease. Calculate your risk at [hp2010.nihbihin.net/atpiii/calculator.asp](http://hp2010.nihbihin.net/atpiii/calculator.asp).

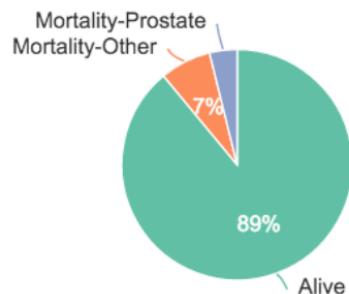
**CONSIDER LIFESTYLE CHANGES TO CORRECT VITAMIN D INSUFFICIENCY.** These include diet, vitamin D supplements, and more exposure to sunlight.

## How big of a threat is my prostate cancer?

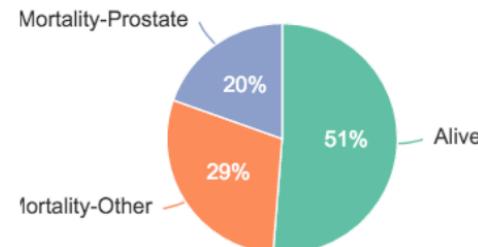
Before thinking about the benefits of specific treatments, it's helpful to first think about how big of threat your prostate cancer is to your future survival. The pie chart below shows the following:

- Your chances of being **alive** (in **GREEN**)
- Your chances of dying from your **prostate cancer** (in **PURPLE**)
- Your chances of dying from **other causes** (in **ORANGE**)

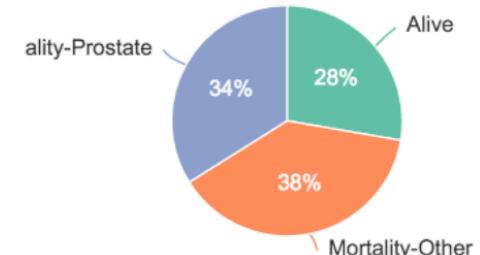
1 Year (70 years old)



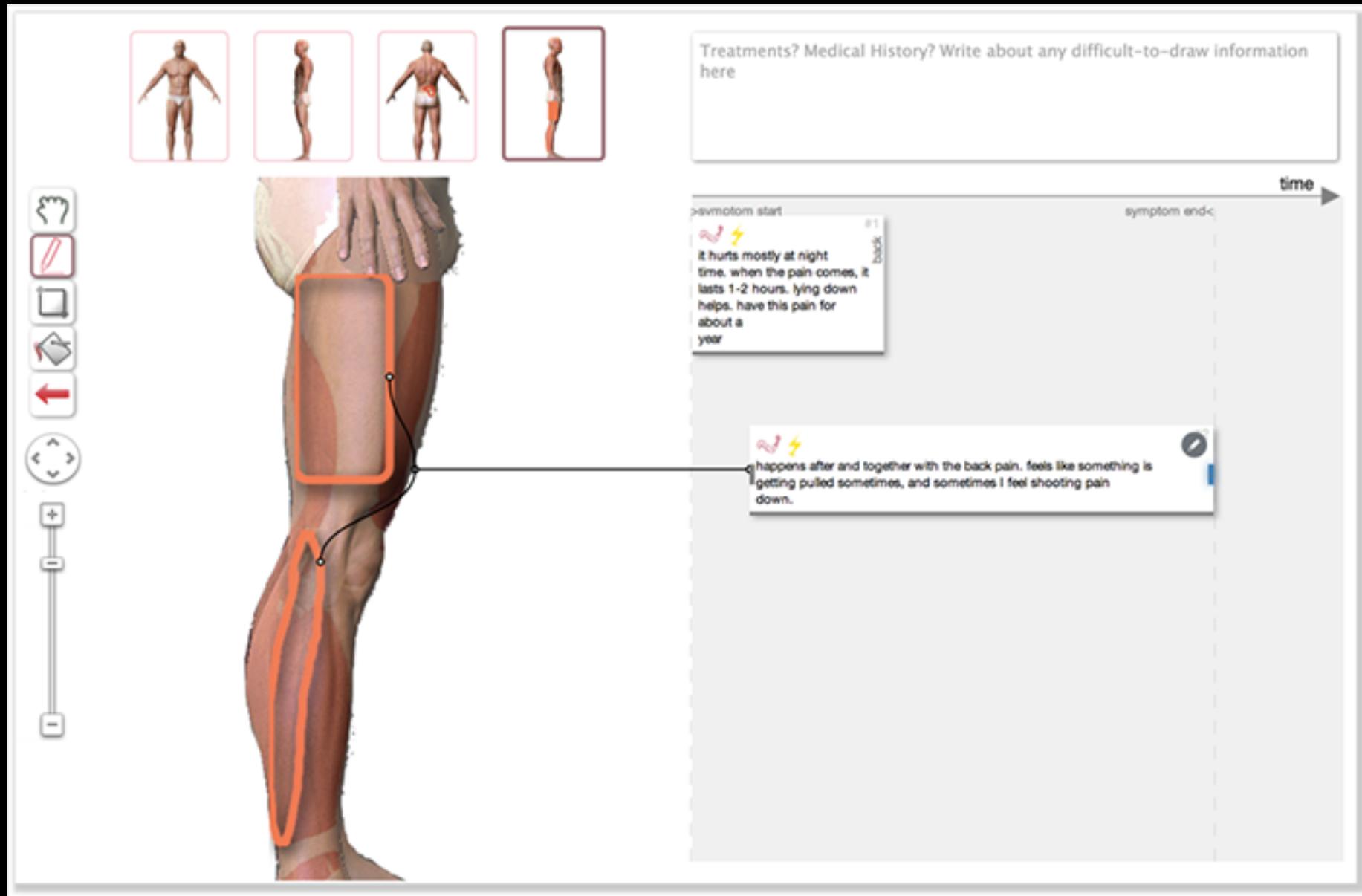
5 years (74 years old)



10 Years (79 years old)



# BodyDiagrams [Amy Jang, Diana MacLean, Jeffrey Heer, CHI'14]



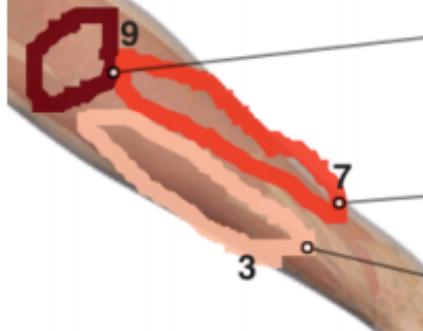
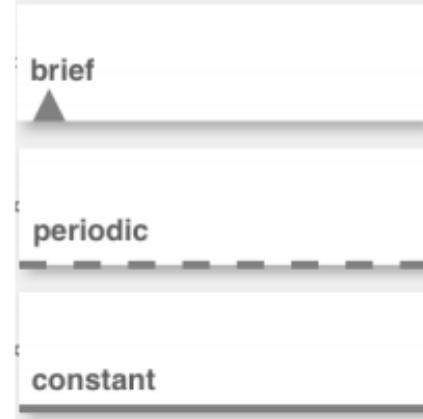
<https://idl.cs.washington.edu/papers/bodydiagrams/>

# BodyDiagrams [Amy Jang, Diana MacLean, Jeffrey Heer, CHI'14]



Pattern	Example	Notes
color		rarely utilized; most participants used only one color even when describing a range of symptoms.
precise marks		indicates precise symptom location
regions		indicates general location of symptom
text	captions	describe drawn marks
arrows		link text annotations to drawn marks
zoom	call outs with more detail	users drew scaled versions of body parts for higher resolution
views	side-view, cross-section	users drew body parts in different perspectives
reference marks	vertebrae, knee cap	users drew body parts as reference "anchors" for the relative location of their symptoms

# BodyDiagrams [Amy Jang, Diana MacLean, Jeffrey Heer, CHI'14]

Attribute	Severity	Frequency	Location
Control	<p>Symptom Severity</p> 	<p>Symptom Frequency</p> <p><input type="radio"/> brief <input checked="" type="radio"/> periodic <input type="radio"/> constant</p>	<p>Symptom Location</p> <p><input checked="" type="checkbox"/>  skin <input type="checkbox"/>  muscle&amp;joint</p> <p><input checked="" type="checkbox"/>  bone <input type="checkbox"/>  neural</p>
Examples			

<https://idl.cs.washington.edu/papers/bodydiagrams/>

# AnatOnMe [Tao Ni, Amy K. Karlson, Daniel Wigdor, CHI'11]



Ni, Tao, Amy K. Karlson, and Daniel Wigdor. "AnatOnMe: facilitating doctor-patient communication using a projection-based handheld device." Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. ACM, 2011.

# CONCLUSIONS

# VISUALIZATION

Very powerful tool for monitoring, analysis,  
communication

Applies to variety of data & problems

Benefits clinicians, patients, researchers

**... is not trivial!**

YOU CAN HELP!

We regularly recruit domain experts to evaluate novel designs/techniques

1.5 - 2h interactive sessions

Interested? Just email me at

**[nicolebs@cs.toronto.edu](mailto:nicolebs@cs.toronto.edu)**



C4M — COMPUTING FOR MEDICINE

# INFORMATION VISUALISATION

---

# QUESTIONS?

Nicole Sultanum

**[nicolebs@cs.toronto.edu](mailto:nicolebs@cs.toronto.edu)**

