

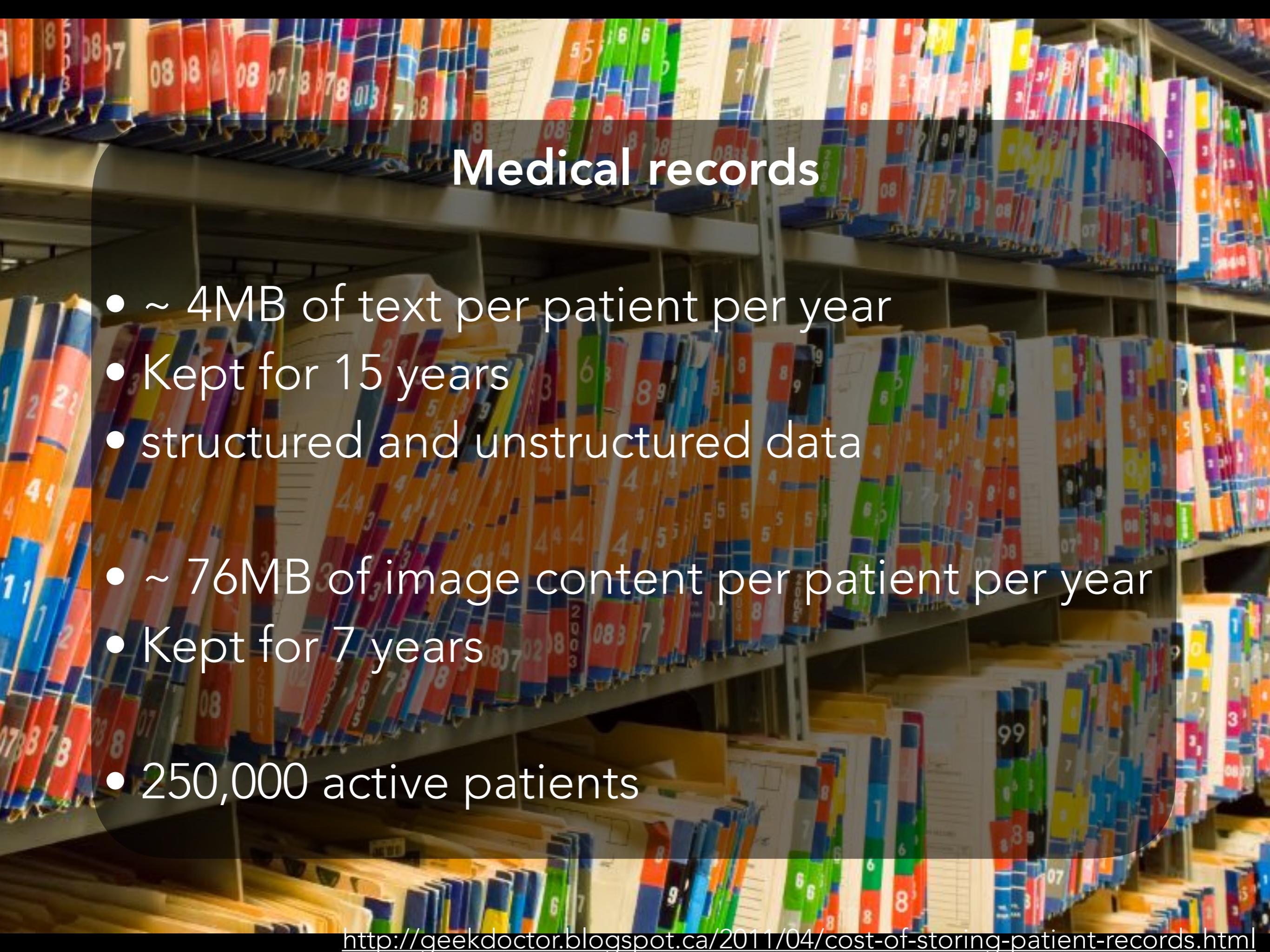
C4M — COMPUTING FOR MEDICINE
INFORMATION VISUALIZATION

Fanny Chevalier



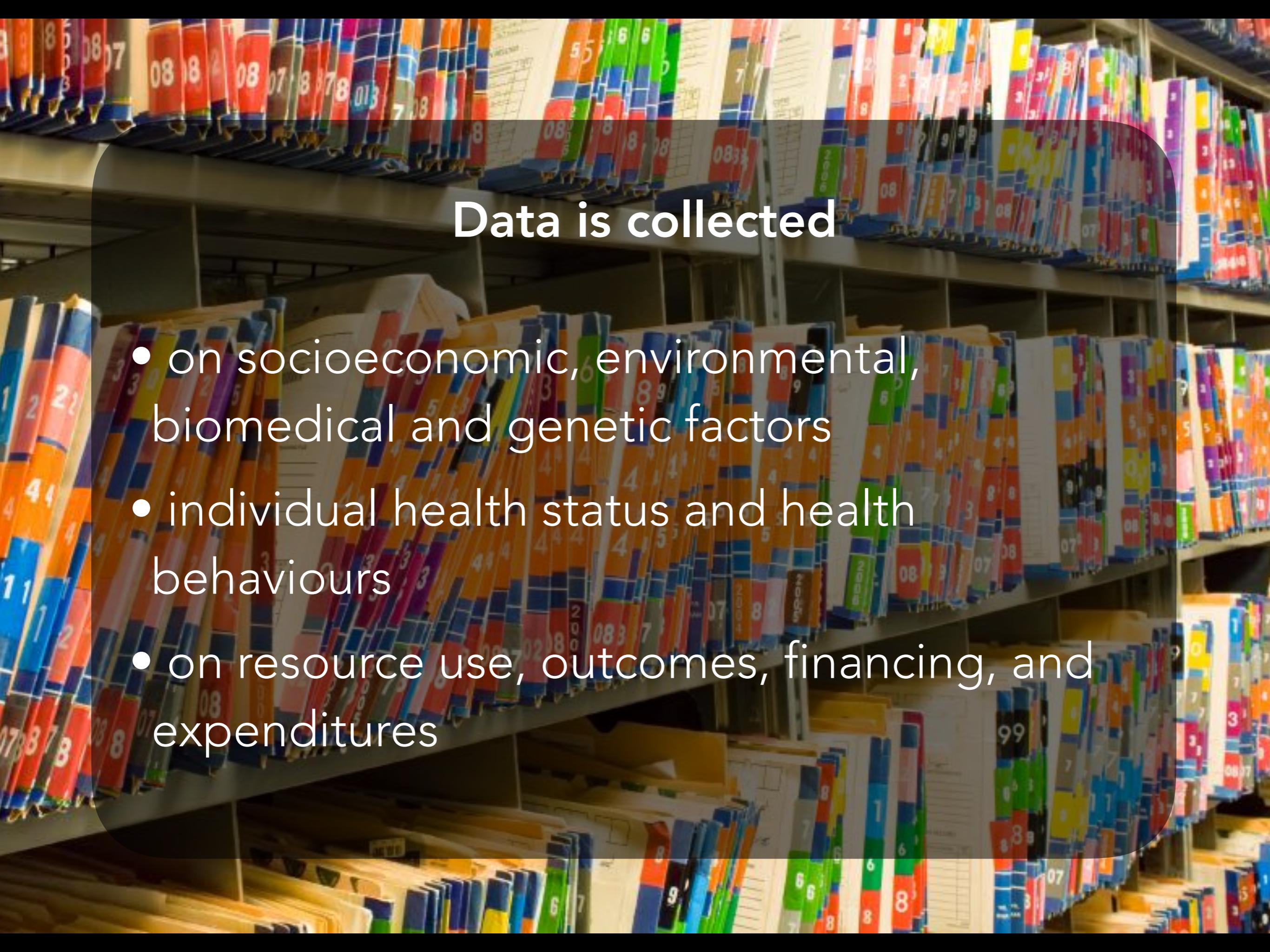


Data

A photograph showing a massive collection of medical records files stacked on shelves. The files are organized by patient number, with labels like '08' and '07' visible on the spines. They come in various colors including red, blue, green, yellow, and orange. The sheer volume of files emphasizes the scale of the data being discussed.

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

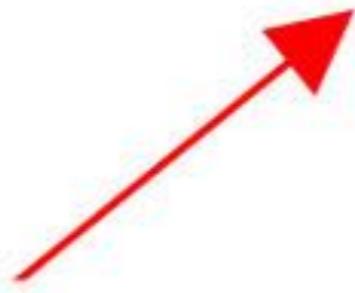
Data

Understanding

*Understand
Relations*

*Understand
Patterns*

*Understand
Principles*



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 |

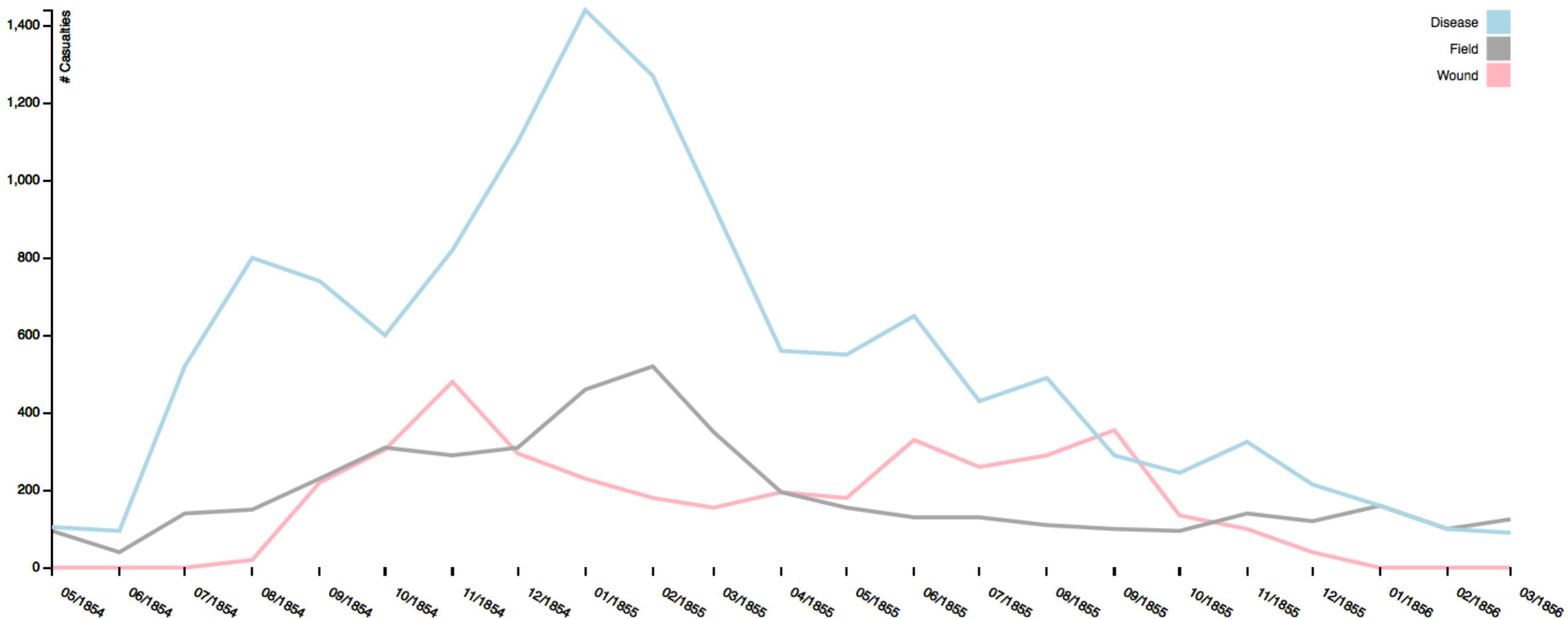
Month with **highest casualty rates** in the **field**?

Month with **highest total casualty rate**?

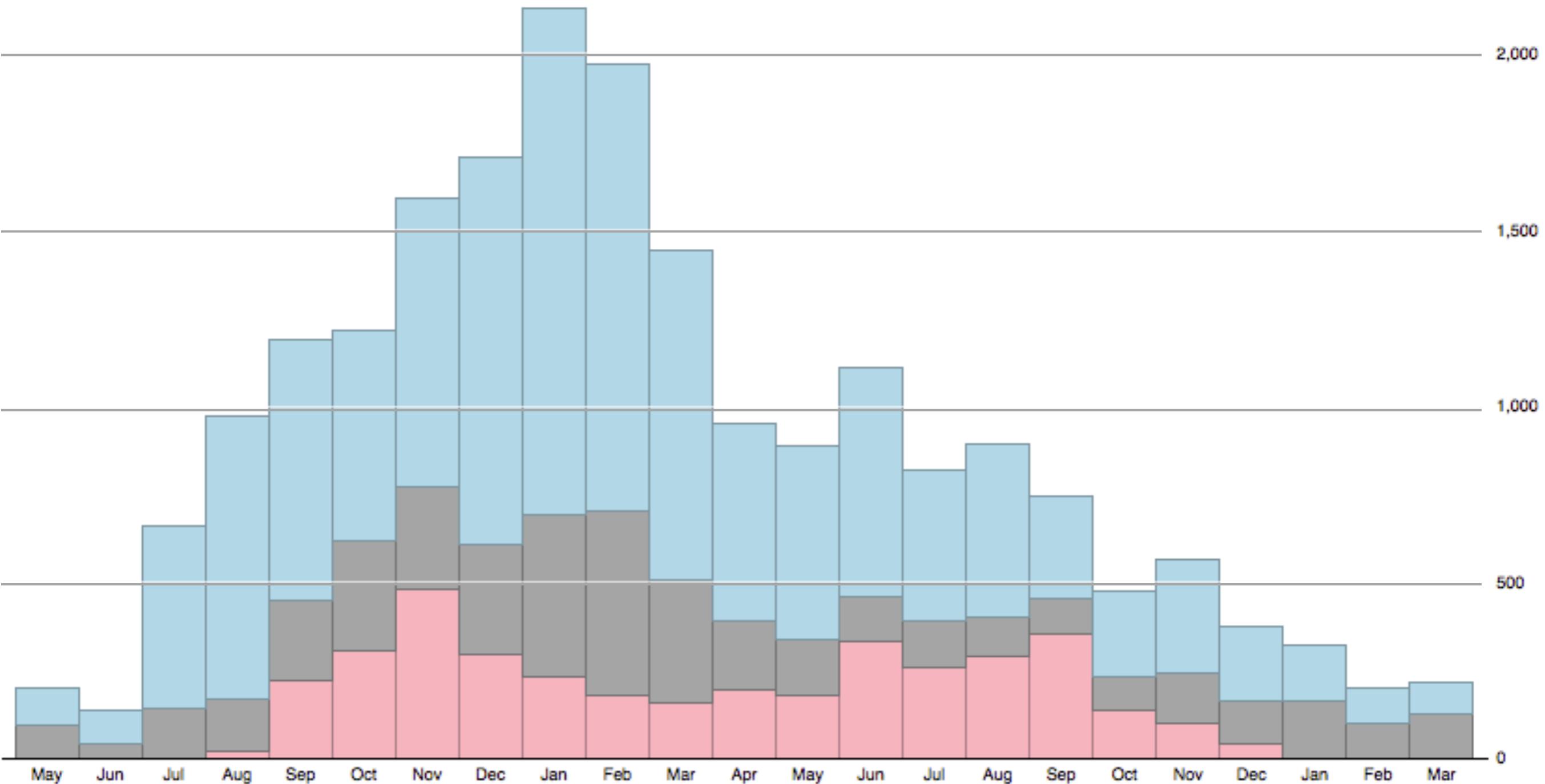
months in which deaths by **wound** exceeds deaths in the **field**?

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

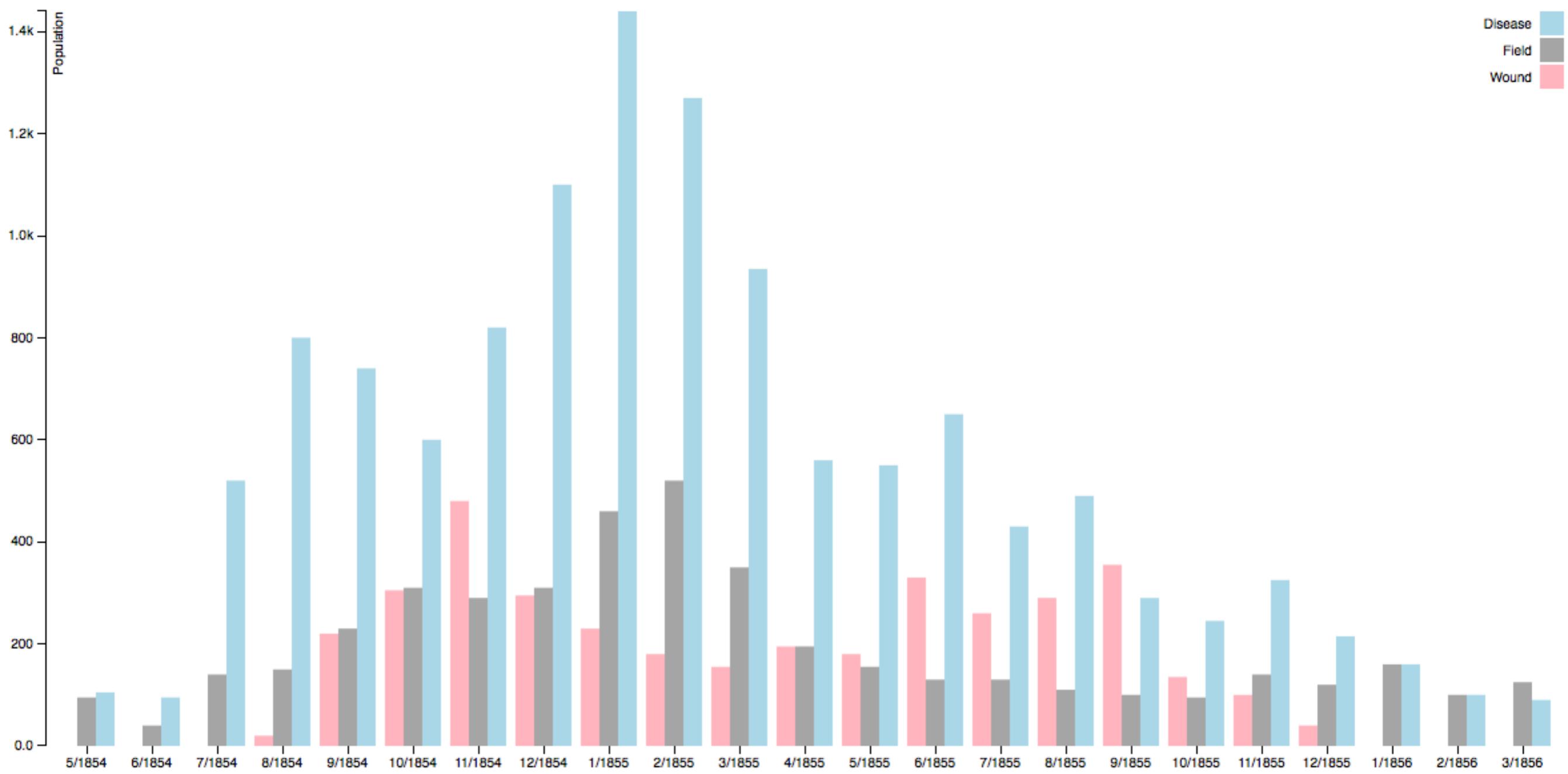
Month with **highest casualty rates** in the **field**?



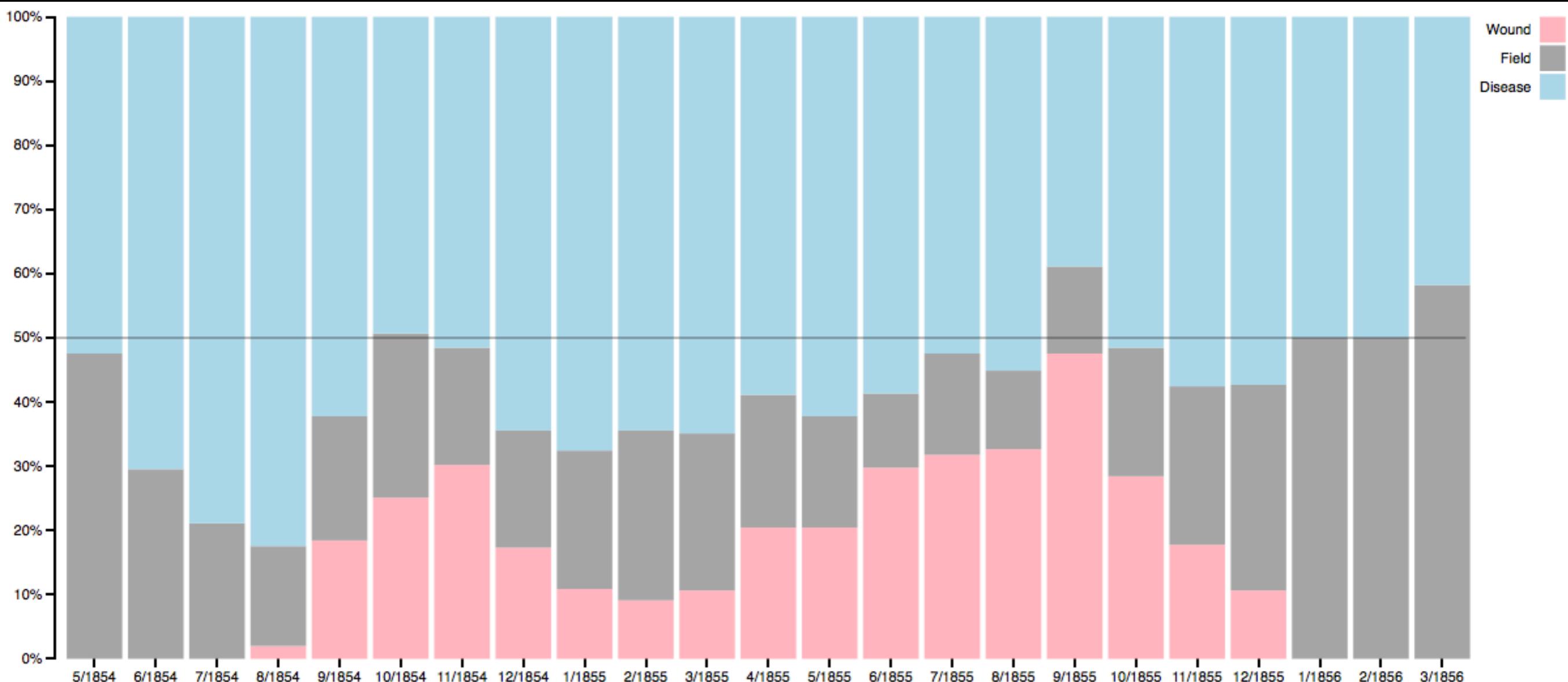
Month with **highest total** casualty rate?



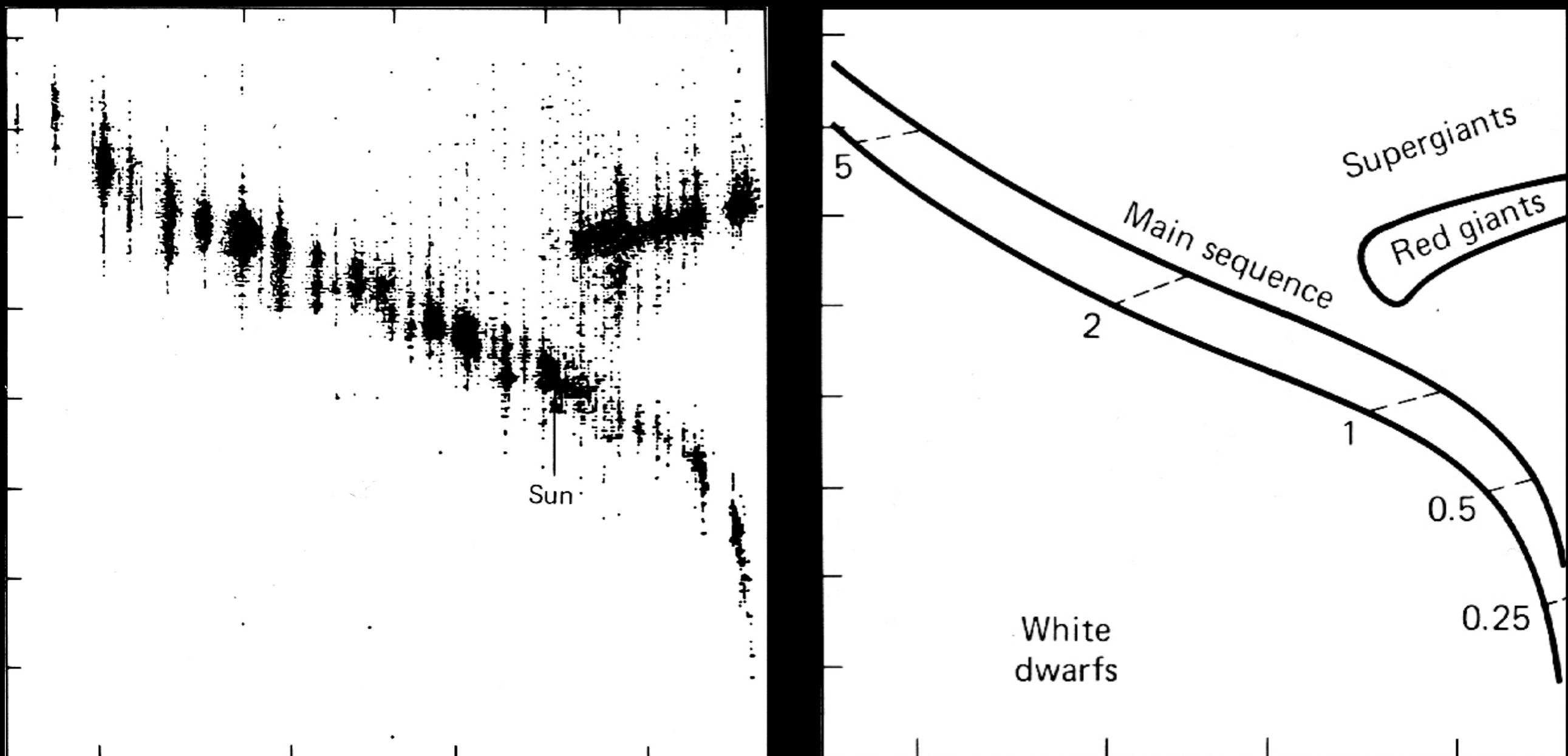
months in which deaths by **wound** exceeds deaths in the **field**?



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

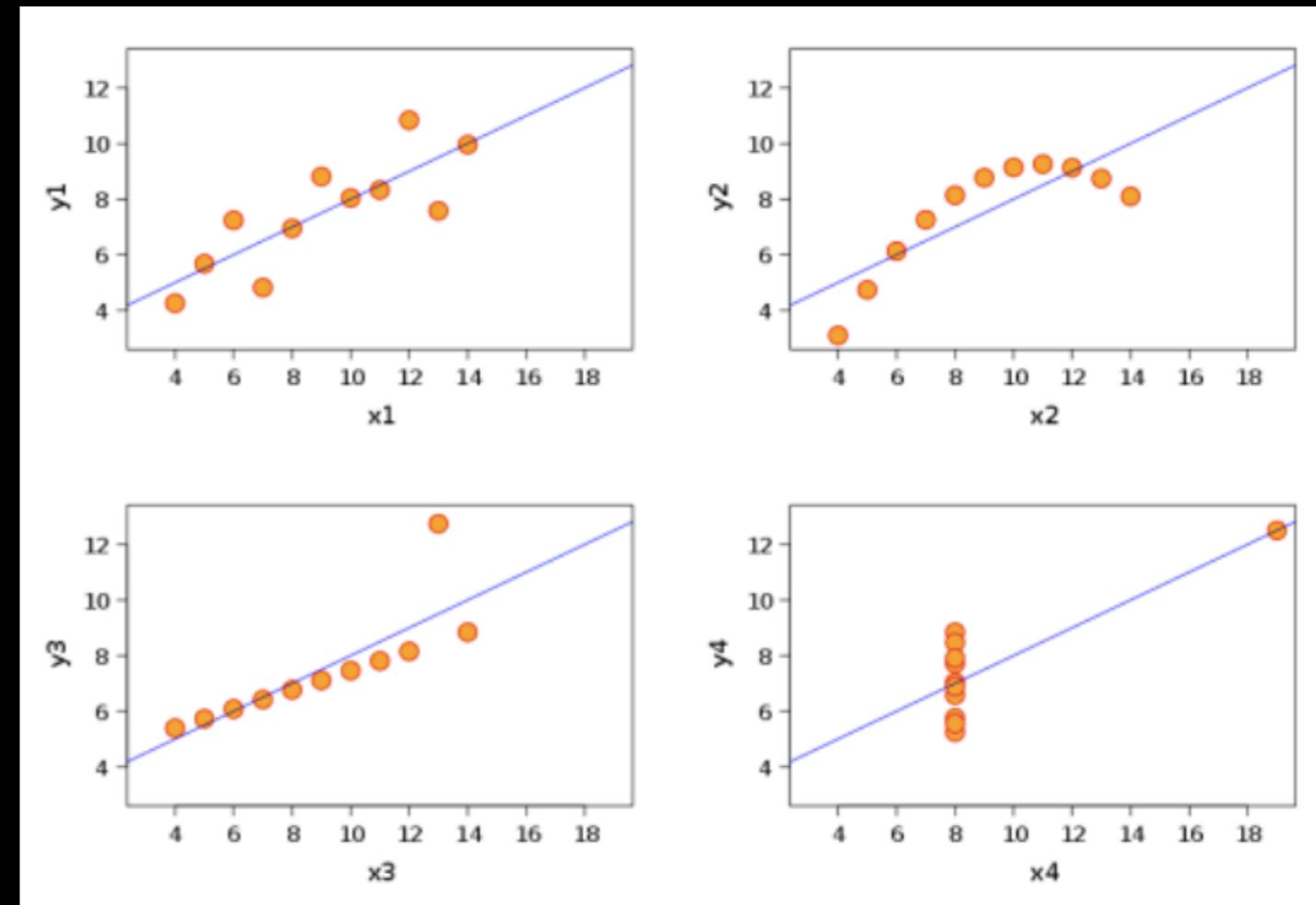
| I | | II | | III | | IV | |
|------|-------|------|------|------|-------|------|-------|
| x | y | x | y | x | y | x | y |
| 10.0 | 8.04 | 10.0 | 9.14 | 10.0 | 7.46 | 8.0 | 6.58 |
| 8.0 | 6.95 | 8.0 | 8.14 | 8.0 | 6.77 | 8.0 | 5.76 |
| 13.0 | 7.58 | 13.0 | 8.74 | 13.0 | 12.74 | 8.0 | 7.71 |
| 9.0 | 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 |

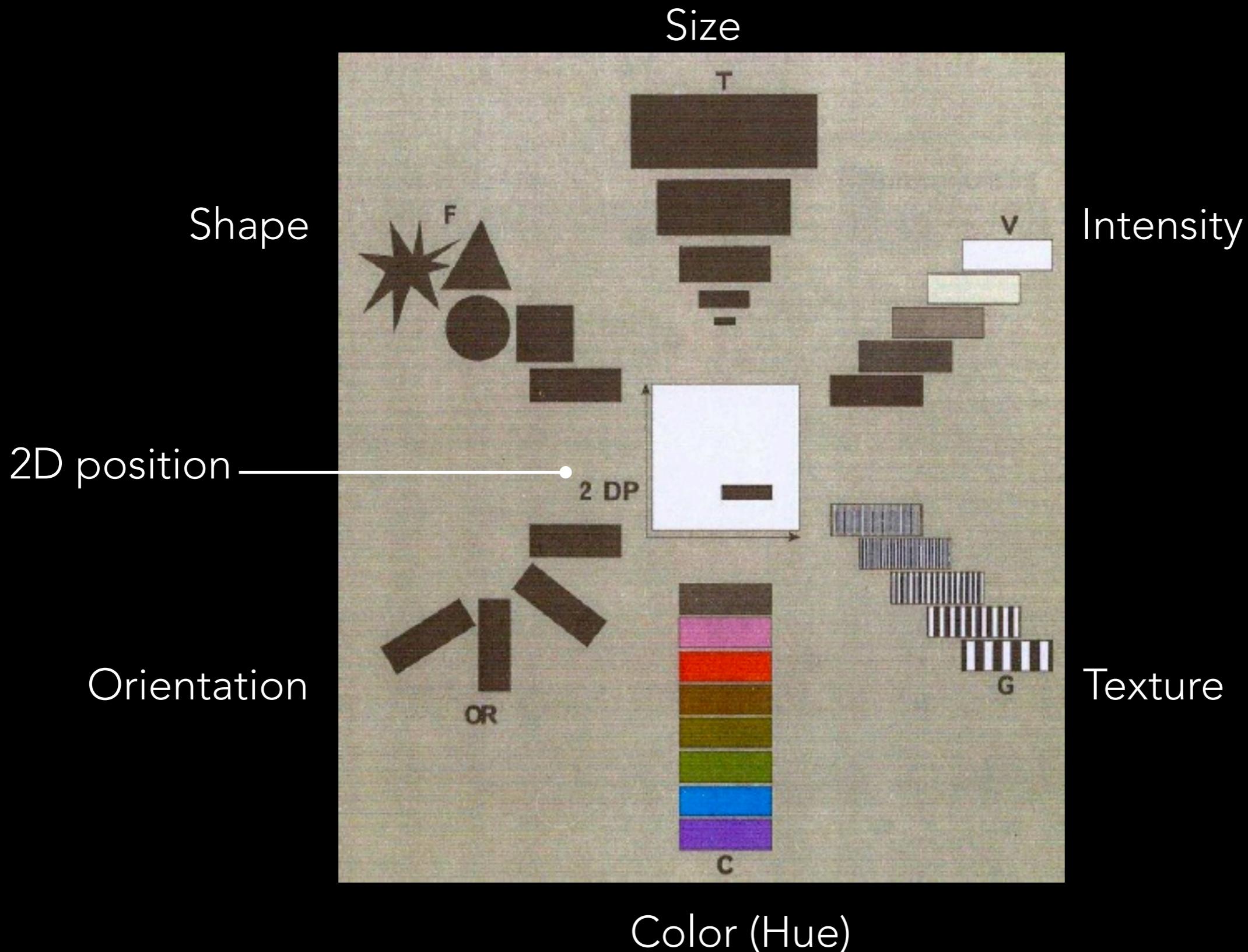


HUMAN IN THE LOOP

- 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)

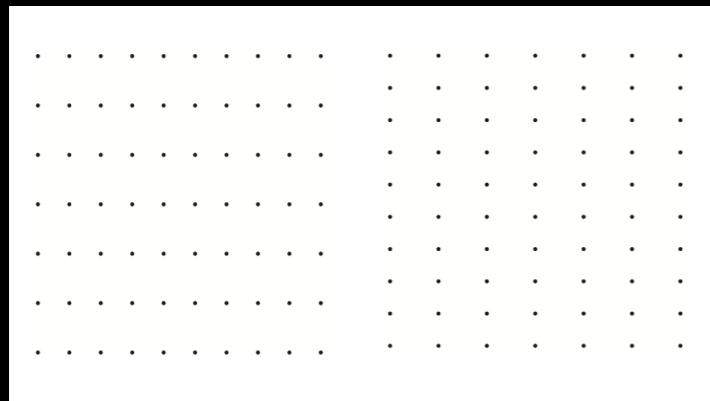


EFFECTIVENESS AND EFFICIENCY

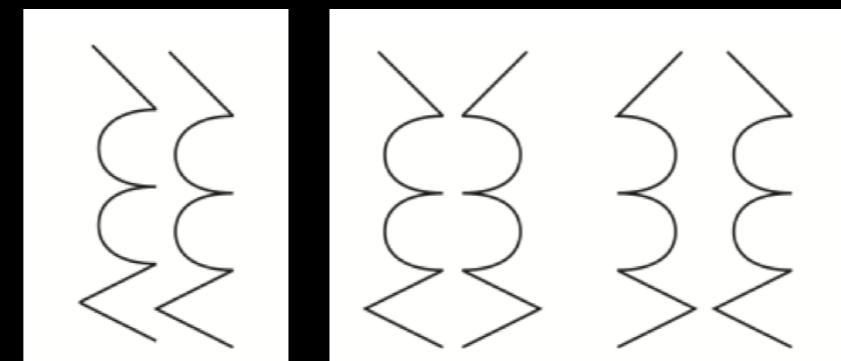
- Some visualizations are objectively better than others, based on:
 - Perceptual principles
 - Task to be solved
 - Underlying data
 - Domain/context knowledge

GESTALT LAWS & ORGANIZATIONAL PRINCIPLES

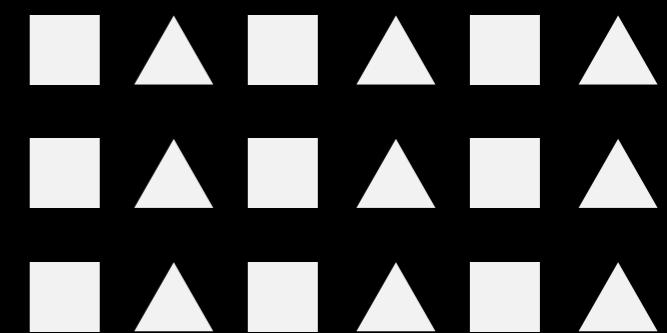
Proximity



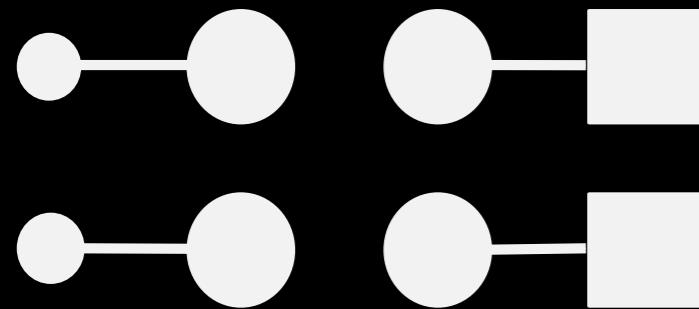
Symmetry



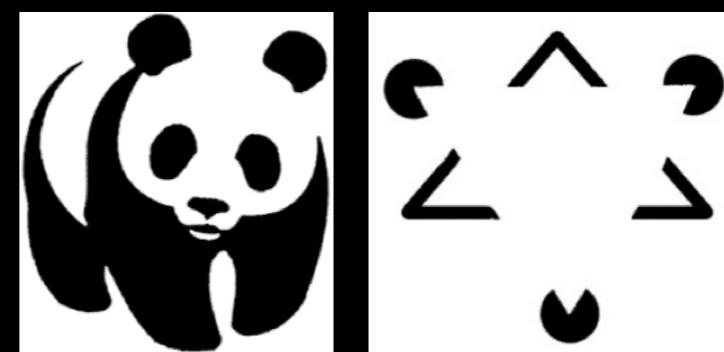
Similarity



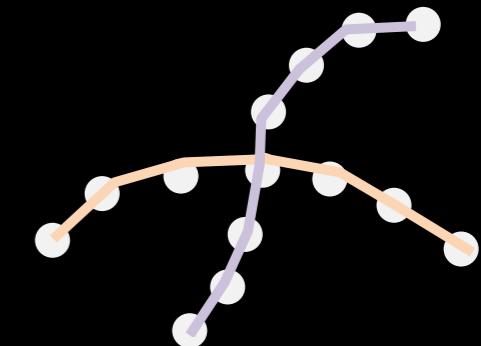
Connectivity



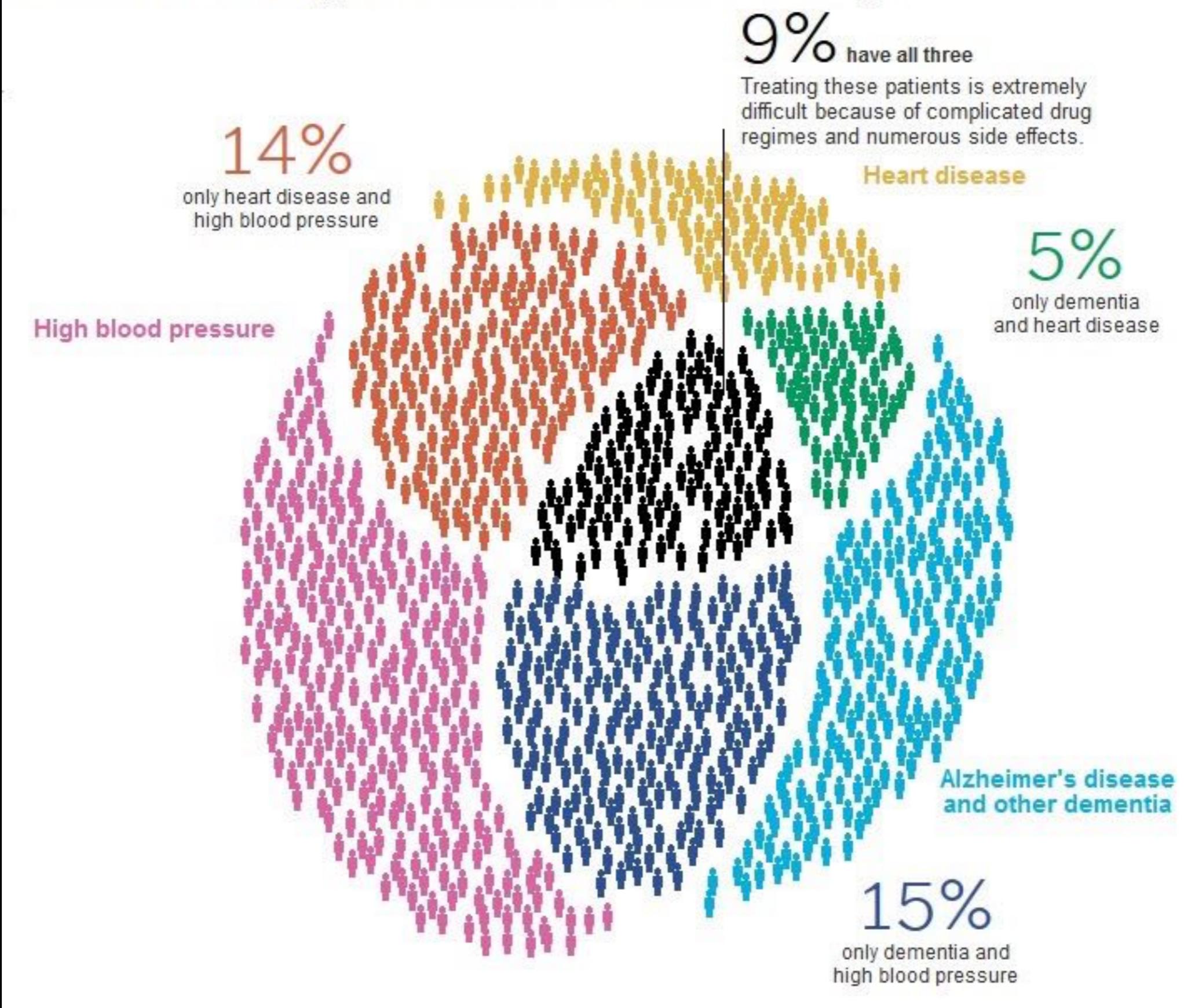
Closure



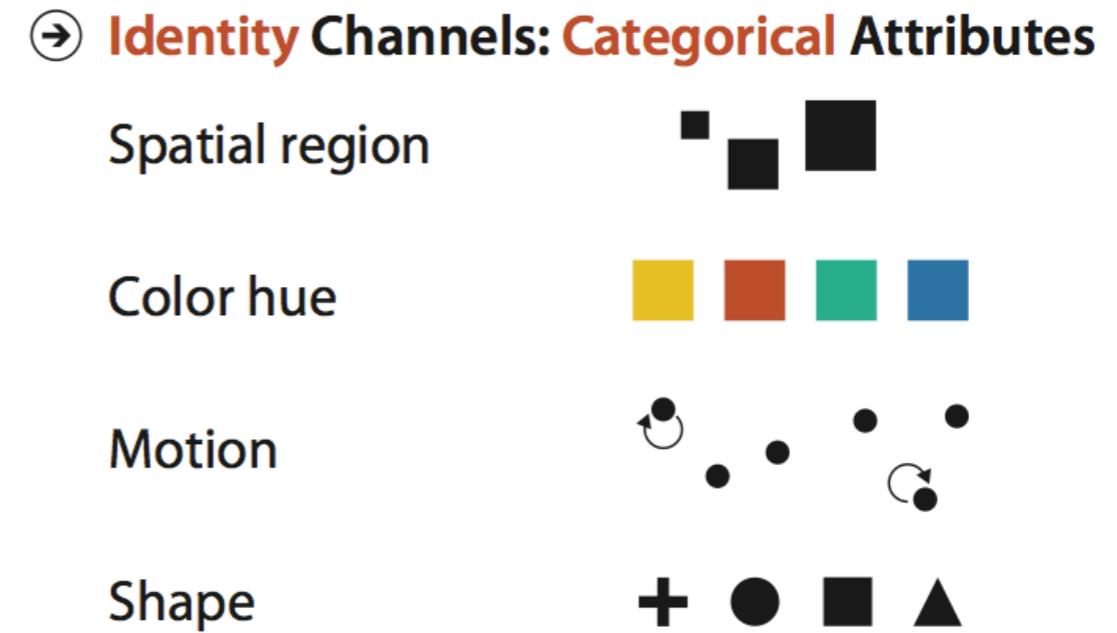
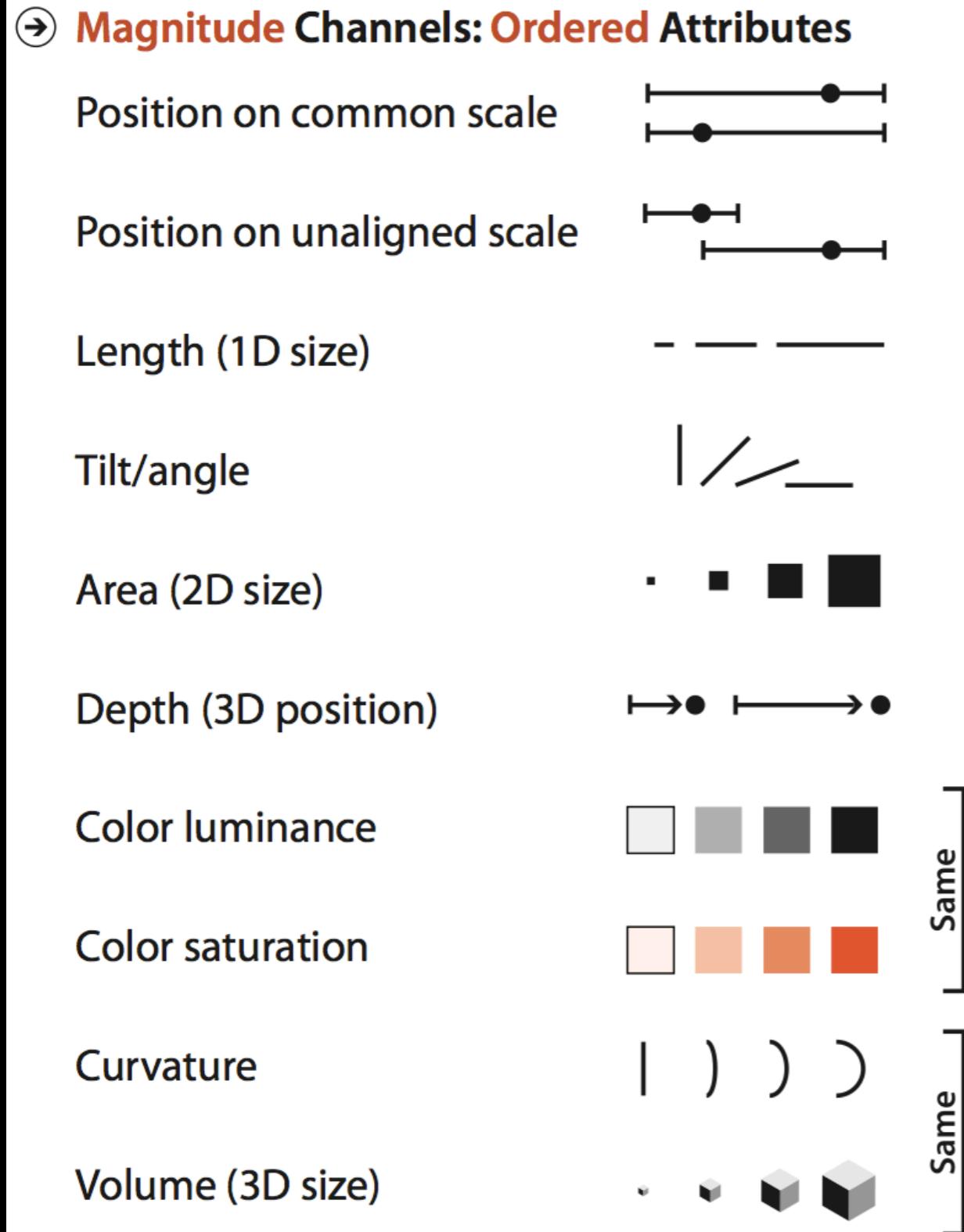
Continuity

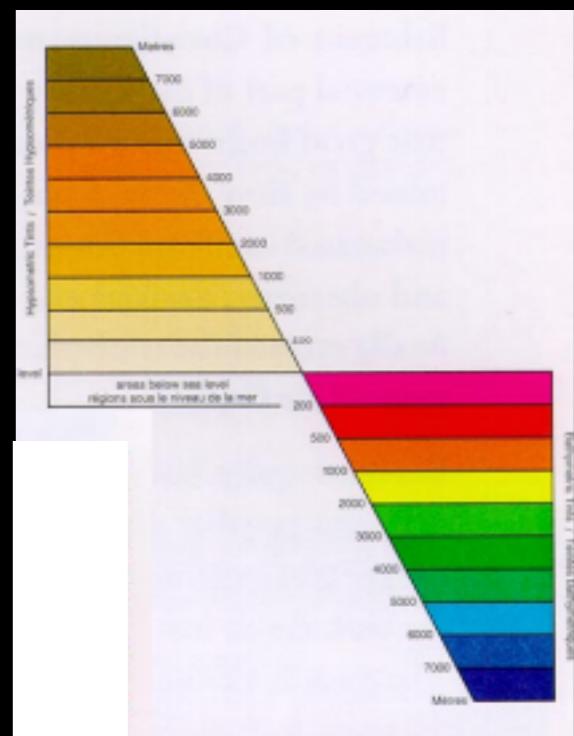
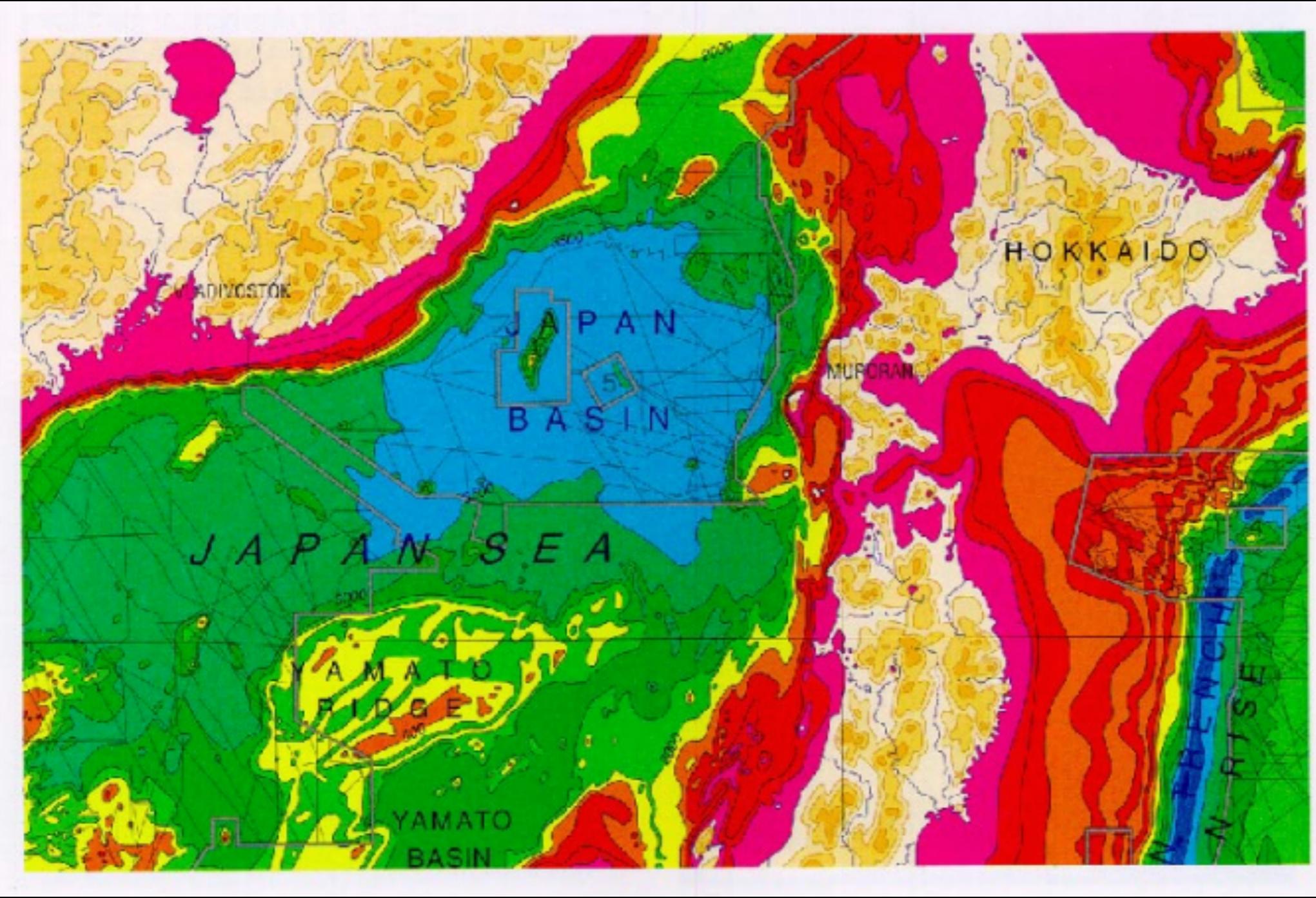


For the Elderly, Diseases That Overlap

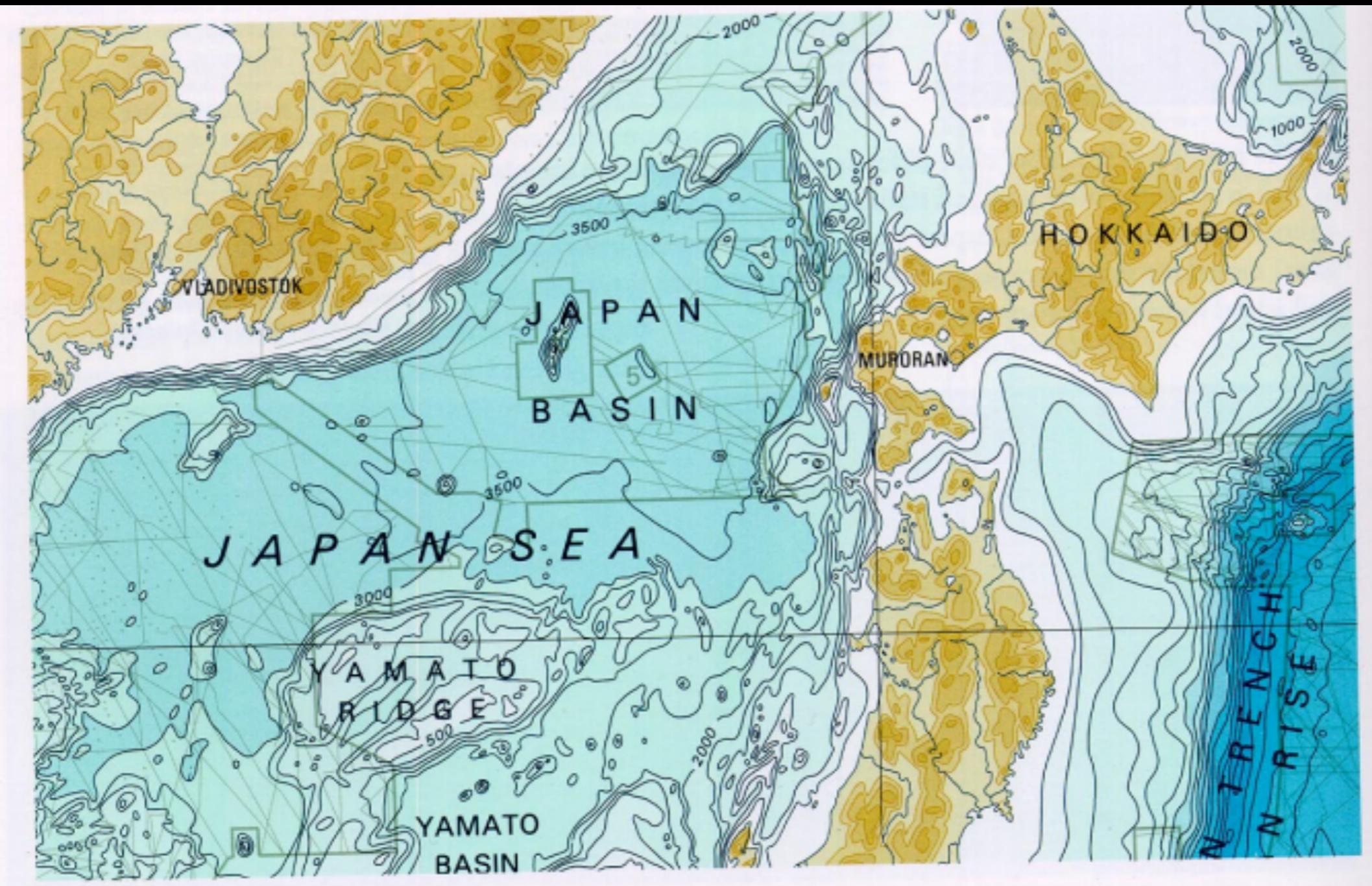
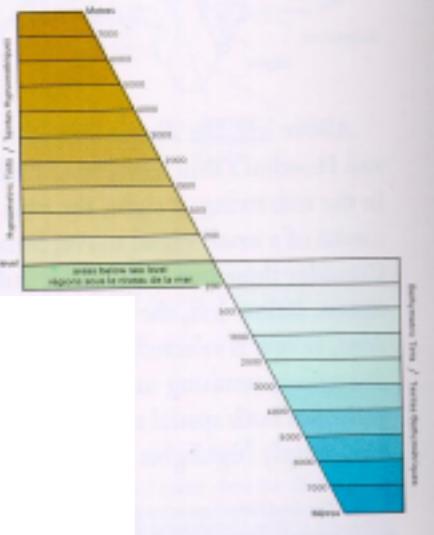


EFFECTIVENESS PRINCIPLE





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

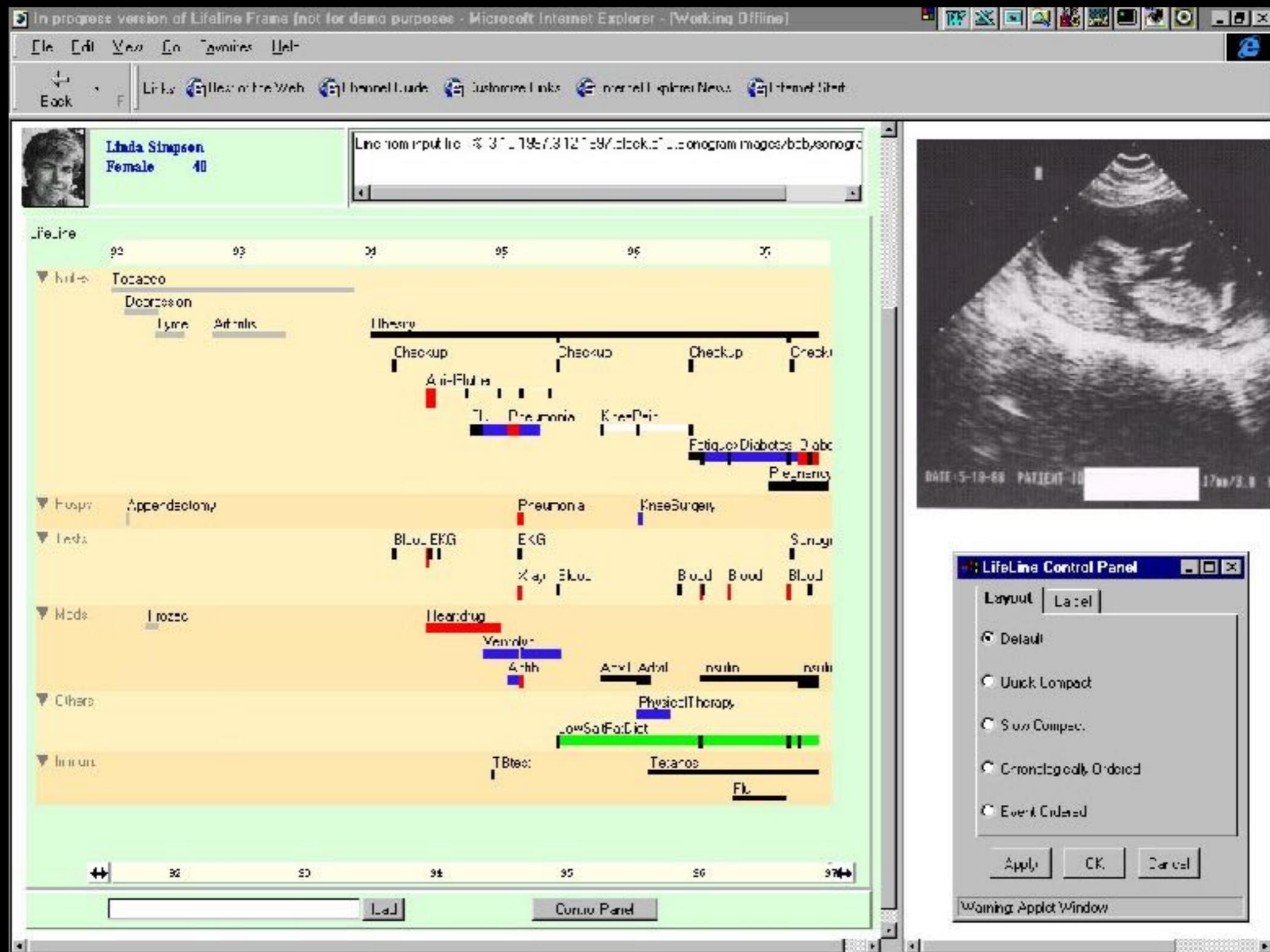
Visual Display of Quantitative Information

VISUALIZATION IN MEDICINE

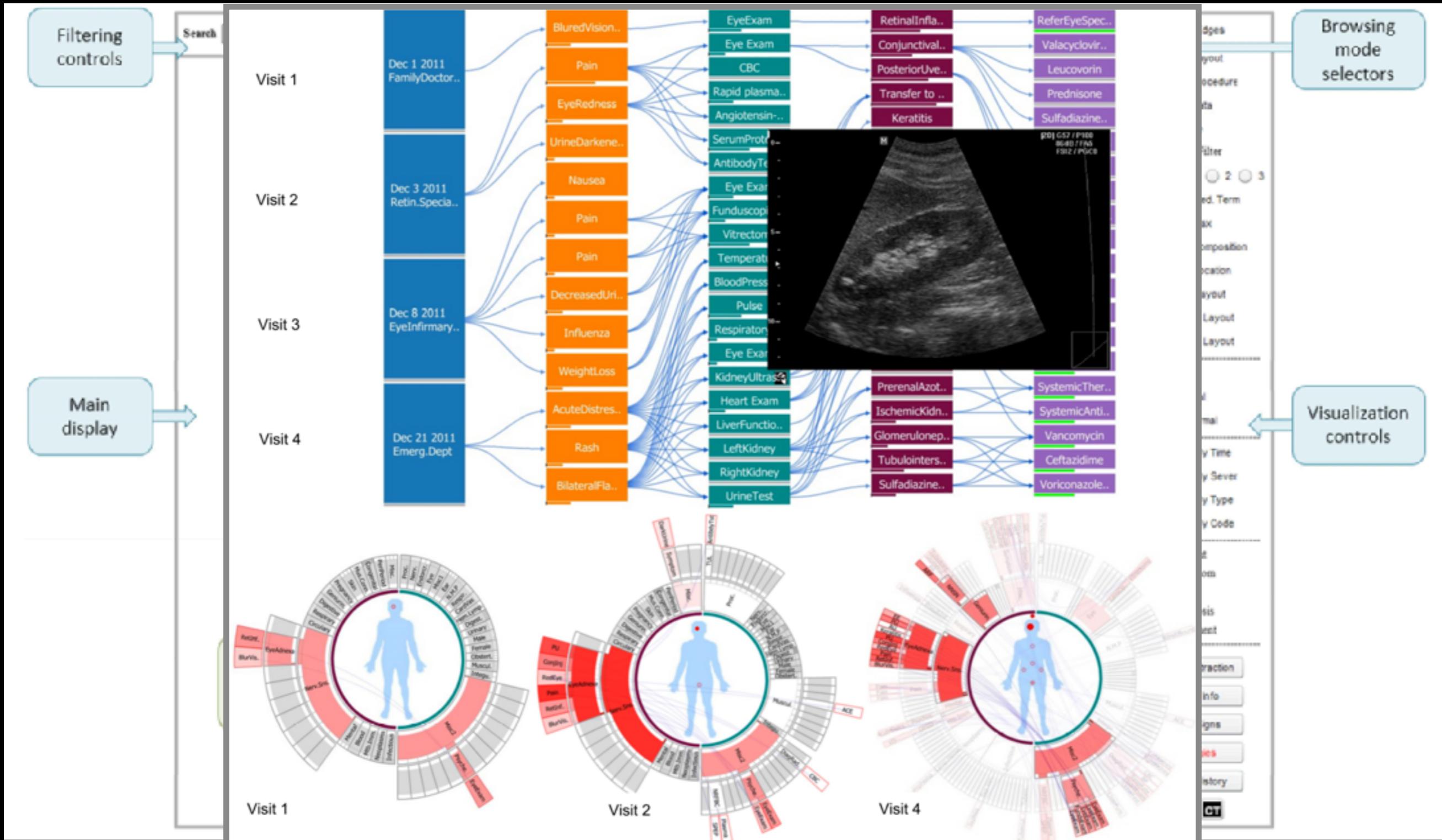


VISUALIZATION FOR CLINICAL PRACTICE

LifeLines [Shneiderman & Plaisant, 1996]



AnamneVis [Zhang et al., VIS 2013]



HARVEST [Hirsh et al., JAMIA 2015]

iNYP

Patient List Registry Patient Data

Profile History/Timelines Data Review Summaries

Laboratory Radiology Pathology Note

EMR NYP/CU CMC

Filter []

Eclipsys Note - Columbia University (20 -10-17-20 -09-06)

Newer Pg# Older

20 -10-18 17:32 Final NYP/CU
20 -10-18 13:34 Final NYP/CU
20 -10-18 13:07 Final NYP/CU
20 -10-18 11:00 Final NYP/CU
20 -10-18 19:44 Final NYP/CU
20 -10-18 08:08 Final NYP/CU
20 -10-18 00:32 Final NYP/CU
20 -10-18 18:52 Final NYP/CU
20 -10-18 19:27 Final NYP/CU
20 -10-18 11:33 Final NYP/CU
20 -10-18 15:40 Final NYP/CU
20 -10-18 11:02 Final NYP/CU
20 -10-18 19:17 Final NYP/CU
20 -10-18 18:43 Final NYP/CU
20 -10-18 14:14 Final NYP/CU
20 -10-18 14:10 Final NYP/CU
20 -10-18 09:31 Final NYP/CU
20 -10-18 16:25 Final NYP/CU
20 -10-18 11:58 Final NYP/CU
20 -10-18 11:21 Final NYP/CU
20 -10-18 09:19 Preliminary NYP/CU
20 -10-18 06:24 Final NYP/CU
20 -10-18 00:55 Final NYP/CU
20 -10-18 21:42 Preliminary NYP/CU
20 -10-18 19:04 Final NYP/CU

Cardiology Consult Free Text Note
Medicine Follow-Up Free Text Note
Case Manager Plan Of Care
Initial Nutrition 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
Transfer Note
Emergency Department Disposition Note
Emergency Resident / Nurse Practitioner / Attending Note (Milstein)

Cardiology Consult Free Text Note • 20 -10-18 14:14

Expand Print

Cardiology Consult
Requested by Dr []
Reason: Fluid overload

HPI: 57 yo woman with a pmhx significant for morbid obesity, HTN, HLD, DM2, CKD (stage V) not on RRT and making urine, CAD s/p mLAD DES in 7/20, and pulmonary HTN (based on RHC on 7/20 who was on oxygen at rest and had desat). 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 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 had worsened PND this past month. The patient also reports 3 months of intermittent chest pain. She describes the pain as sharp, retrosternal, and 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.

PMHx:
1. Morbid obesity
2. HTN
3. HLD
4. DM2
5. CKD (stage V) not on RRT and making urine
6. CAD s/p mLAD DES in 7/20

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

Visits Timeline - Problems

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 CHRNC DIASTOLIC HRT FAIL

Feb - 20 Mar - 20 Apr - 20 Jun - 20 Jul - 20 Aug - 20 Sep - 20 Oct - 20 Nov - 20 Dec - 20 Jan - 20 Feb - 20 Mar - 20 Apr - 20 May - 20 Jun - 20 Jul - 20 Aug - 20 Sep - 20 Oct - 20 Nov - 20 Dec - 20 Jan - 2014 Mar - 20 May - 2014

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 |
| Cardiology Consult Free Text Note | 10/10/20 | 10:14 AM |
| 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, DM2, CKD (stage V) not on RRT and making urine, CAD s/p mLAD DES in 7/20, and pulmonary HTN (based on RHC on 7/20 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 had worsened PND this past month. The patient also reports 3 months of intermittent chest pain. She describes the pain as sharp, retrosternal, and 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.

PMHx:
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]

- Aspirin (ACETYLSALICYLIC ACID) 325MG
- Nitroglycerin 1/150 (0.4 MG)
- Norvasc (AMLODIPINE) 5MG
- Triamcinolone CREAM 0.5%
- Lipitor (ATORVASTATIN) 40MG
- Zestril (LISINOPRIL) 40MG
- Atenolol 50MG
- Hertz (HYDROCHLOROTHIAZIDE) 25MG

Issues by topic: [Clear all](#)

- Cardiovascular
- General Medicine
- Gyn/Ob/Breast
 - Cancer
 - Diabetes
 - Psychosocial
 - Respiratory
 - Dermatology
 - Internal Medicine
- Endocrinology**
 - Mental Health
 - Neurology

Highlight section:

- Chief complaint
- History of present illness
- Past history**
 - Family and social history
 - Medications
 - Allergies
- Review of Systems
- Physical exam
- Labs & imaging
- Assessment & Impression
- Plan

3 May 2067 thyroid nodule 2065, hot, follow TSH
Hot thyroid nodule - recheck TSH next visit

Thyroid nodule : 2065, thyroid scan 2066 consistent with hot nodule and toxic multinodular goiter, saw Dr Dolan, foll...

thyroid nodule : 2066, hot, follow TSH

Will check electrolytes and TSH

thyroid nodule : 2065, hot, follow TSH

thyroid nodule : 2065, hot, follow TSH
Check TSH
TSH 0.305/2074 2.297

Got flu shot already.

Problems

- FH breast cancer : 37 yo s
- FM myocardial infarction + mother died 66 yo
- Hypertension
- Uterine fibroids : u/s 2062
- Smoking : quit 2/67 a/p MI
- Hyperlipidemia : CRF mild chl, cigs, HTN, Phx and known hx CAD in pt.
- borderline diabetes mellitus : 4/63 125 , follow bg/bair
- VPM : 2065 - EFT showed freq PM's, bicuspid and complete, nondx for ischemia
- Coronary artery disease : a/p ant SEMI + stent LAD 2/67, Dr Oakley, EFT Clarkfield 3/67 - neg scan for ischemia.
- thyroid nodule : 2065, thyroid scan 2066 consistent with hot nodule and toxic multinodular goiter, saw Dr Dolan, follow TSH.

Medications

- Aspirin (ACETYLSALICYLIC Acid) 325MG, 1 Tablet(s) PO QD
- Nitroglycerin 1/150 (0.4 MG) 1 TAB SL x1 PRN prn CP

node

3 May 2067 ...EMI + stent LAD 2/67, Dr Oakley thyroid nodule 2065, hot, follow TSH. Medications NOR...
... - will try to put up with it. 6. Hot thyroid nodule - recheck TSH next visit. 7. Borderline glc ...
5 Dec 2068 ...Clarkfield 3/67 - neg scan for ischemia. Thyroid nodule : 2065, thyroid scan 2066 consistent with hot nod...
...ule : 2065, thyroid scan 2066 consistent with hot nodule and toxic multinodular goiter, saw Dr Dolan, foll...
...1 if fevers, worsens or persists. 2. Hot thyroid nodule - was slightly higher last visit - will refer to ...
1 Dec 2069 ...d. She was "pleased" with everything. thyroid nodule : 2065, hot, follow TSH. Will recheck today. Has...
27 Jul 2072 ... with cardiology now that Dr Oakley gone thyroid nodule : 2065, hot, follow TSH. TReated with RAI Februar...
31 Jan 2073 ... mg although she hasn't done this yet. thyroid nodule : 2065, hot, follow TSH. TReated with RAI Februar...

Doccurate [Sultanum et al. 2018]

Current date: 26 Sep 2183

Name: Walker Peery

Birth (Age): 28 Sep 2144 (38)

Sex: M

Running Document Interval Type

- 3d ECG
- 1w Nur/O.
- 2w Disch.
- 3w Rad.
- 1m Nur.
- 3m Phys
- Soc.W.

Filter Collections

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

Psychosocial

urine Berzos, Bards, Upiales, Cocaine, Amphet, Mitrone 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**] stoh.
- given that he has hx of DTs and wid 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 tx.
- use toradol then motrin/tylenol for CP
- patient also reports having leg/back pain which is burning, bilat, and ongoing. will try naurentin as has been tried previously

elevated lactate: ddx includes dehydration, infection, liver disease, hypovolemia, poor sample. Lactic acidosis not likely given the alkalosis 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 16 in the ED with a normal HCO3 and alkalosis on VBG. ASA negative as were other toxins. Difficult to interpret but wonder

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

X (29212009) Alcohol-induced organic mental disorder

X (363101005) Drug withdrawal

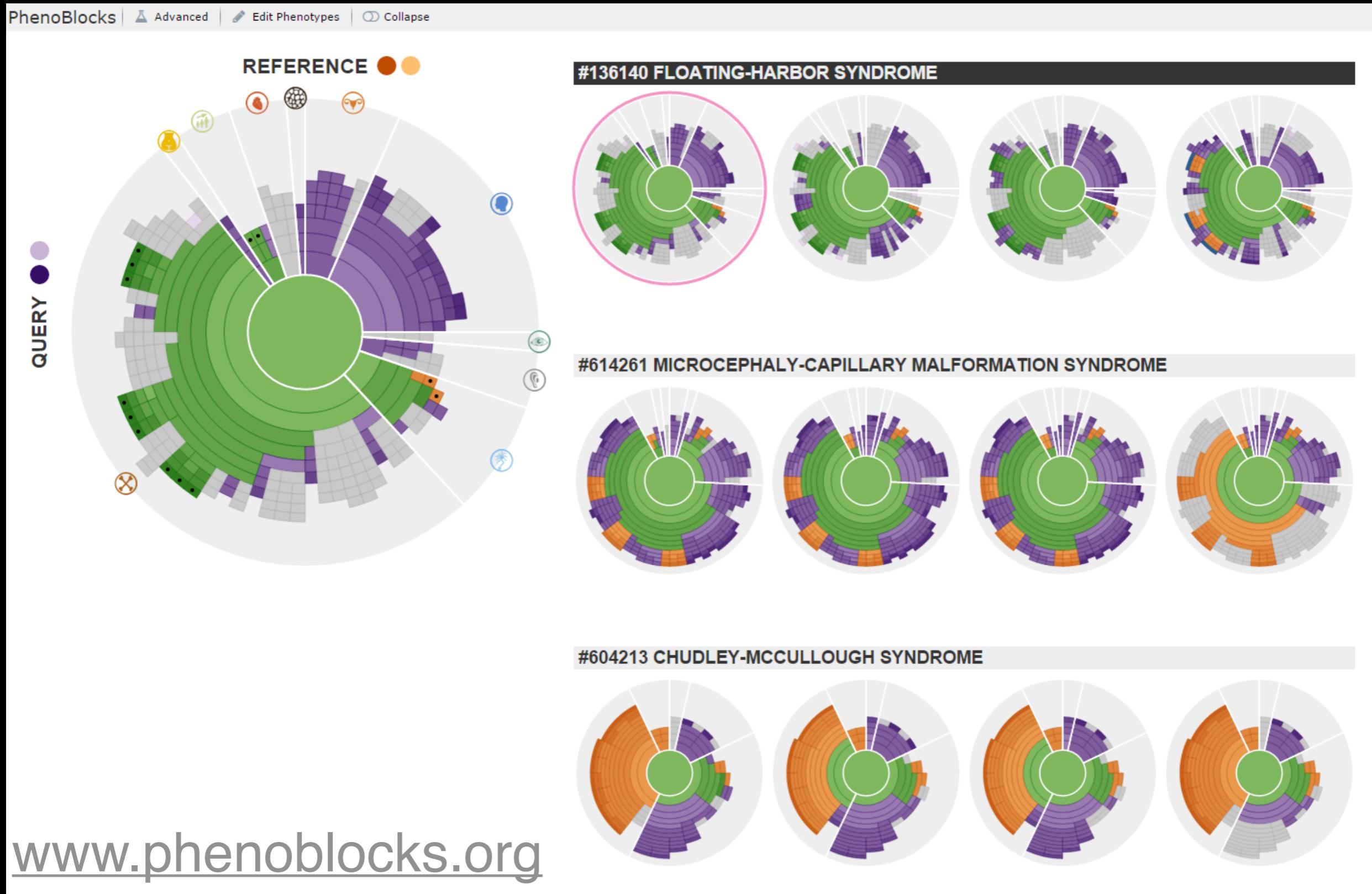
X (191480000) Alcohol withdrawal syndrome OK

Keywords Search... Add

abusive X smoking X
smoker X etoh X

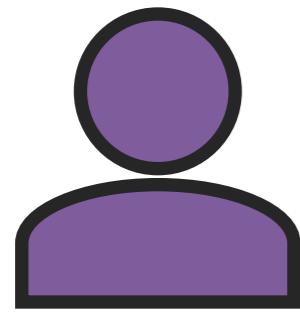
Save Filter Collection:
Psychosocial
Save

PhenoBlocks [Glueck et al., VAST'15]

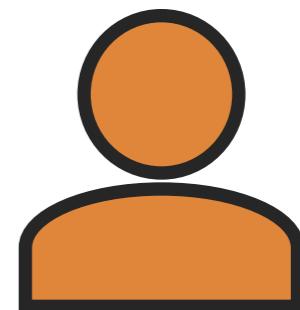
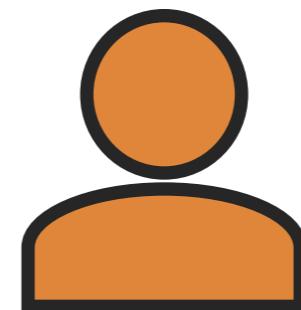
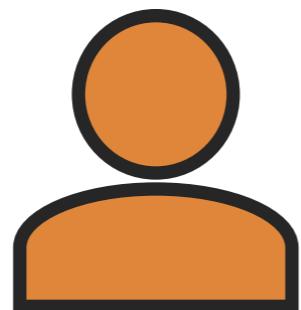
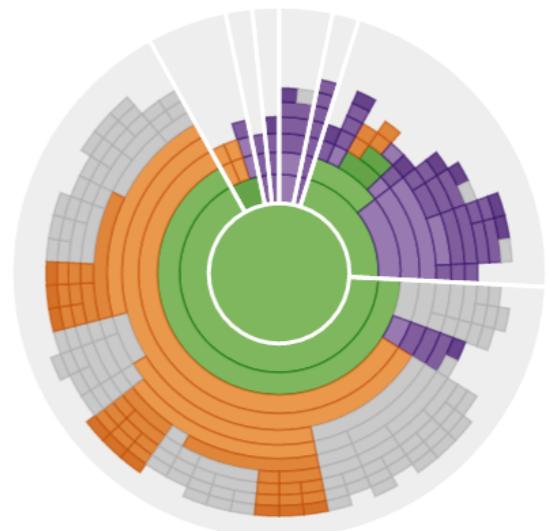
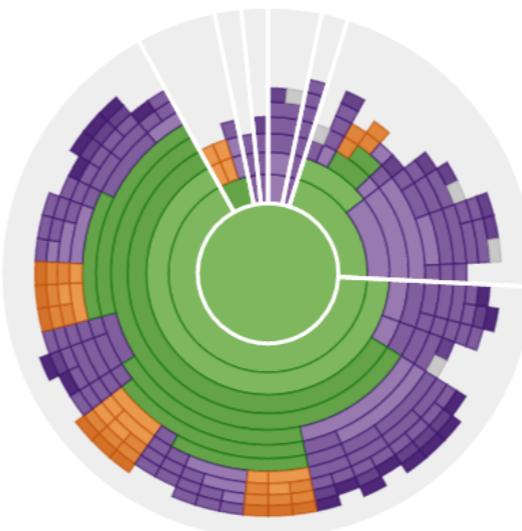
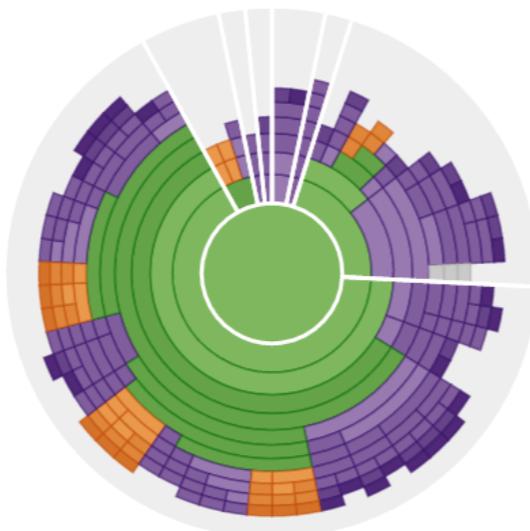


Glueck, Michael, et al. "PhenoBlocks: Phenotype Comparison Visualizations." IEEE transactions on visualization and computer graphics 22.1 (2016): 101-110.

PhenoBlocks [Glueck et al., VAST'15]

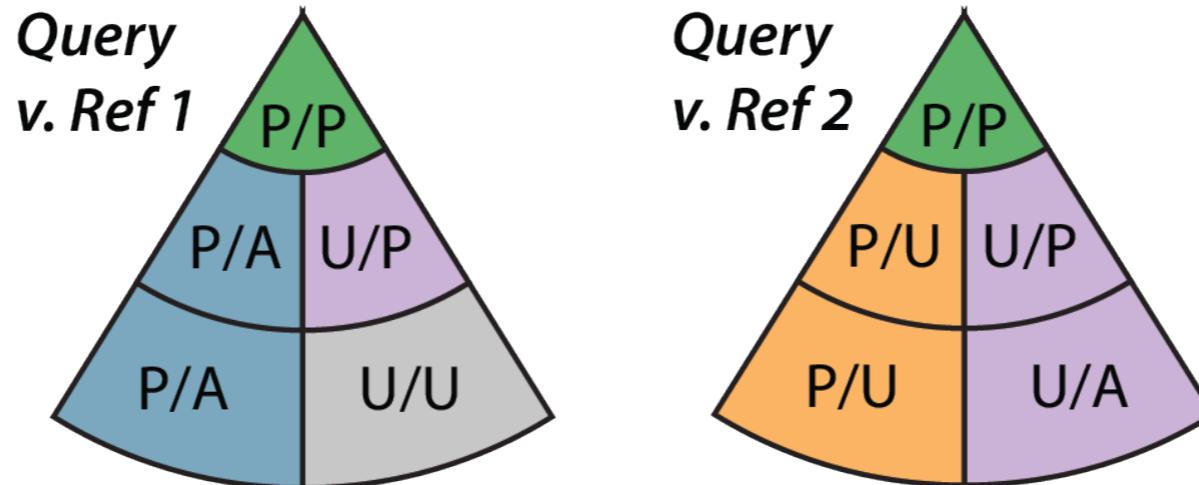


QUERY
undiagnosed



REFERENCES
diagnosed

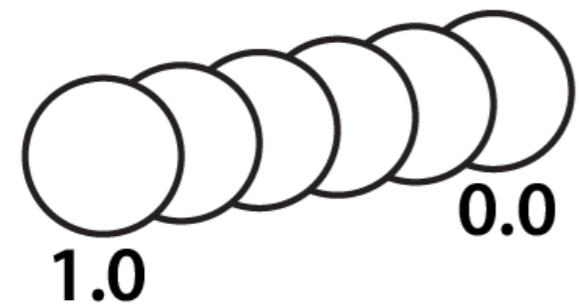
PhenoBlocks [Glueck et al., VAST'15]



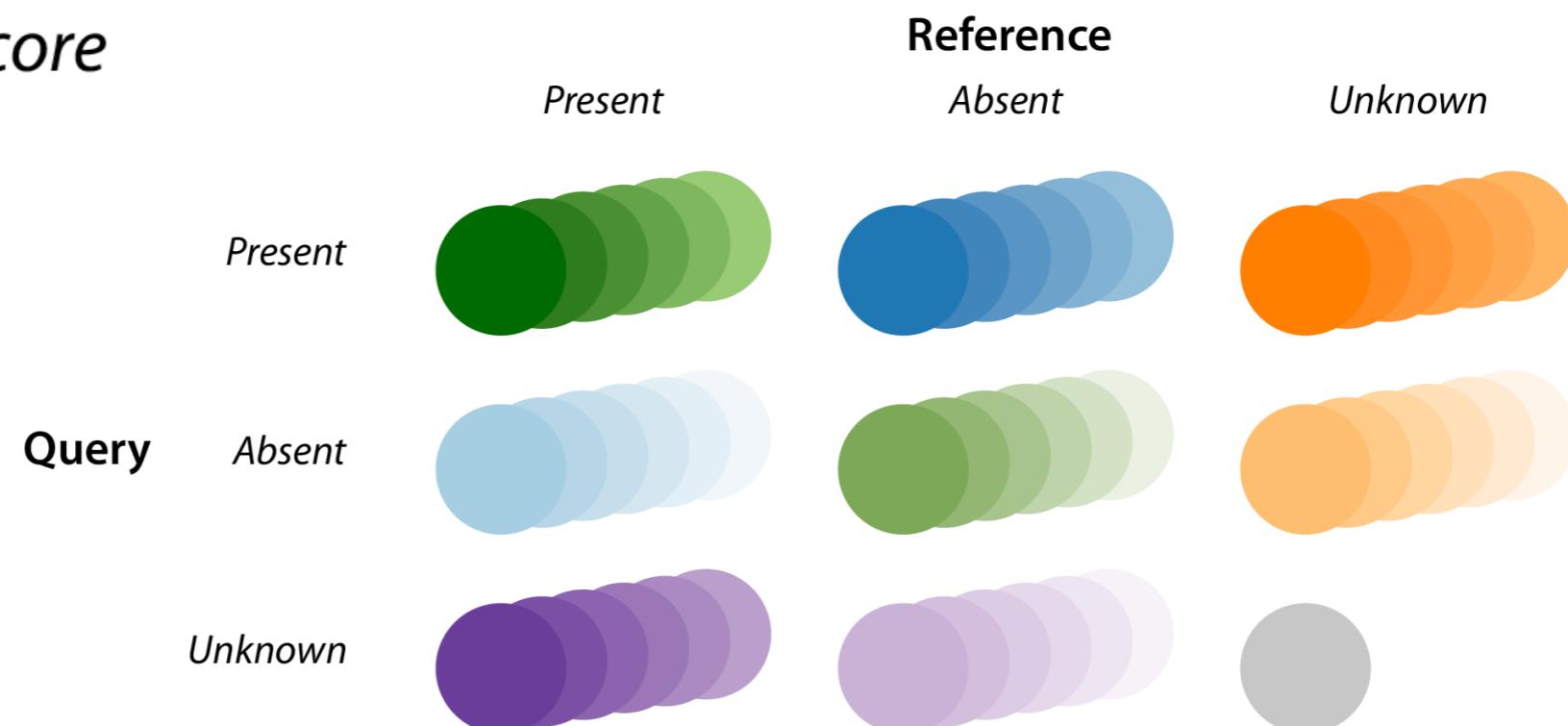
| Nine States | | Reference | | |
|-------------|---------|-----------|--------|---------|
| | | Present | Absent | Unknown |
| Present | | P/P | P/A | P/U |
| Query | Absent | A/P | A/A | A/U |
| | Unknown | U/P | U/A | U/U |

Shared in Both
Divergent in Both
Missing in Query
Missing in Reference
Unknown in Both

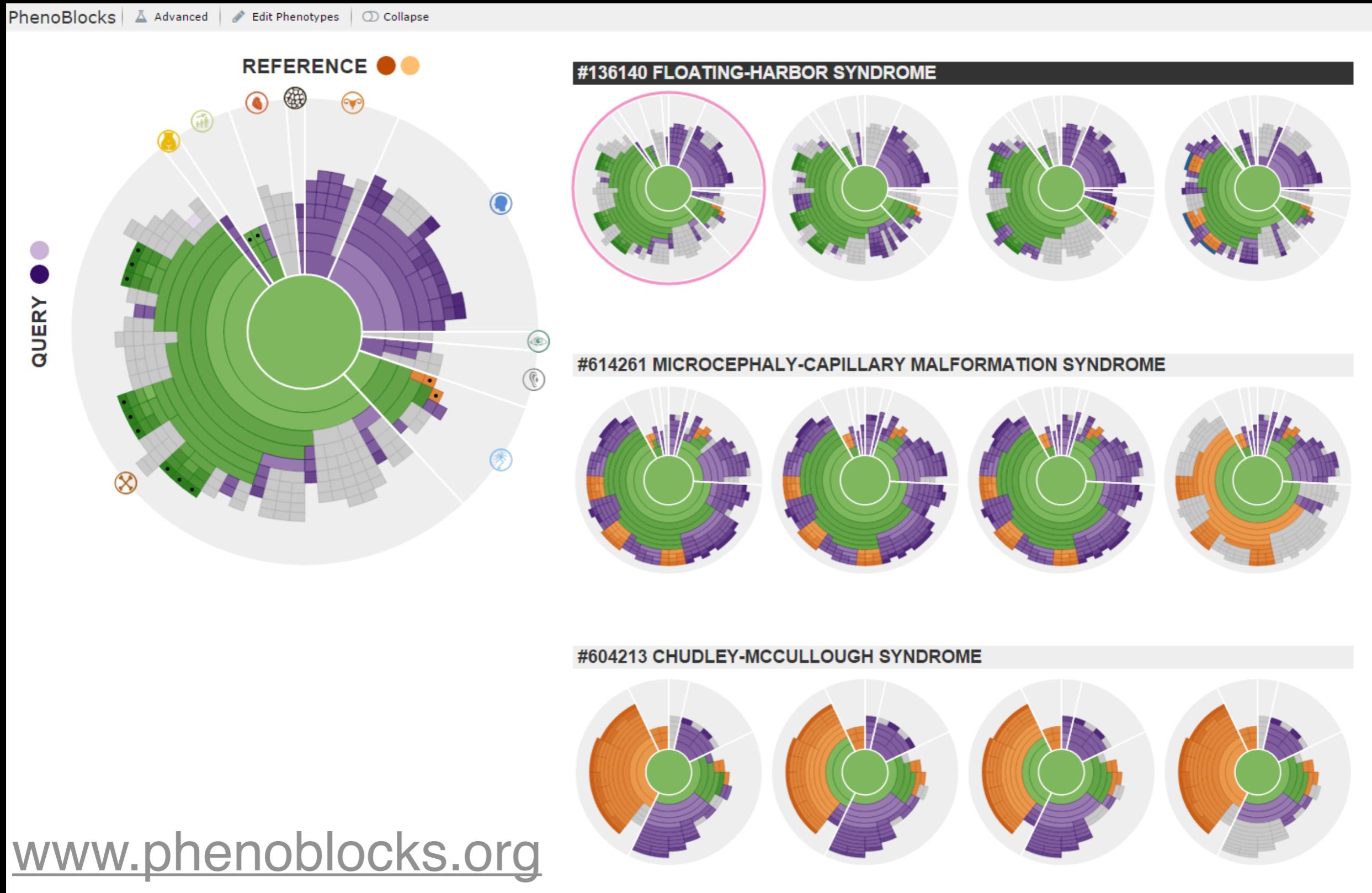
PhenoBlocks [Glueck et al., VAST'15]



Hard Handle Score



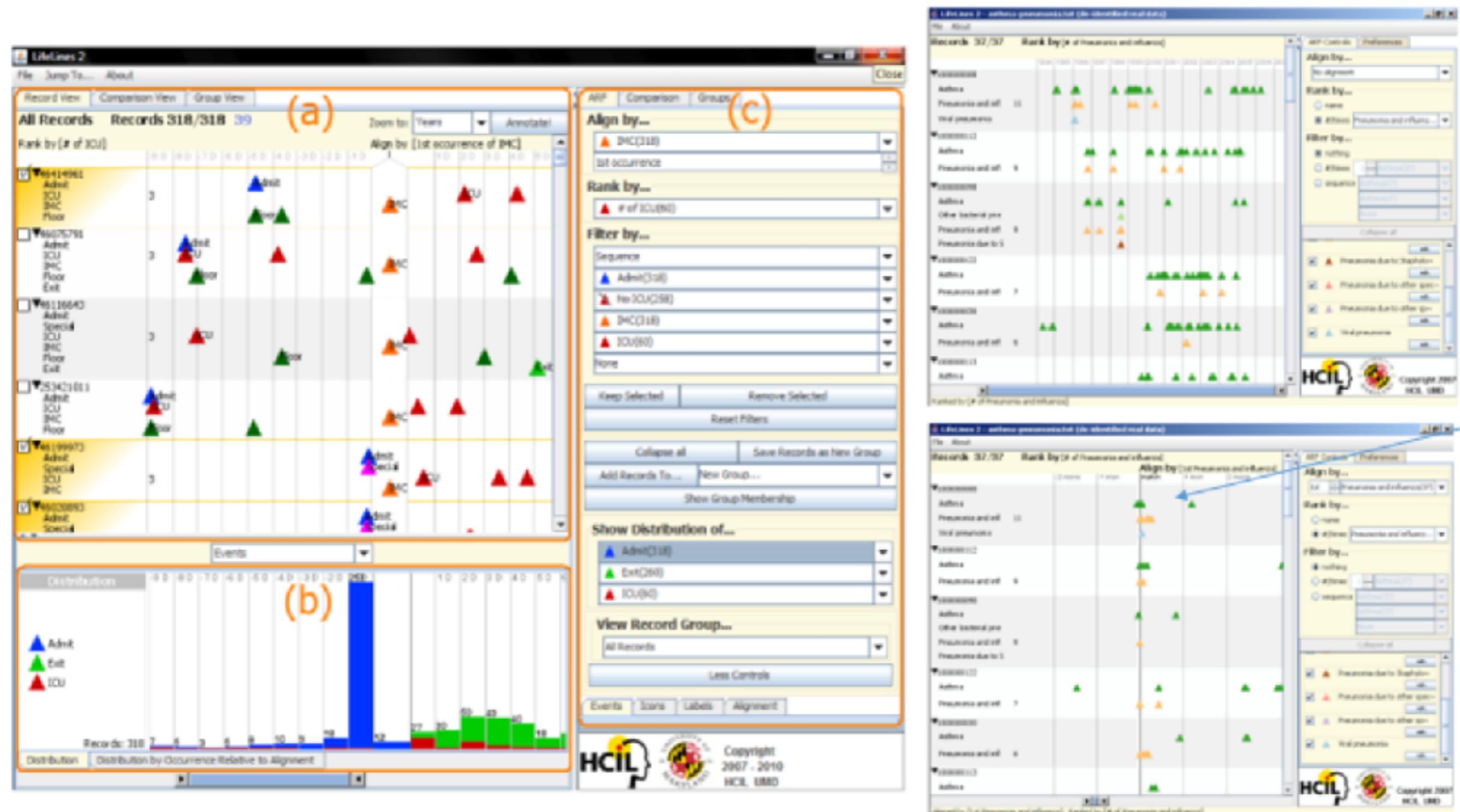
PhenoBlocks [Glueck et al., VAST'15]



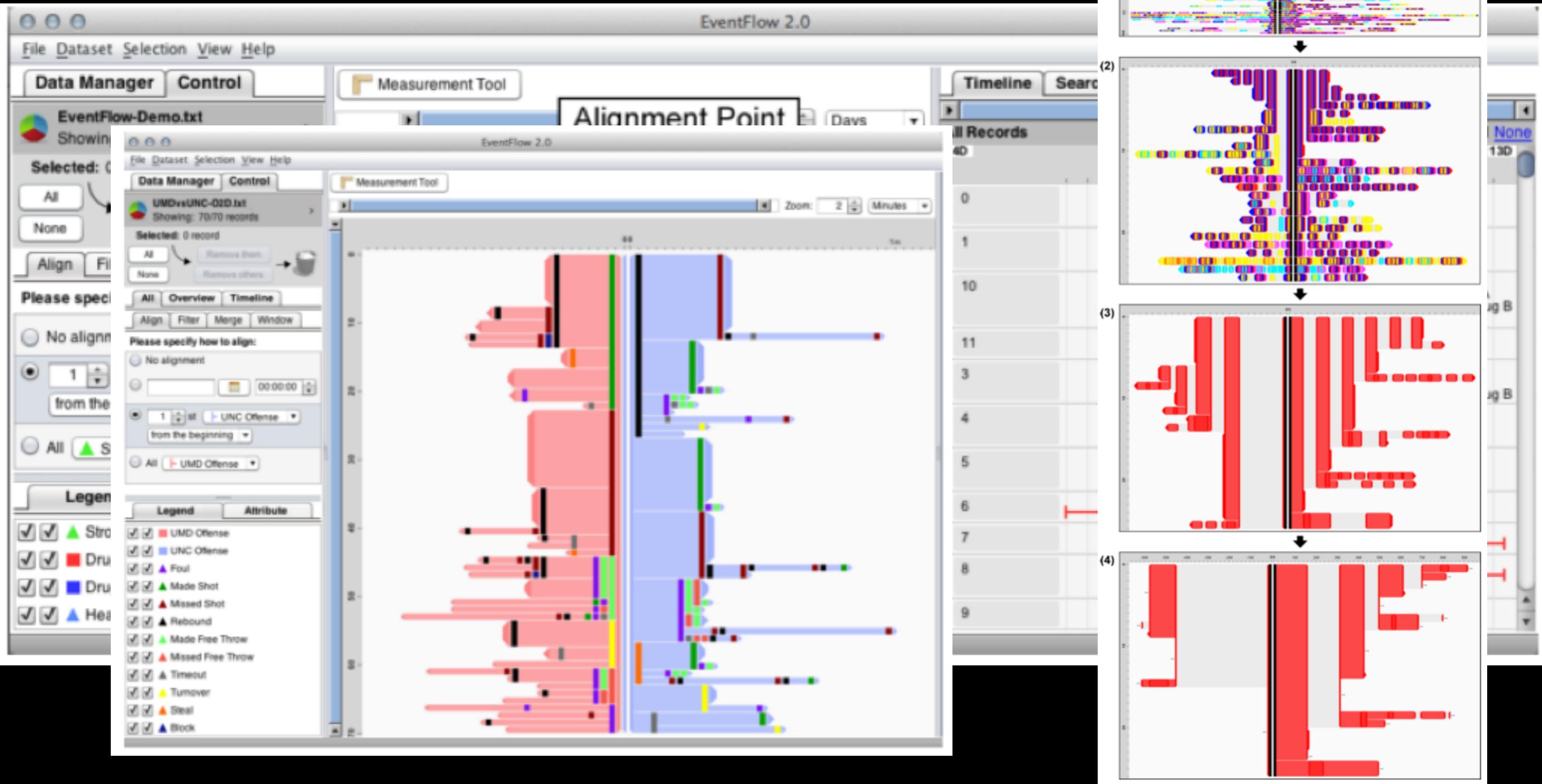
Glueck, Michael, et al. "PhenoBlocks: Phenotype Comparison Visualizations." IEEE transactions on visualization and computer graphics 22.1 (2016): 101-110.

VISUALIZATION FOR MEDICAL RESEARCH

LifeLines2 [Wang et al., 2008]

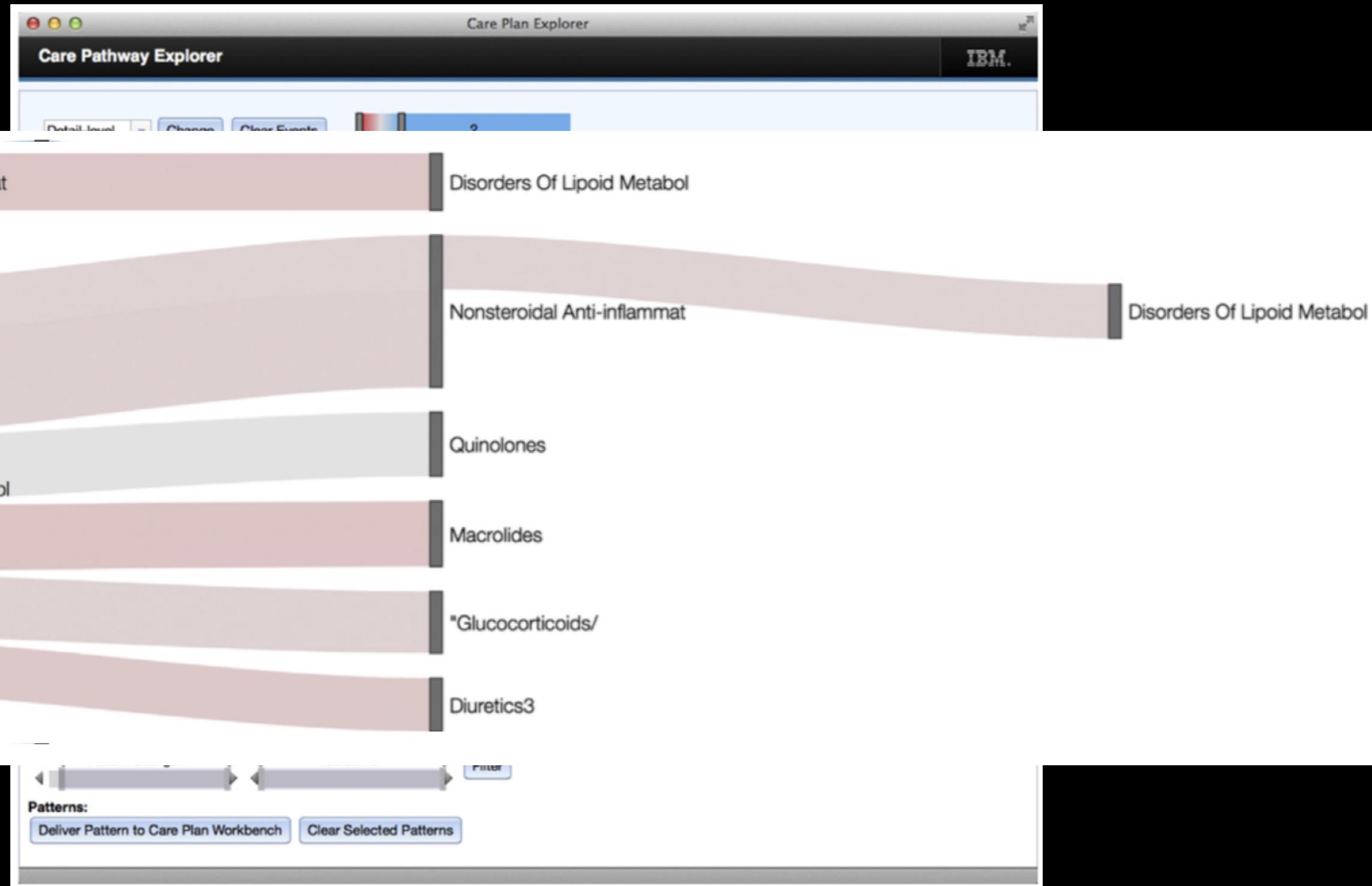


EventFlow [Monroe et al., 2013]



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.

PhenoStacks [Glueck et al., VAST'16]

PhenoStacks

Build 0.0.1; HPO 2016-01-13
FLHS, MICCAP, HJCYS, JBTSL7, CMCG-MFDGA

Dataset: FLOATING HARBOR

Present (purple)
Absent (green)
Ancestor (blue)
Unknown (yellow)



Summary of Comparisons

0 1

Layout

Categories

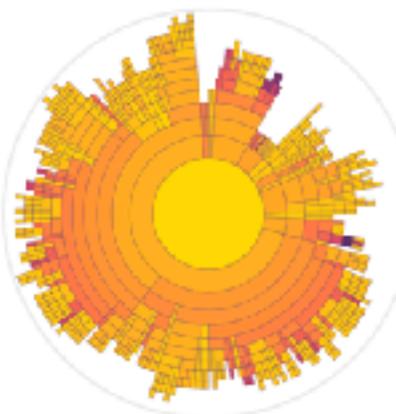
Information Content

Cohorts

ID

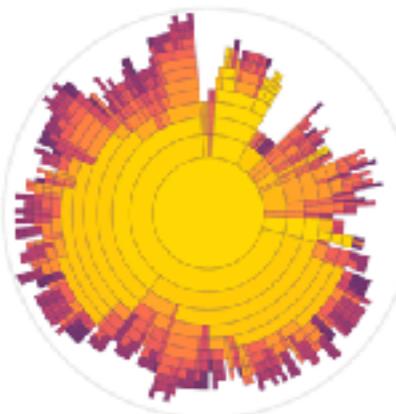
Search Phenotypes

Frequently Present



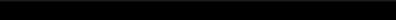
Prominent nasal tip
Low hanging columella
Long nose
Wide nose
Narrow nasal bridge
Moderate expressive language delay
Short 4th toe
Short 5th metacarpal
Broad finger tip
Dislocated radial head
Broad thumb
Short middle phalanx of the 5th finger
Brachydactyly syndrome
Short 1st metacarpal
11 pairs of ribs
Short clavicles
Hip dysplasia
Broad finger tip
Dislocated radial head
Broad thumb
Short middle phalanx of the 5th finger
Kyphoscoliosis
Brachydactyly syndrome

Infrequently Present



Ivory epiphyses, Congenital costovertebral fistula, Mesocardia, Unilateral cleft lip, Short 4th toe, Mild expressive language delay, Severe expressive language delay, Cellulitis, Abn. epididymis, Bilateral conductive hearing loss, Short 1st metacarpal, Short 5th metacarpal, Velopharyngeal insufficiency, Short clavicles, Lip dysplasia, 11 pairs of ribs, Dislocated radial head, Coarctation aorta, Short middle phalanx of the 5th finger, Nephrocalcinosis

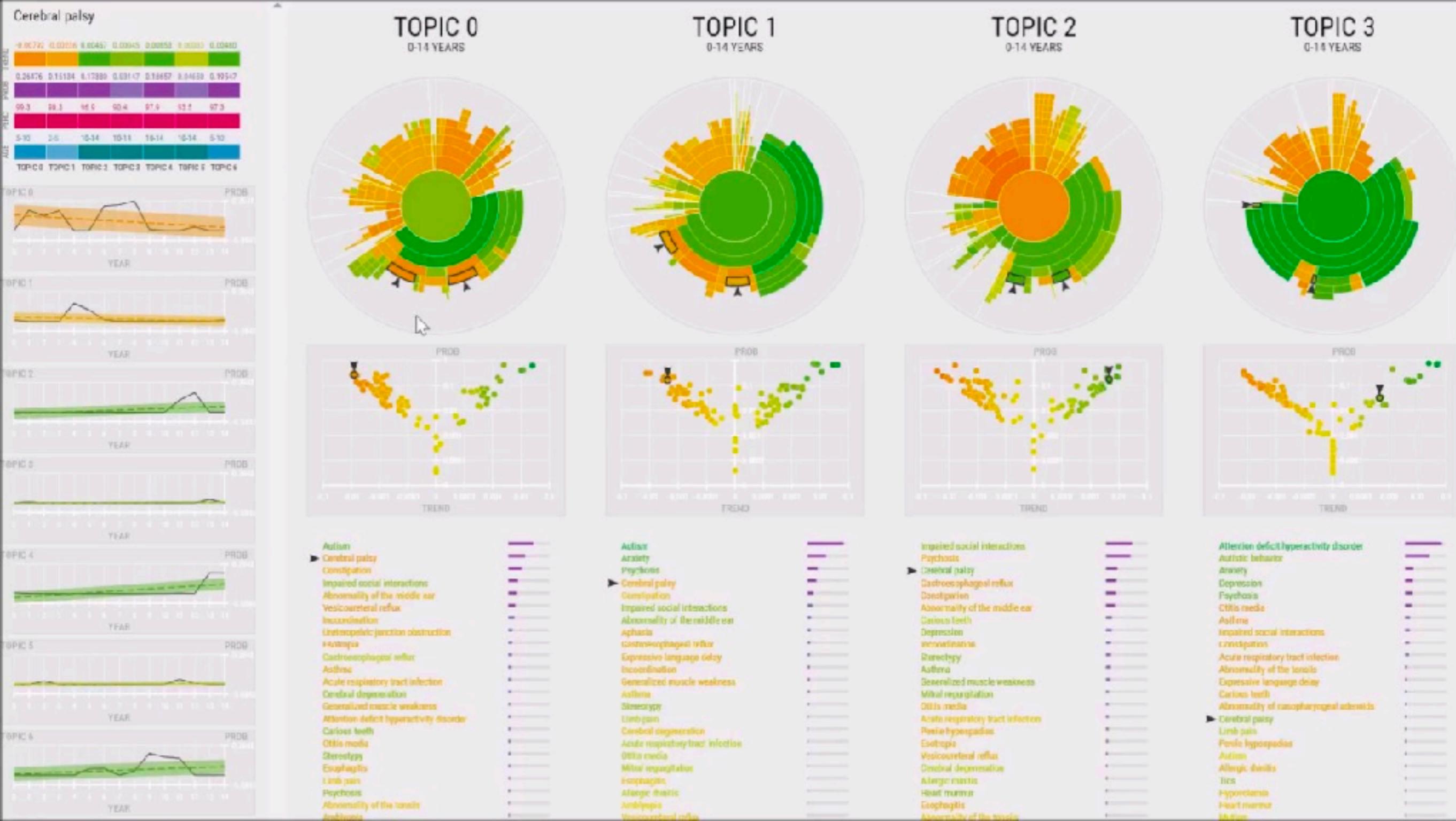
Frequently Absent



Unilateral cleft lip, Prominent nasal tip, Low hanging columella, Velopharyngeal insufficiency, Long nose, Wide nose, Narrow nasal bridge, Persistence of primary teeth, Microdontia, Dental malocclusion, Short philtrum, Thin upper lip vermillion, Caucasoid tooth, Wide mouth, Triangular face

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

PhenoLines [Glueck et al., VAST'17]



VISUALIZATION FOR COMMUNICATION

Motor & Sensory Homunculus



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

Phone: 858-668-

Ref. No.

Spec. No.

333-086-0655

DONAIRE, NONITO

| Spec. No. | Ref. No. | Spec. No. | Received Date Collected | Due Back to | Net M | Amt/Ml/100 | Spec. No. |
|-----------|------------|-----------|-------------------------|-------------|----------|------------|-----------|
| 22247228 | M3056E1101 | | 11/29/10 10:52 | 12/03/10 | 26/10/10 | 1 | |

TESTS RESULT FLAG UNITS REFERENCE INTERVAL

| | | | | |
|-------------------------|-----|--|--------|------------|
| BUN/Creatinine Ratio | 12 | | | 9 - 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 - 35 |

IGF-1

| | | | |
|------------------------------|-----|-------|-----------|
| Insulin-Like Growth Factor I | 242 | ng/mL | 117 - 325 |
| Testosterone, Serum | 691 | ng/dL | 280 - 800 |

**Effective December 13, 2010, Testosterone reference*; interval will be changing to:

| MALE TANNER STAGE | FEMALE TANNER STAGE |
|-------------------|---------------------|
| 1 <3 | 1 <3 - 6 |
| 2 <3 - 432 | 2 <3 - 10 |
| 3 55 - 770 | 3 <3 - 24 |
| 4 180 - 763 | 4 <3 - 27 |
| 5 198 - 982 | 5 5 - 38 |

| MALE ADULT 20-49 years | FEMALE ADULT 20-49 years |
|---------------------------|-----------------------------|
| 249 - 836 | 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

Ferritin, Serum 185 ng/mL 30 - 400

01 DO LabCorp San Diego Dir: Kelli Hanson, MD
13112 Evening Creek Dr Ste 200, San Diego, CA 92128-4108
02 BM LabCorp Burlington Dir: William F Hancock, MD
1447 York Court, Burlington, NC 27215-3561
For inquiries, the physician may contact Branch: 800-752-4744 Lab: 858-668-3780

DONAIRE, NONITO 22247228 333-086-0655-0

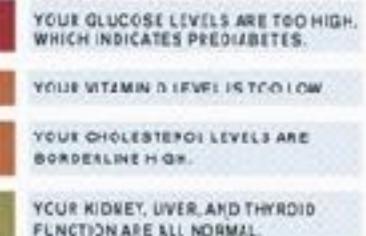
FINAL REPORT

Page 2 of

Your Test Results

Your results at a glance:

Questions?



PATIENT Cora Peterson

Gender: Female
age: 41

Date: August 12, 1969
Collected 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): 126 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.

Your results at a glance:

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

DR. PICO DUVAL
(210) 666-6263

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 <http://2010.nhlbi.nih.gov/atpiii/calculator.asp>.

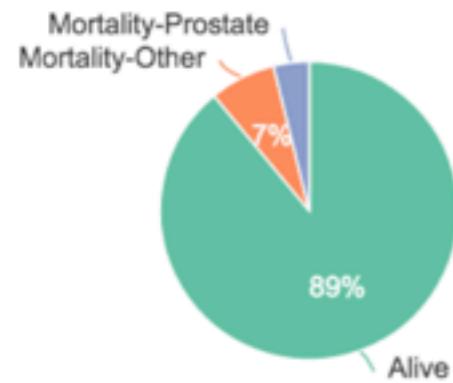
CONSIDER LIFESTYLE CHANGES TO CORRECT VITAMIN D INSUFFICIENCY. These include diet, vitamin D supplements, and more exposure to sunlight.

How big of a threat is my prostate cancer?

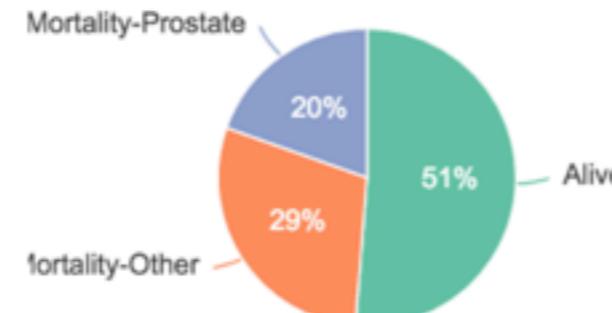
Before thinking about the benefits of specific treatments, it's helpful to first think about how big of threat your prostate cancer is to your future survival. The pie chart below shows the following:

- 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**)

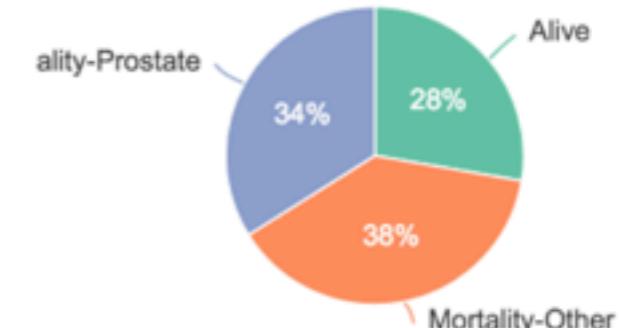
1 Year (70 years old)



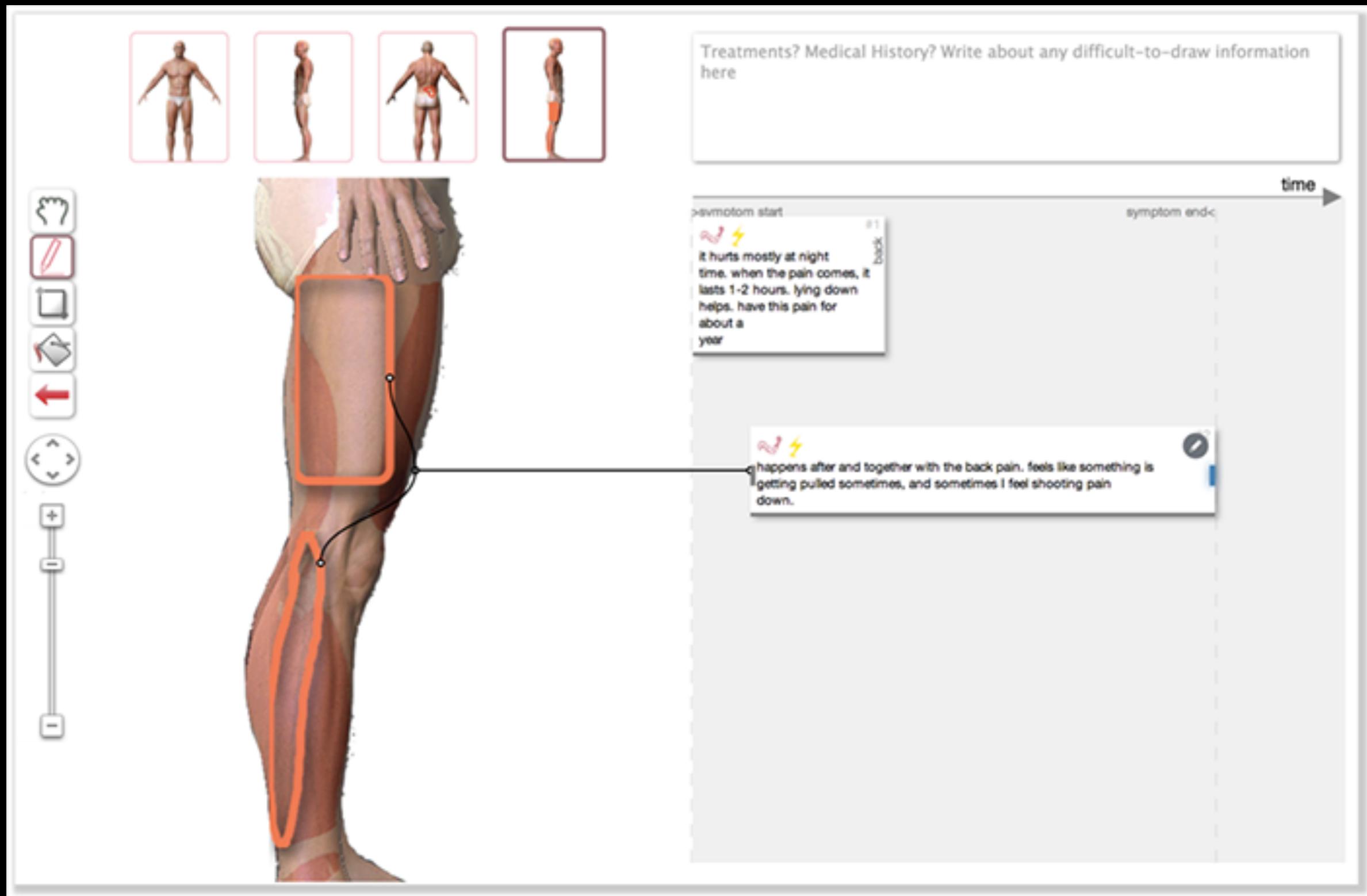
5 years (74 years old)



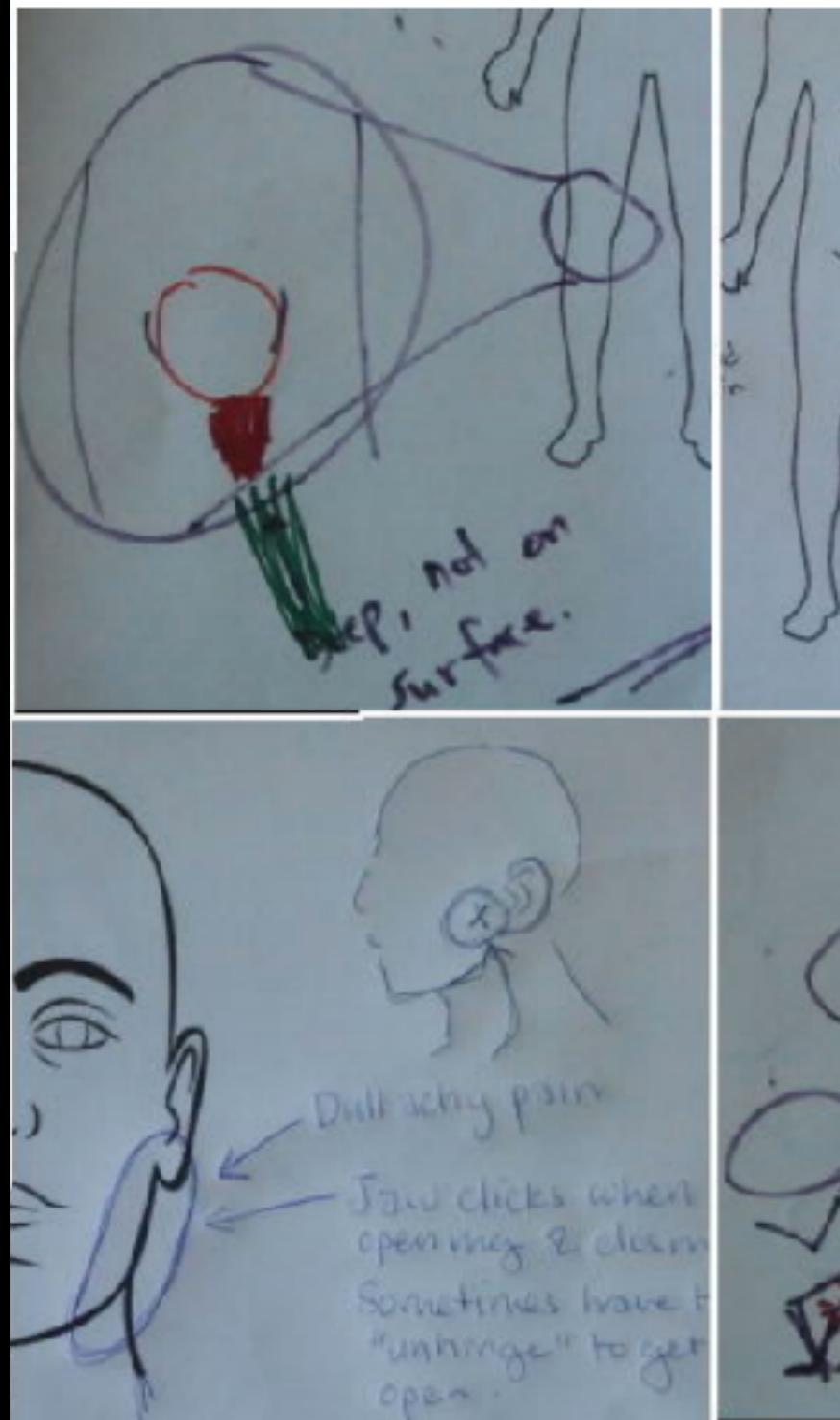
10 Years (79 years old)



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

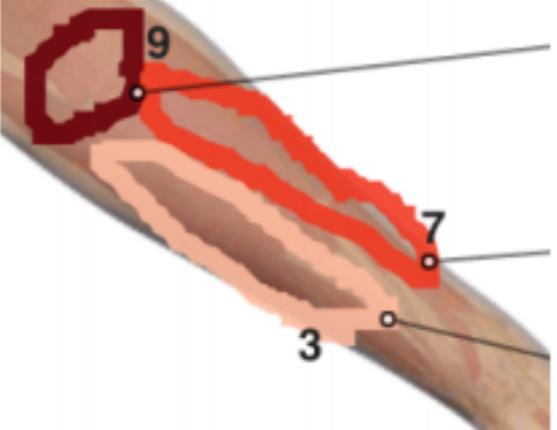
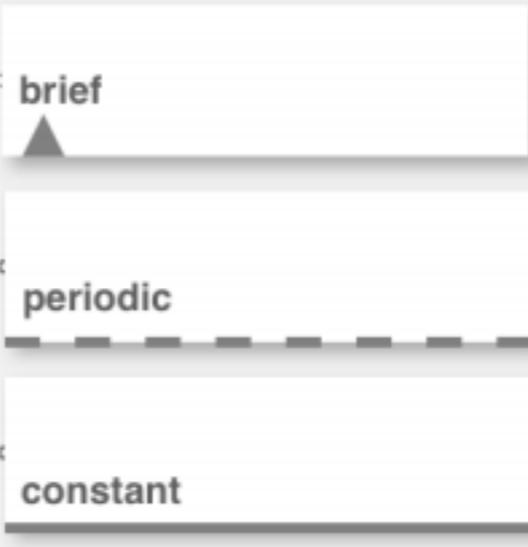


BodyDiagrams [Amy Jang, Diana MacLean, Jeffrey Heer, CHI'14]



| 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> <input type="radio"/> brief <input checked="" type="radio"/> periodic <input type="radio"/> constant | <p>Symptom Location</p> <input checked="" type="checkbox"/> skin <input type="checkbox"/> muscle&joint <input checked="" type="checkbox"/> bone <input type="checkbox"/> neural |
| Examples |  |  |  |

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.

We present
BodyVis
an e-textile shirt that
combines biometric
sensing and interactive
visualization to reveal
hidden parts and
functions of the
human body.



<https://makeabilitylab.cs.washington.edu/project/BodyVis/>

CONCLUSIONS

VISUALIZATION

Very powerful tool for monitoring, analysis,
communication

Applies to variety of data & problems

Benefits clinicians, patients, researchers

... is not trivial!

INFORMATION VISUALISATION

QUESTIONS?

Fanny Chevalier

fanny@cs.toronto.edu



UNIVERSITY OF
TORONTO