Stanford CS 520 Knowledge Graphs

Dr. Jans Aasman
(allegrograph.com)

About Franz Inc.

- Privately held, Self-funded, Profitable

- Headquartered: **Oakland, CA**

- Flagship product: **AllegroGraph**

- Compiler History**: Common Lisp and Prolog**

  for Artificial Intelligence and Complexity

- Industries: **Healthcare, Intelligence/Defense, Pharma/Biotech**

- Key Customers: **Montefiore, BAE, 2ls, BlueCross/BlueShield, Novartis,**

  Credit Suisse, AstraZeneca

- Strategic Partners: **BAE, Intel, Cloudera, Montefiore Health Systems**

  Pool Party, 2ls, Smart Logic, TopQuadrant, Expert

  Systems

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For today – just a simple introduction

- What is in a Knowledge Graph

- Use case we are involved with

  - Document and Text based Knowledge Graphs

  - Event Based Knowledge Graphs.

- Demo of

  - Chomsky Knowledge Graph

  - Large Hospital Use Case

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What is in a modern knowledge graph?

- A semantic graph database, scalable, secure, acid

- Ontologies and taxonomies

- Reasoning and rule based processing

- Smart integration of silos of information

- Machine Learning and Advanced Analytics

- Natural Language Processing and Text classification

And recently: more and more:

- Speech recognition

- Chatbots.

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We use our KG platform in various domains

- Do you want to live forever?

    - Biography Knowledge Graphs for interesting (and/or public) figures

- Predict risk in the automotive supply chain

We have solutions in various domains

- What do my agents talk about? What conversation style leads to more sales?
    - A knowledge graph for Intelligent Call Centers

SOLUTION BRIEF

Healthcare and Life Sciences
Data Analytics Solutions

Montefiore Creates Data Analytics Platform to Advance Patient Care

Addressing value-based healthcare with Intel® Xeon® processors and Franz AllegroGraph*

Challenge
Located in the Bronx, Montefiore Health System serves one of the most ethnically and socioeconomically diverse populations in the US. The complex includes the Montefiore Medical Center, the Albert Einstein College of Medicine, and a research facility. Unlike a pay-per-service model, as an accountable care organization Montefiore delivers value based on patients' long-term health—during their hospital or clinic visit and after they return to the community.

- How can we make our data integration, our ETL, queries, feature extraction and holistic overview a 100 times easier?
    - An events based knowledge graph.

Two main types of KG

- Document and NLP based knowledge graphs

  - Chomsky Knowledge Graph

- Entity/Event based knowledge graphs.

  - Montefiore

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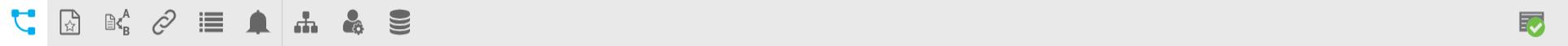# The Chomsky Knowledge Graph

Overall

- Preserve Chomsky's legacy

Practical

- Make it easy for journalists, students, researchers, strategists and politicians to find 'his thoughts'

Our platform solution:

- Knows everything about what Chomsky ever said or wrote, what others wrote about him, how concepts he talked about connect 'internally' and 'externally' (that is: to other knowledge sources, including linked open data, news paper articles)

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Using a collaborative tool to create a Chomsky Taxonomy

PROJECT   CORPORA   TOOLS   ADVANCED   en ▾ vietnam war   🔍

- Chomsky Project
  - Concepts (3)
    - Equality/Inequality (3)
    - Freedoms (2)
    - power (2)
      - Hard Power (4)
        - Attacks on Individuals (6)
        - Military Attack (4)
        - Violent Force (0)
        - War (2)
          - Cold War Proxy Wars (3)
            - Korean War (0)
            - Nicaraguan Revolution (0)
            - Vietnam War (0)
          - Unwinnable War (4)
      - Soft Power (5)
  - Events (4)
  - Legislation (3)
  - Media (4)
  - Nation States/Geographic Areas (23)
  - Organizations (8)
  - People (4)
- Lists
- Collections
- GraphEditors

Vietnam War

https://allegrograph.poolparty.biz/ChomskyProject/461

(+) Add to Collection   ⊘ Add to Blacklist   ⊘ Add to ExactMatch   (✕) Delete Concept

Details   Notes   Documents   Linked Data   Triples   Visualization   Quality Management   History

SKOS   👤 +

Broader Concepts
- ✕ Cold War Proxy Wars
- ✕ Unwinnable War
- ✕ Wars/Conflicts
- ✏️

Narrower Concepts
✏️ ⊕

Related Concepts
- ✕ Cambodia
- ✕ Ho Chi Minh
- ✕ Laos
- ✕ North Vietnam
- ✕ South Vietnam
- ✕ United States of America
- ✕ Vietcong
- ✏️

Top Concept of Concept Schemes
✏️

Preferred Label
⊘ Vietnam War   en

Alternative Labels
- ⊘ Resistance War Against America   en
- ⊘ Second Indochina War
- ⊘ War in Vietnam
- ⊕

Hidden Labels
⊕

Scope Notes
⊕

Definitions
⊕

Chomsky Project

- Concepts (3)
  - Equality/Inequality (3)
  - Freedoms (2)
  - power (2)
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- Collections
- GraphEditors

Cold War Proxy Wars

https://allegrograph.poolparty.biz/ChomskyProject/525

⊕ Add to Collection   ⊘ Add to Blacklist   ⊘ Add to ExactMatch   ⊗ Delete Concept

Details   Notes   Documents   Linked Data   Triples   Visualization   Quality Management   History

SKOS   👤 +

Broader Concepts
War

Narrower Concepts
⊗ Korean War
⊗ Nicaraguan Revolution
⊗ Vietnam War

Related Concepts
⊗ Soviet Containment

Top Concept of Concept Schemes

Preferred Label
Cold War Proxy Wars   en

Alternative Labels
⊕

Hidden Labels
⊕

Scope Notes
⊕

Definitions
⊕

A glance at the knowledge graph
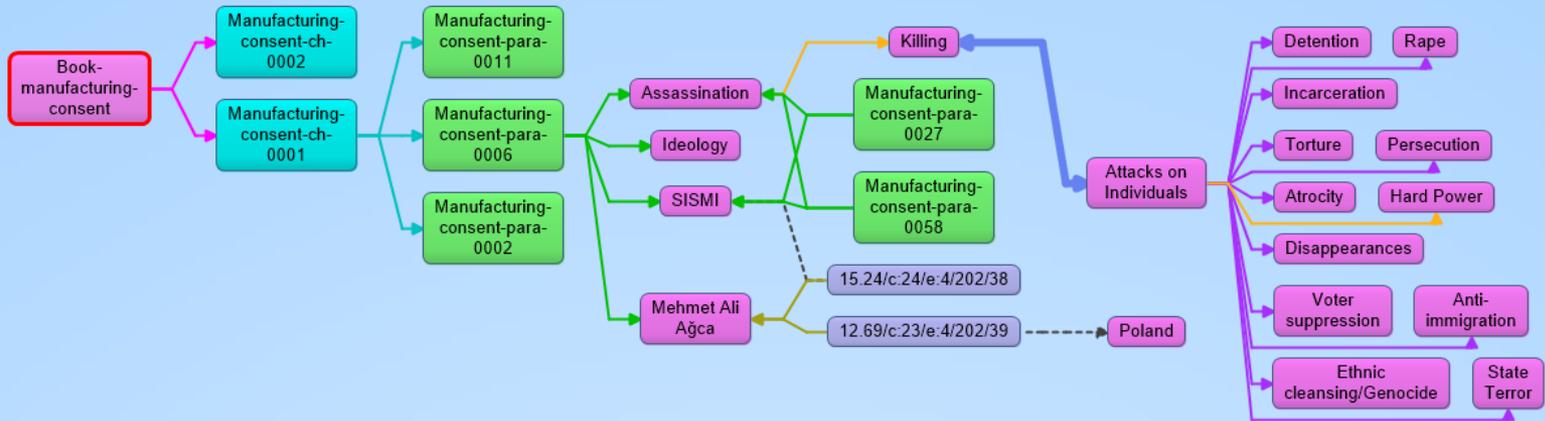
An events based approach

to integrate

enterprise data

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(intel®)

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WE'VE DECIDED TO TAKE BIG DATA TO THE NEXT LEVEL...

HUMONGOUS DATA

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Respiratory failure is very dangerous. More than 40 % mortality even if it occurs in hospital
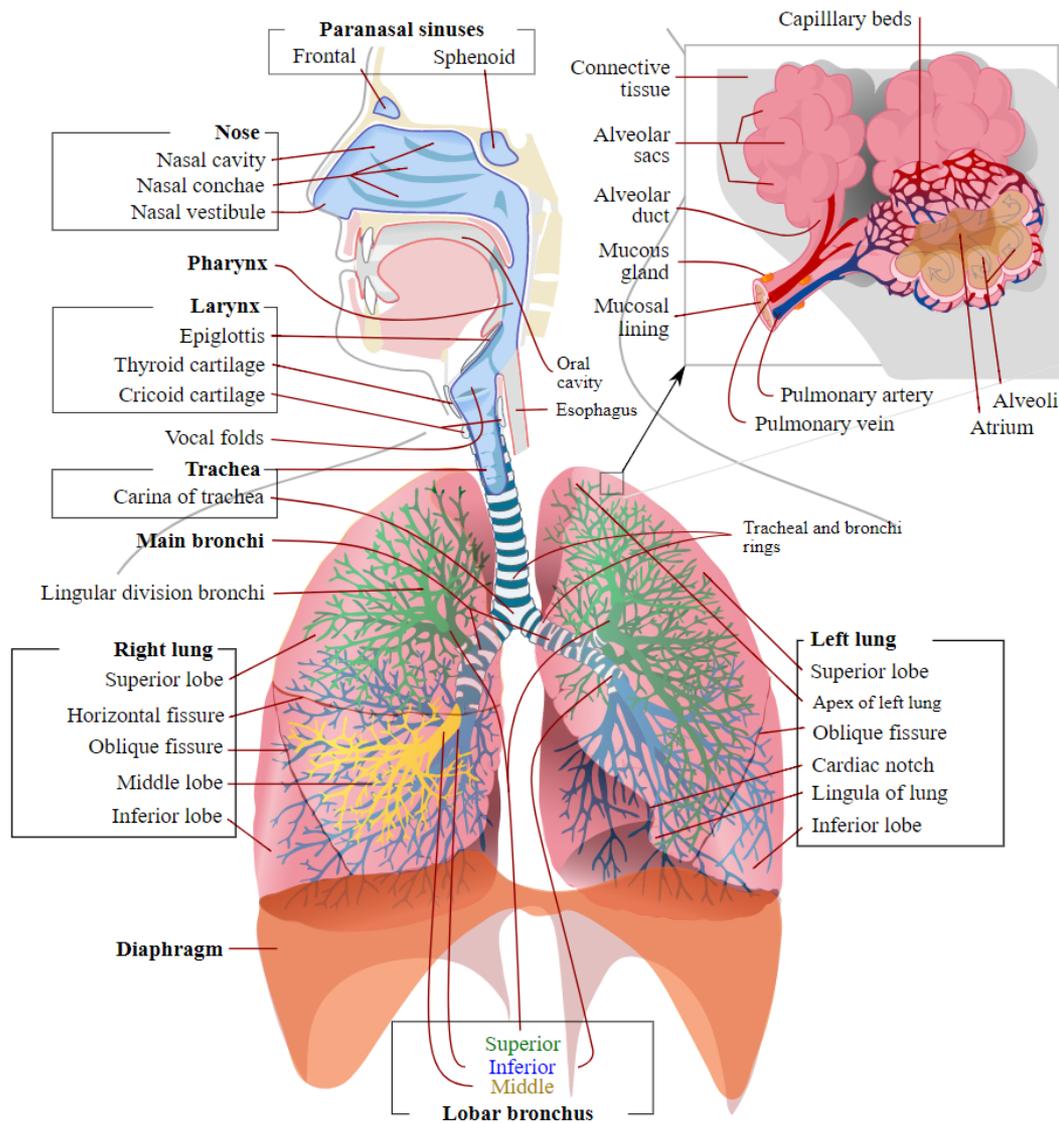
Needs instant intubation if at risk; but when?
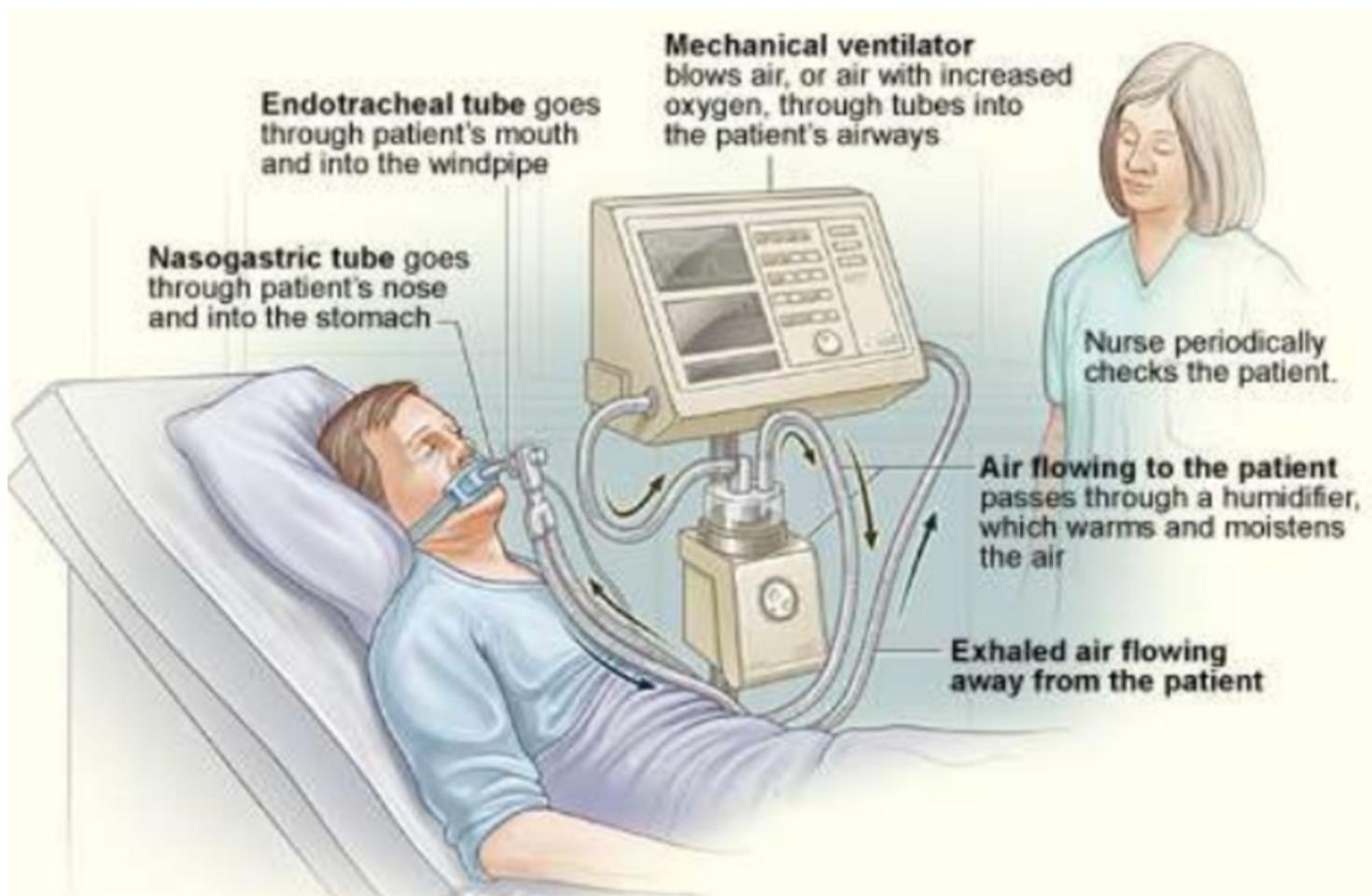
First production use case: a predictive model for respiratory failure on top our Knowledge Graph

- A random forest model detects respiratory

  failure up to 48 hours before the event.

  Faster than doctors and nurses

- The model uses 46 complex variables,

  a doctor in general looks at 3 to 4 variables.

  - A mix of lab results, (real time) measurements, diagnostics, other
  - Complex: give me largest difference between the value for SerumCalciumLevel and
    the midpoint 9.5 in the range of 0 to 20 for the last 24 hours.

- Greatly reduce unnecessary intubation with same clinical outcome
- Saves many millions per year

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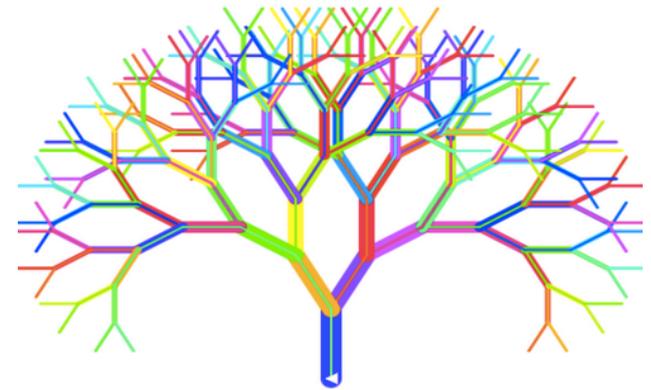
This is why it is hard for a clinician: every variable has its Distribution and relationship to 'risk'

Epic | Patient Lookup | Remind Me | Personalize | HCS-iSTOP | UpToDate | NYC CIR | Sign My Visits | MMC Intranet | Clinical Pager | Track Board | Print | Secure | Log Out

Search

McEntee,Patrick
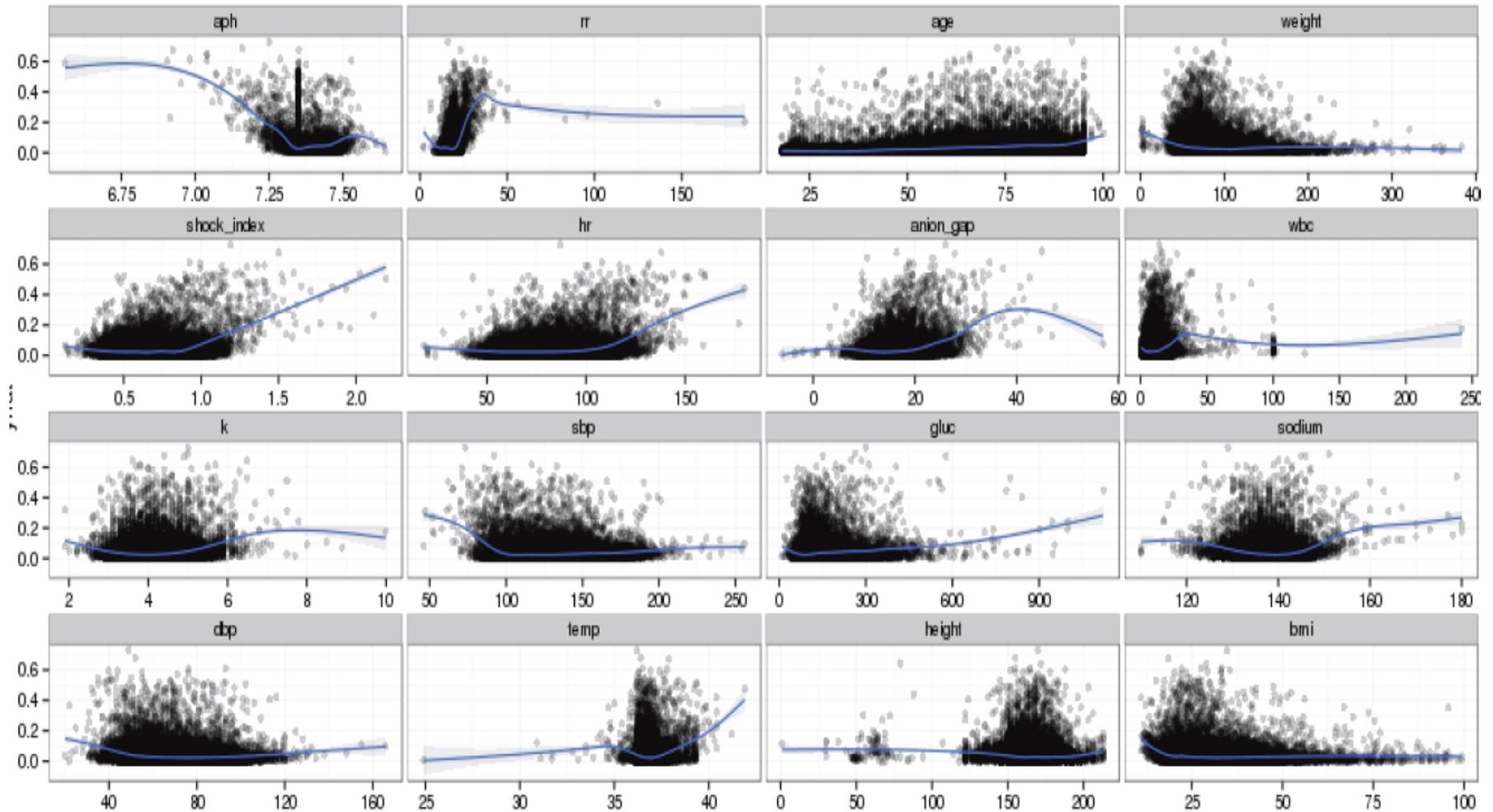
Evaluate need for critical care consult — Required

Critical care consult or contraindication — Required

Indications for critical care consult:
- Patient identified as at increased risk for acute respiratory failure or death in the hospital by APPROVE
- Patient is receiving or being evaluated for Non-Invasive Ventilation (NIV) for respiratory dysfunction
- Any concern for patient
- Even if previously seen by critical care, Critical Care consult can be called back as needed.
Can also page overhead for Rapid Response for emergencies

○ Inpatient consult to critical care
○ Reason for no crtical care consult

Evaluate for potential sepsis or infection — Required

Severe sepsis/sptic shock orders or contraindication — Re

○ Will Consider severe sepsis/septic shock order set
○ Reason for no sepsis order set
○ Severe sepsis/septic shock order set already activated

Daily Care
Transfer
Discharge
Procedure
FYI

More Activities

MICHELLE G.

Prev APPROVESCORE=0.26 on 12/27/2
Prev APPROVESCORE=0.24 on 12/27/2

Acknowledge reason:

Not primary prov
Pt not changing;
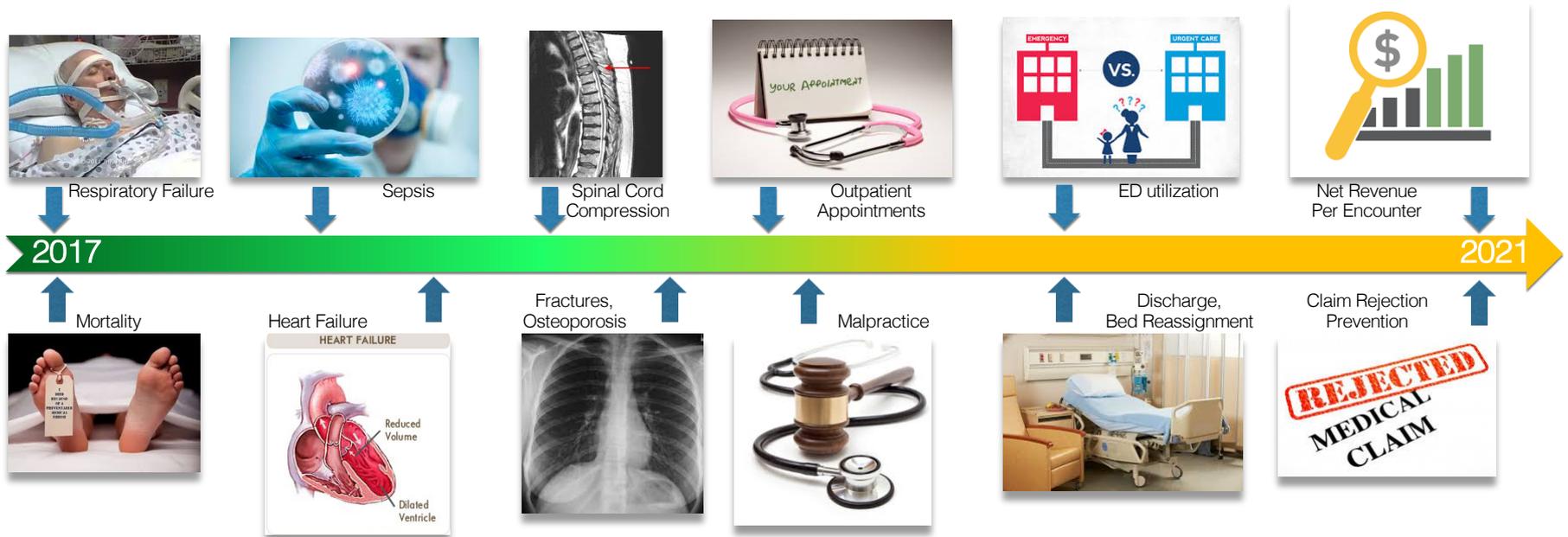
☑ Open Order Set: At-risk for acute respi

Lang: **English**
PLUS-cDi... Montefiore MyChart...
Adv Dir Filed?: **None**
FYI

Pharm: LI SCRIPT, LLC - WOODBURY, NY - 333 C...
PCP w/ Phone: GUPTA, SINDHU (718-822-2138)

? | Resize ⇕ | Summary ⏷

e ⏷ | Report: FS | Problem List

Index

Current Meds	I&O and Results
All Labs - Last 72 hr	All Imaging - Last 72 hr
Diet Orders	Active Lines
Problem List	Allergies
History	Treatment Team
SmartLinks and SmartPhrases	ICD-10 Diagnosis Smartphrases
My Charges & Notes	All Notes - Last 72 hr
EMG SmartLinks and Provider Checklist SmartPhrases	

24 Hrs   8 Hrs   **4 Hrs**   1 Hr   15 Min   All
701 - 01/20 0700
1501   1901 ▶

6.1)	98.2 (36...	Temp
lary	Oral	Temp...
99	97	Heart...
nitor		Heart...
19	18	Resp r...

Consider goals of care discussion — Required

Goals of care discussion — Required

○ Goals of care discussion took place with patient and/or family in the past 48 hours
○ Goals of care discussion will take place in the next 24 hours
○ Reason for not discussing goals of care

Evaluate need for palliative care consult — Required

Palliative care consult — Required

Are any of the following?
- Patient has pre-existing condition which my lead to death in the next 6 months.
- Patient has difficult to control physical or psychological symptoms like pain, shortness of breath, etc.
- Patient's goals of care are unclear.
- There is disagreement between patient, family, and hospital staff concerning major treatment decision or preference for resuscitation or life-support.
If any of the above are true, patient may benefit from palliative care services.

○ Inpatient consult to palliative care
○ Reason for not ordering palliative care consult

Ask me anything   Links   1/20/2017

Knowledge Graph Roadmap in Montefiore

- Developed using grant funding (NHLBI, PCORI, and ICTR) and Intel/Franz collaboration
- Fully integrated with Epic, and hosted by MIT Data Center.
- Go-Live January 2017 with Respiratory Failure and Mortality Prediction → Prevention
- C: Sepsis, HF, Spinal Cord Compression (etc) all with **associated ROI**
- Wide and multi-disciplinary spectrum of applications confirms a **platform** approach

Respiratory Failure

Sepsis

Spinal Cord Compression

Outpatient Appointments

ED utilization

Net Revenue Per Encounter

2017

2021

Mortality

Heart Failure

Fractures, Osteoporosis

Malpractice

Discharge, Bed Reassignment

Claim Rejection Prevention

EINSTEIN
Albert Einstein College of Medicine

Montefiore
DOING MORE

Events directly connect to Entity

The KG provides radical simplification of the EDW schema:

we turn everything into an EVENT

- Healthcare: everything that can happen to a patient is a time based (sub) event: Check In, Check Out, Test, Diagnosis, Procedure, Medication administration, Medication order, Sensor reading for vital signs, Invoice, Bill payment, Non-bill payment, all insurance interactions.

- Telecom: everything that happens with a telco user is a time based (sub) event: telephone call, sms, whatsapp, web site visit, location record, crm call, bill pay, non-bill pay …

- Even your demographic features are events (names, address, etc)

- **From thousands of tables to one event table (well, graph)**
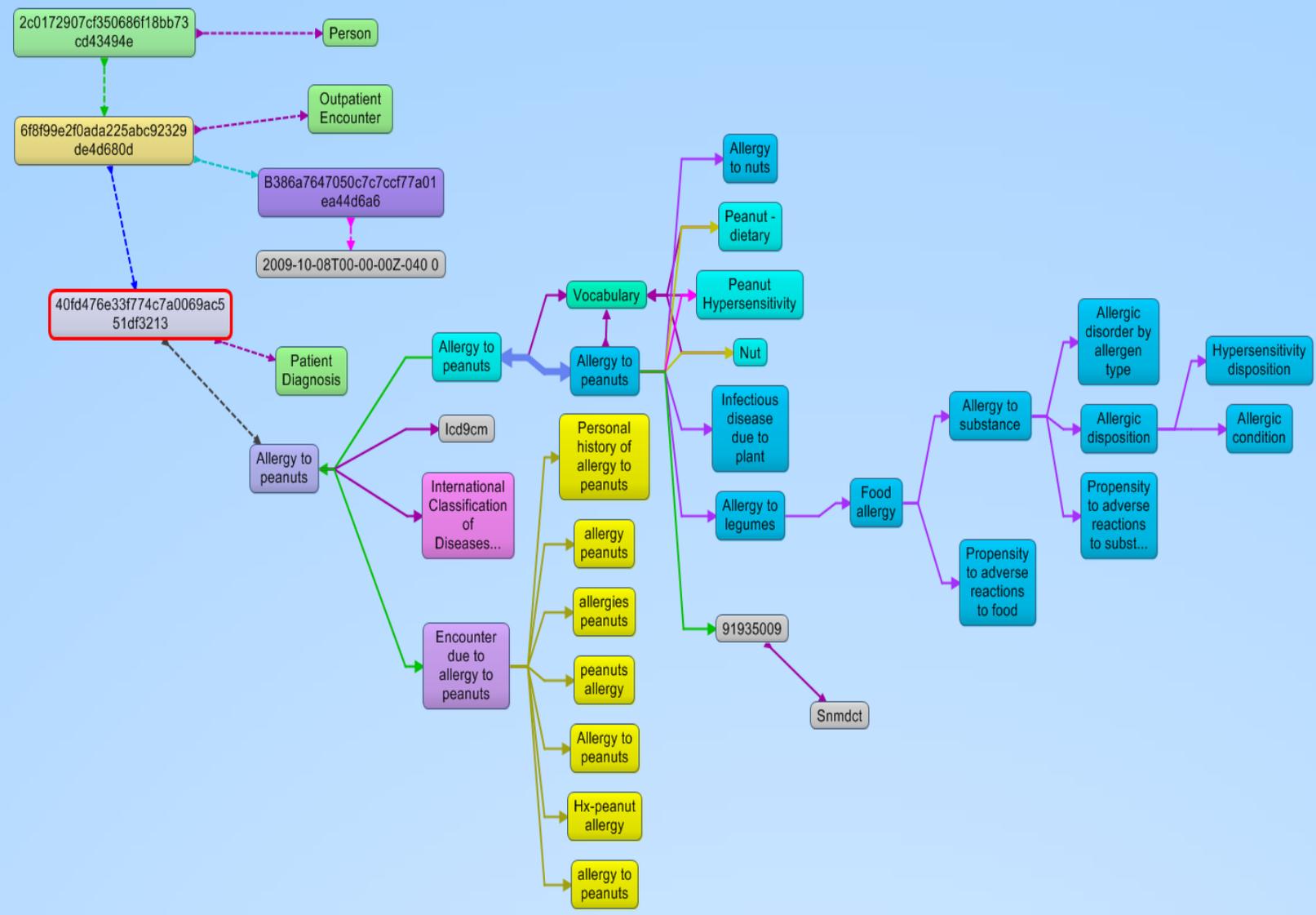
Queries are dramatically simplified

How many patients had 'gallbladder calculus' in 2010 and later

SPARQL	SQL

Select (count(distinct ?pt) as ?count) where {
  ?pt cdm:encounter ?enc .
  ?enc timew3c:begins/upper:value ?date ;
   cdm:diagnosis/upper:correspondsTo/skos:exactMatch ?cui.
 filter (?date > '2010-01-01T00:00:00'^^xsd:dateTime)
 ?cui mth:chd* mth:C0497327.}
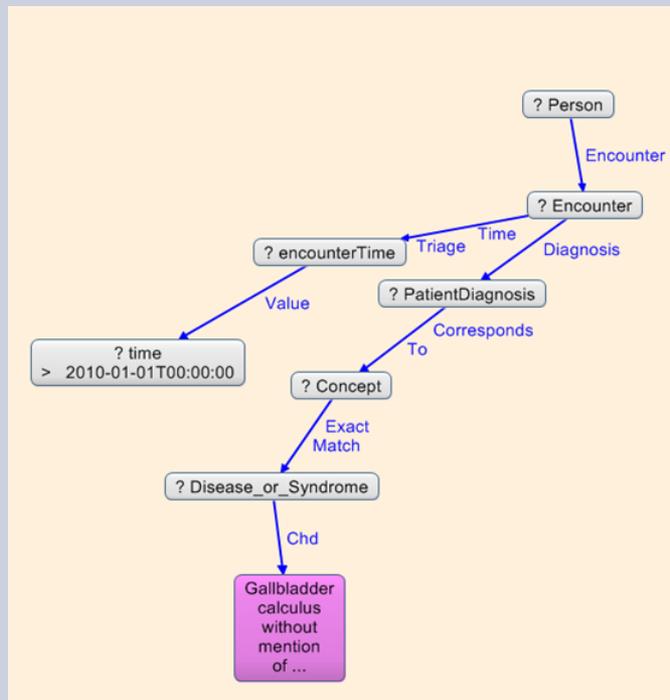 	
	(Part 1 of 3)
	Select dx.dxCode, dx.dxCount, cl.dxClassName, cl.ClassCount
	From (select distinct c.person_source_value as person,
	c.condition_source_concept_id as dxCode, f.concept_name as dxName,
	a.concept_id_2 as dxClass, e.concept_name as dxClassName from omopv5.concept_relationship a
	join cdrn.condition_occurrence c on a.concept_id_1=c.condition_source_concept_id join omopv5.concept_ancestor d
	on d.descendant_concept_id=a.concept_id_2 join omopv5.concept e on e.concept_id=d.ancestor_concept_id
	join omopv5.concept f on f.concept_id=d.descendant_concept_id
	where a.relationship_id='Maps to' and d.min_levels_of_separation=2 and e.standard_concept='S') dx JOIN (select distinct c.person_source_value as person,
	c.condition_source_concept_id as dxCode, f.concept_name as dxName, a.concept_id_2 as dxClass, e.concept_name as dxClassName from omopv5.concept_relationship a join cdrn.condition_occurrence c on a.concept_id_1=c.condition_source_concept_id join omopv5.concept_ancestor d on d.descendant_concept_id=a.concept_id_2
	join omopv5.concept e on e.concept_id=d.ancestor_concept_id join omopv5.concept f on f.concept_id=d.descendant_concept_id
	where a.relationship_id='Maps to' and d.min_levels_of_separation=2 and e.standard_concept='S') cl on dx.dxClass=cl.dxClass
	order by cl.dxClass desc

And accessible as a key/value store for a 360 view of a patient

- It takes a one liner to get all data and knowledge for one patient in < 1 s

Simple example of putting output of analytics back in the Knowledge Graph

- Find interesting co-occurences (oddsratios) and make them 'graph' discoverable

- For every disease we can show you the top 5 most related ones

- Based on your EMR we can easily find all your risk areas. Some are very surprising.

Patient Population — 1,802,464

Peanut Allergy		Ingestion Dermatitis		
		TO+	TO-	
	FROM+	544 (5)	736	1,280
	FROM-	6304	1,795,424	

6,848

Odds Ratio	210.51
95% CI Lower	187.91
95% CI Upper	235.82

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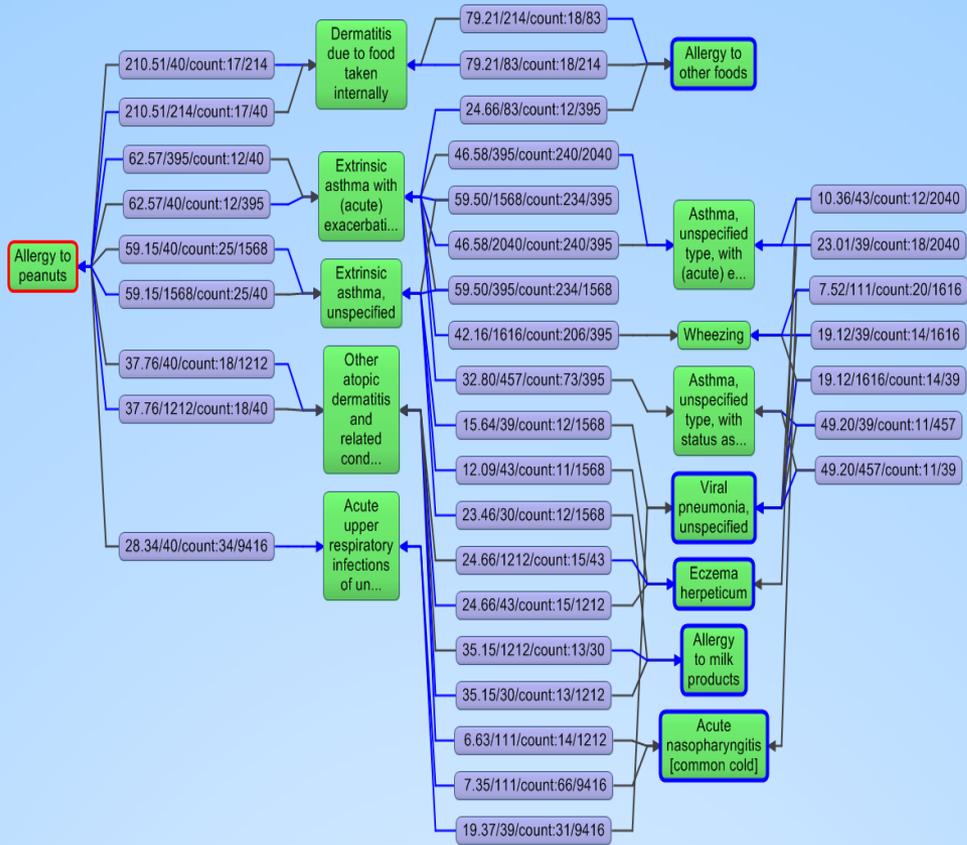
Take away

- Building knowledge graph is great fun

- Semantic technology ensures that your Knowledge Graph can play with other knowledge graphs.

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The END
questions?