

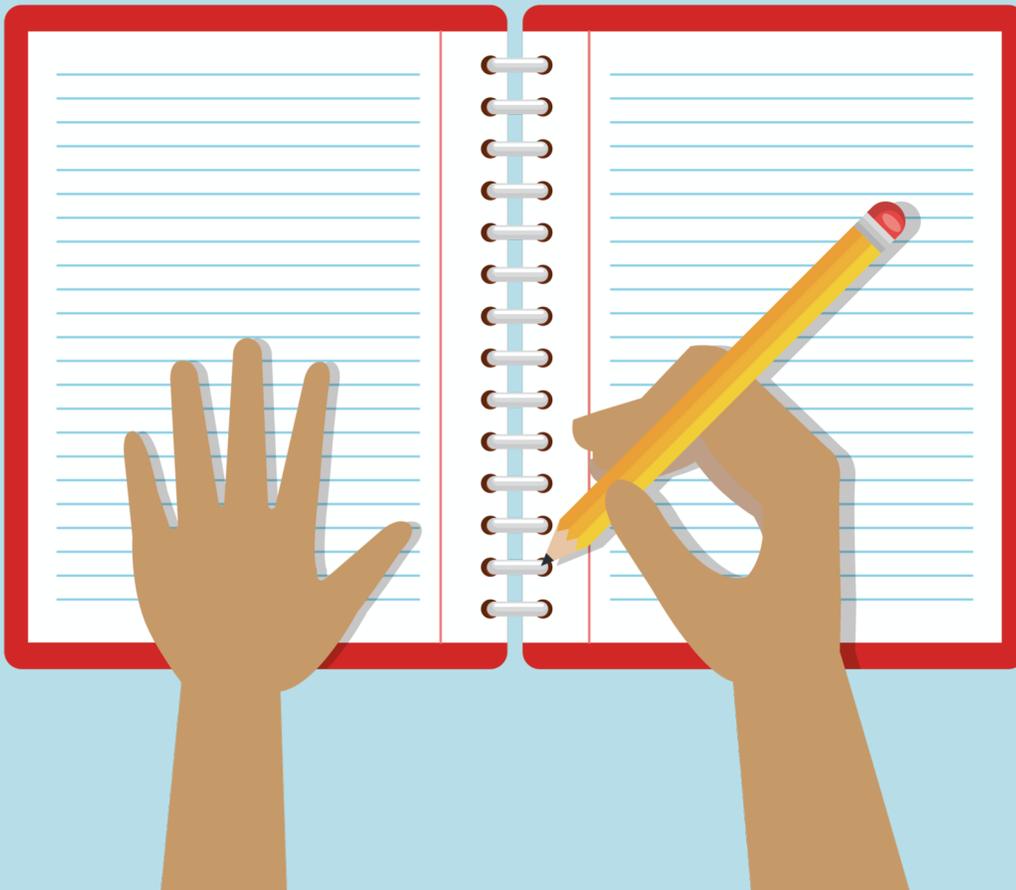


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March 17, 2020

<http://project-emerse.org/presentations.html>

# If you're thinking of taking notes



these slides can be found at:

link will be on  
most slides



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ELECTRONIC MEDICAL RECORD SEARCH ENGINE

<http://project-emerse.org/presentations.html>

*roadmap for  
today's  
presentation*

live demo

2

1

slides

Q&A

3

# What is EMERSE?

A search engine, kind of like Google, for free text medical record documents

(technically, it's an *information retrieval* system)



Simple to use



Designed to be self-serve

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# What is EMERSE?

- A research tool, available at no cost
  - Apache 2.0 licensing
- Requires local implementation
- Picking the right tool for your research is important
  - multiple tools are often needed



# Unstructured vs Structured Data

EMERSE is for this...	i2b2/ACT is for this...
<i>Unstructured Data (free text)</i>	<i>Structured Data</i>
Mrs. Jones is a 56 year old female with a history of HTN, hypercholesterolemia, and T2DM who comes to the clinic today with a 3 day h/o dizziness and severe headache on the left side.	WBC: 5.6 Total cholesterol: 182 Weight: 67.4 AST: 30 ALT: 52

# 80% of EHR data are in unstructured free text



structured data

unstructured data/free text

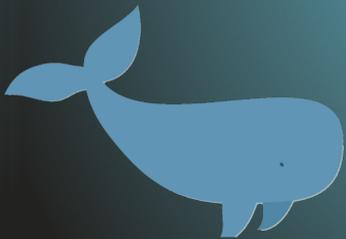
# 80% of EHR data are in unstructured free text

"potential cases may be missed or wrongly dated when coded data alone are used.." (PMID: 23964710)

"structured data is best used for first pass filtering of EHR data...prior to a more nuanced second pass using unstructured data" (PCMCID: PMC4333685)

"...urinary incontinence, an important patient-centered outcome following prostate cancer treatment, was reported almost exclusively in the free text of EHRs and was rarely coded as an ICD 9 diagnosis code." (PMCID: PMC4899050)

"Claims and structured EHR data give an incomplete picture of burden related to geriatric syndromes. Geriatric syndromes are likely to be missed if unstructured data are not analyzed."  
(PMID: 29972595)



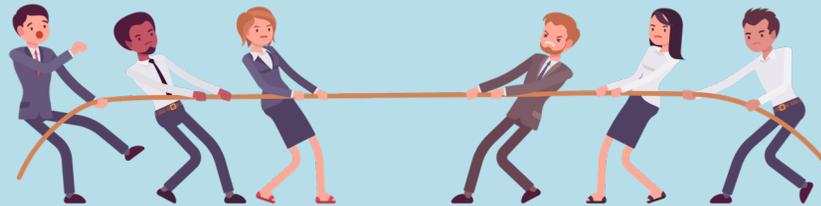
# What isn't EMERSE?

It is not: natural language processing (NLP)

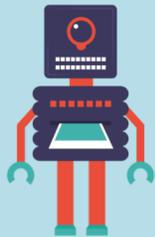
- but full NLP may not always be needed
- and NLP can be hard to use or customize



# EMERSE vs NLP



EMERSE: *augmented* intelligence

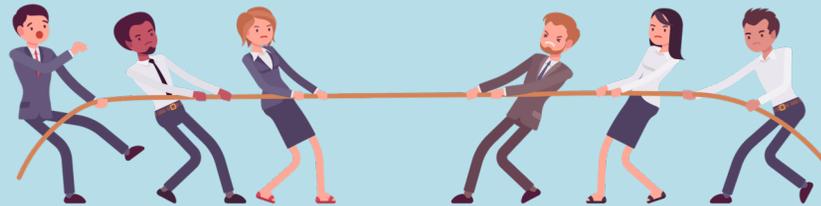


NLP: *artificial* intelligence

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# EMERSE vs NLP



EMERSE ●

● NLP

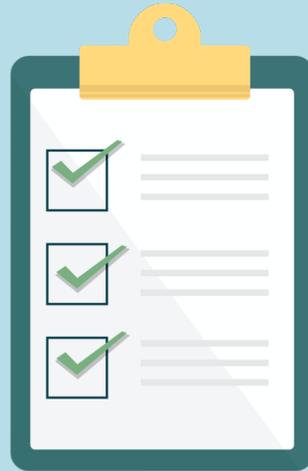
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# Find cohorts

EMERSE allows you to find cohorts based on things mentioned in the notes

- diseases
- drugs
- symptoms
- anything!



# Find cohorts

It's perfect for finding diagnoses that don't have a specific ICD-10 code... like leiomyosarcoma...

► **ICD-10-CM Diagnosis Code C49.6** 📄 [convert to ICD-9-CM]

Malignant neoplasm of connective and soft tissue of trunk, unspecified

↳ Malignant neoplasm of conn and soft tissue of trunk, unsp; Angiosarcoma, trunk; Cancer of the soft tissue, trunk; **Leiomyosarcoma**, trunk; Liposarcoma, trunk; Malignant fibrous histiocytoma, trunk; Primary angiosarcoma of trunk; Primary **leiomyosarcoma** of trunk; Primary liposarcoma of trunk; Primary malignant fibrous histiocytoma of trunk; Primary malignant neoplasm of soft tissues of trunk; Primary rhabdomyosarcoma of trunk; Primary sarcoma of trunk; Rhabdomyosarcoma, trunk; Sarcoma, trunk; Malignant neoplasm of back NOS

<https://www.icd10data.com/search?s=leiomyosarcoma>



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# Find cohorts

...or Bainbridge-Ropers Syndrome

ICD-10-CM Code **Q87.0**

Congenital malformation syndromes predominantly affecting facial appearance

---

**BILLABLE**

POA Exempt

ICD-10 from 2011 - 2016

...or hundreds of other disorders with no specific code

<https://www.icd10data.com/search?s=leiomyosarcoma>

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# Working with cohorts

find a cohort  
from within  
EMERSE



EMERSE patient lists  
(up to 100,000 per list)

upload a list  
of patients

import list  
from another  
system (such as i2b2)

# Highlight documents for chart review

**Thoracocentesis** confirmed the recurrence of **mantle cell lymphoma**. Disease restaging work-up revealed multicompartiment lymphadenopathy in the neck, mediastinal, retrocrural, retroperitoneal and pelvic regions. **Bone marrow** was also involved. The patient was treated with a total of six cycles of rituximab, cyclophosphamide, vincristine, doxorubicin and dexamethasone (**R-HyperCVAD**) completed in January 2007. That treatment led to complete remission that lasted until October 2008, when the disease was found to have recurred in the left pleural space and **retroperitoneum** without **bone marrow** involvement.

<https://jmedicalcasereports.biomedcentral.com/articles/10.1186/1752-1947-4-329>



<http://project-emerse.org/presentations.html>

# Query expansion

Click individual terms to highlight or de-highlight Vertical View ✕

Synonyms (70)

atomizer atomizers blu blu e-cig cartomizer cartomizers ciga-like ciga-likes cigalike cigalikes cigarette clearomizer clearomizers

e-cig e-cigarette e-cigarettes e-cigs e-pipe e-pipes e-vapor eCig eCigarette eCigarettes eCigs electronic cigarette

electronic cigarettes electronic nicotine delivery device electronic nicotine delivery devices ePipe ePipes JUUL JUUL pod JUUL pods

Juul vaping device JUUL vapor Juuling JUULpod JUULpods JUULvapor Kandy pen Kandy pens Kandypen Kandypens liquid nicotine

Mark Ten MarkTen MarkTenXL mod mods Myblu nicotine Phix Phix pod Phix pods Phix vaping device Phix Vapor Phixing

PhixVapor tank system tank systems vape vape pen vape pens vaped vaper vapers vapes vaporizer vaporizers Vuse

Spelling Alternatives (8)

e-cigarete e-sig e-sigs esig esigs vapo vopin vapiong

Highlight All De-Highlight All Add Highlighted Terms

vaping

Synonyms

# Query expansion

- Can use “EMERSE Synonyms” or upload your own dataset (e.g., ICD-10, human phenotype ontology, MeSH terms)
- Simple file format
  - [http://project-emerse.org/documentation/administrator\\_guide.html#truepreparing-a-synonyms-file](http://project-emerse.org/documentation/administrator_guide.html#truepreparing-a-synonyms-file)

# EMERSE Synonyms

- Manually curated over past 12+ years
- Has many terms/phrases not found in standard vocabularies, taxonomies, ontologies (but are found in clinical notes)
- Reasonable licensing terms for academic centers
- > 1 million unique rows
- Details are at:  
<http://project-emerse.org/synonyms.html>
- To explore a subset, visit:  
[http://www.davidhanauer.com/EMERSE\\_synonyms\\_T\\_Terms/](http://www.davidhanauer.com/EMERSE_synonyms_T_Terms/)

<http://project-emerse.org/presentations.html>

# What's in the Synonyms?

Category	Example
Acronyms	CXR chest x-ray
Abbreviations	chemotherapy chemo
Professional and consumer terms	emesis puking
Misspellings	diarriaea diahhrea
Trade and generic drug names	Tylenol acetaminophen
Chemotherapy regimens	FOLFOX, folinic acid, fluorouracil, oxaliplatin
Word Stems	sleep, sleeping, sleepy

Category	Example
True synonyms	frigid cold
Phrasing variations	lido w/ epi epi-lidocaine
Malapropisms/ usage errors	beast mass prostrate cancer
Root word variations	adenotonsillectomy tonsilloadenoidectomy
Hyphenations	pseudosarcomatous pseudo-sarcomatous
Idioms	under the knife under the weather
Neologisms	trabecularity (vs trabeculation)

# What's in EMERSE?

## Free text notes

- admission notes
- history and physical
- progress notes
- pathology reports
- radiology reports
- more!



@ Michigan: 2.5 million patients  
170 million notes  
1995-present

# What's not in EMERSE?

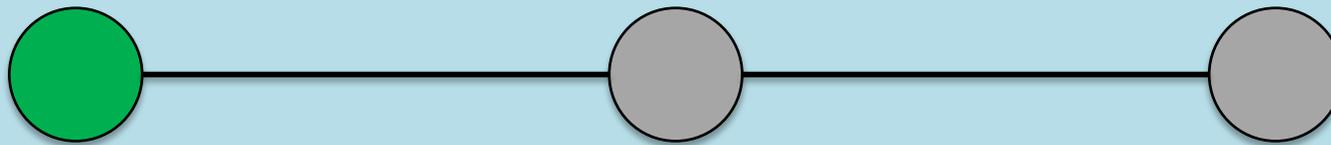
## Structured data

- discrete lab values
- vital signs
- billing codes

Other tools such as **i2b2** exist for structured data

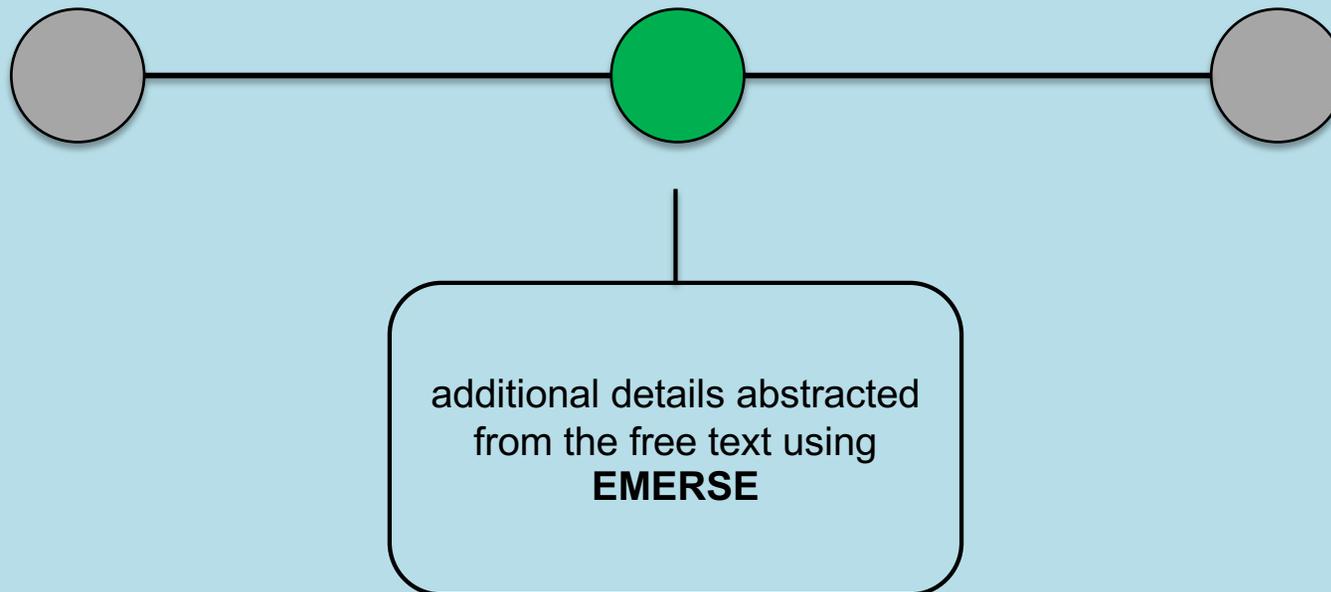


# Typical workflow

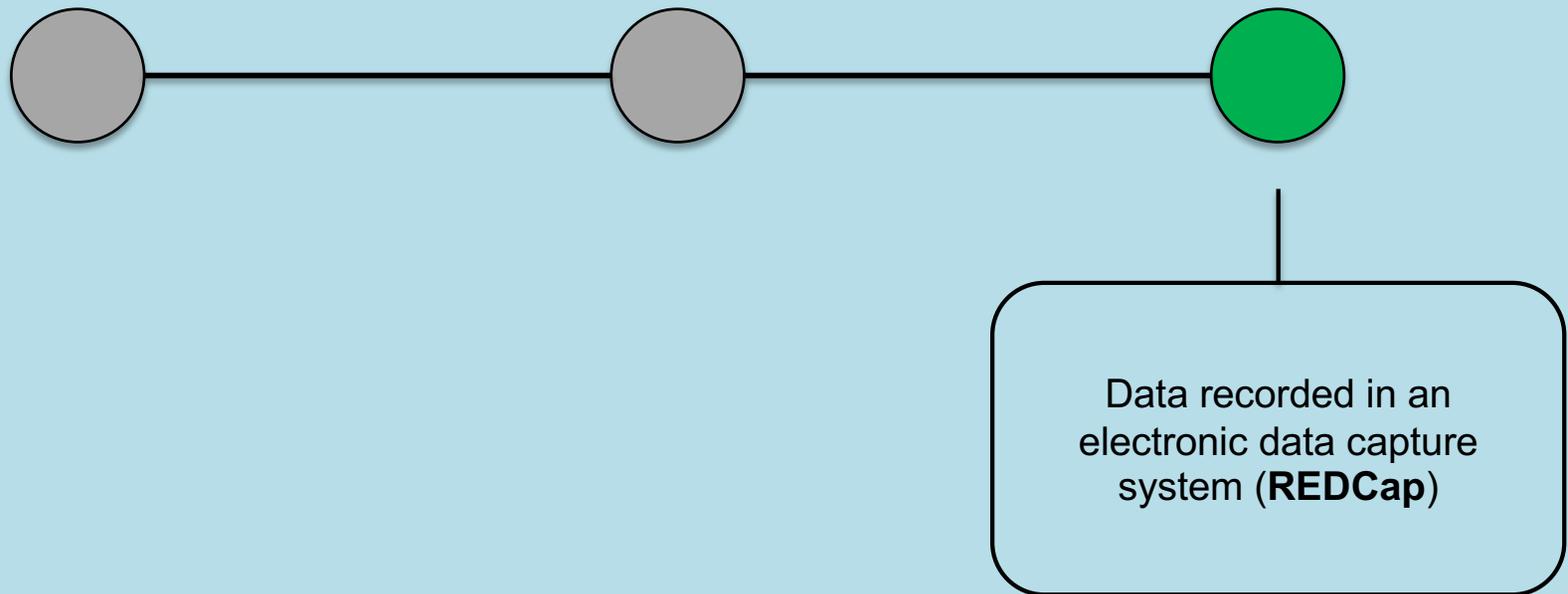


initial cohort identified  
with a cohort discovery  
tool (**i2b2**) using structured  
data (or via **EMERSE**  
'Find Patients')

# Typical workflow



# Typical workflow

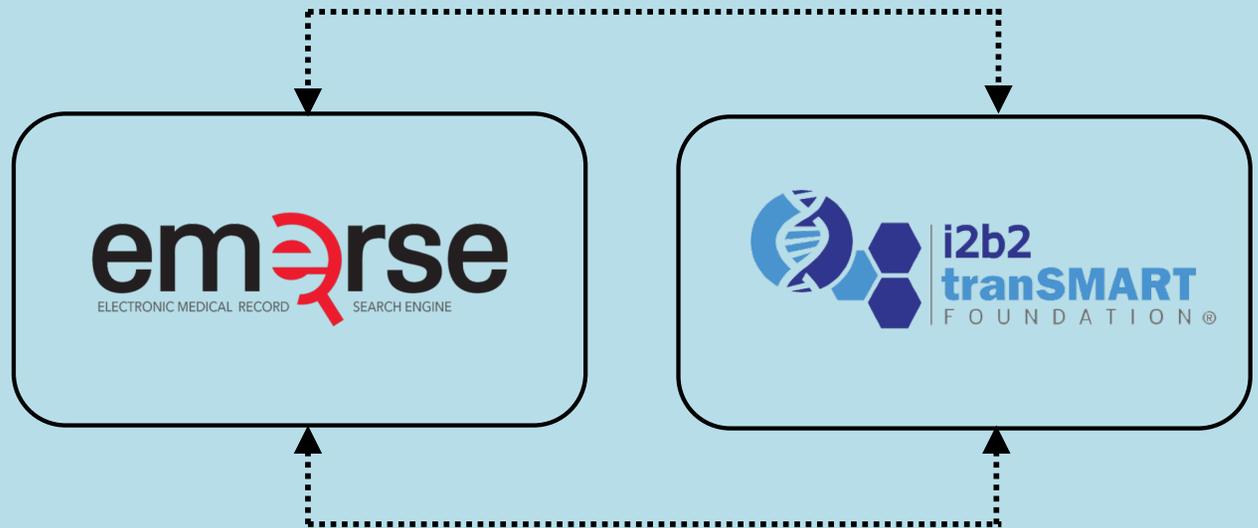


# EMERSE and i2b2 could go together like...

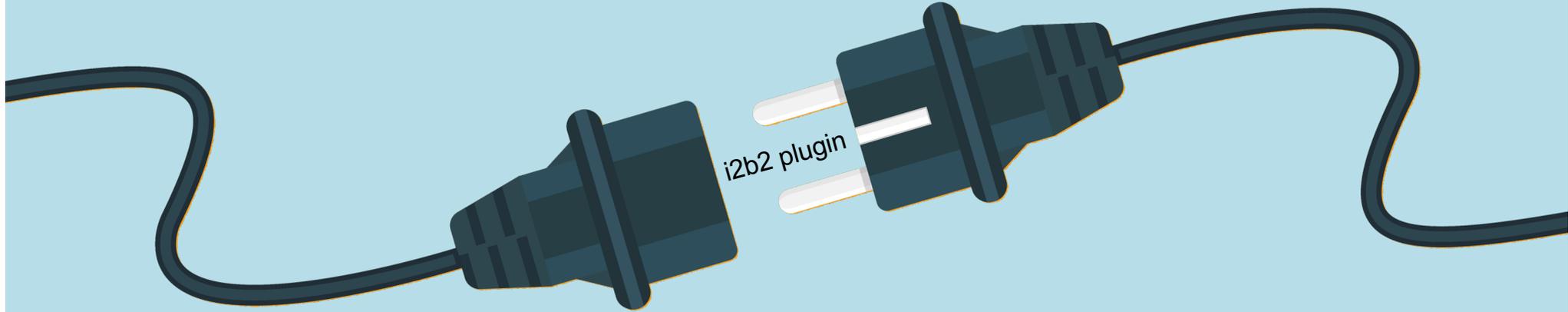


# EMERSE and i2b2 could go together like...

- i2b2 queries EMERSE/Solr API for list of patients as additional criteria  
e.g.: structured data & note contains phrase: \_\_\_\_\_
- ✓ i2b2 sends patient cohort to EMERSE  
*(this has been done before)*
- EMERSE queries i2b2 to narrow cohort using structured data



# EMERSE and i2b2 have been connected in the past



**Navigate Terms** Find Terms

- Cancer Registry
- Demographics
  - Age
    - 0-9 years old
    - 10-17 years old
    - 18-34 years old
    - 35-44 years old
    - 45-54 years old
    - 55-64 years old
    - 65-74 years old
    - 75-89 years old
    - >89 years old
  - Gender

**Workplace**

- hanauer

**Previous Queries**

- Animal Bites from ICD codes [10-3-2013] [hanauer]
- List of bites from i2b2 [10-3-2013] [hanauer]
- Stage 4-55866 L@08:23:24 [9-25-2013] [hanauer]
- Stage 4@08:09:13 [9-25-2013] [hanauer]
- Stage 4@08:08:42 [9-25-2013] [hanauer]
- BRFAS-Estro-Livin@08:05:36 [9-25-2013] [hanauer]

**Query Tool**

Query Name: Animal Bites from ICD codes

Temporal Constraint: Treat all groups independently

Group 1			Group 2			Group 3		
Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude	Dates	Occurs > 0x	Exclude
Treat Independently			Treat Independently			Treat Independently		
Bite of other animal except			Female			45-54 years old 55-64 years old		

one or more of these AND one or more of these AND one or more of these

Run Query Clear Print Query 3 Groups New Group

**Query Status**

Finished Query: "Animal Bites from ICD codes" [15.2 secs]  
Compute Time: 13 secs

Patient Set for "Animal Bites from ICD codes"

Number of patients (Count only) for "Animal Bites from ICD codes"  
patient\_count: 285



i2b2 Web Client

https://i2b2.med.umich.edu/webclient-16-REL-mc/default.htm

Query & Analysis Tool Project: i2b2 Identified Last Updated: 31-AUG-2013 User: David Hanauer Find Patients | Analysis Tools | Message Log | Help | Logout

**Navigate Terms** Find Terms

- Cancer Registry
- Demographics
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    - 0-9 years old
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- hanauer

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- Stage 4@08:08:42 [9-25-2013] [hanauer]
- BREAS-Estro-Livio@08:05:36 [9-25-2013] [hanauer]

**EMERSE Export**

Specify Data Plugin Help

Drop a Patient Set you want to export to EMERSE into the input box below.

Patient Set:

**Plugins**

Detailed List View Category: ALL

- MIChart Chart View**  
This plugin retrieves details of a selected patient set using the Patient Data Object (PDO).
- EMERSE Export**  
This plugin retrieves MRNs of a selected patient set and exports it to EMERSE.



Navigate Terms

Find Terms

- Cancer Registry
- Demographics
  - Age
    - 0-9 years old
    - 10-17 years old
    - 18-34 years old
    - 35-44 years old
    - 45-54 years old
    - 55-64 years old
    - 65-74 years old
    - 75-89 years old
    - >89 years old
  - Gender

Workplace

hanauer

Previous Queries

- Animal Bites from ICD codes [10-3-2013] [hanauer]
- Results of Animal Bites from ICD codes [10-3-2013] [hanauer]
- Patient Set for "Animal Bites from ICD codes" - FINISHED
- Number of patients (Count only) for "Animal Bites from ICD code"
- List of bites from i2b2 [10-3-2013] [hanauer]
- Stage 4-558661 @08:23:24 [9-25-2013] [hanauer]

EMERSE Export

Specify Data

Plugin Help

Drop a Patient Set you want to export to EMERSE into the input box below.

Patient Set: Animal Bites from ICD codes [10-3-2013] [hanauer] [PATI

Export Patient Set to EMERSE



Plugins

Detailed List View

Category: ALL

- MiChart Chart Review**  
This plugin retrieves details of a selected patient set using the Patient Data Object (PDO).
- EMERSE Export**  
This plugin retrieves MRNs of a selected patient set and exports it to EMERSE.

**Patients** test list (2 Patients)  
**Dates** All  
**Terms** "cat bite" "dog bite"  
**Search**

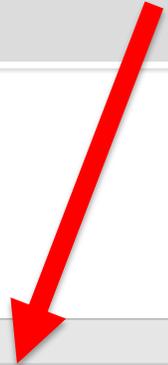
User: hanauer **EMERSE**

Patients:

Set Patients

Create Patient List

### Patient Lists



Name	Description	Owner	Created	Modified
Animal Bites from ICD codes	Export from I2b2	David Hanauer	10/03/13 11:10	10/03/13 11:10
Sam List	Sammy	David Hanauer	07/23/13 23:48	07/23/13 23:48
dog bites - living alone	blah blah	David Hanauer	02/01/13 15:58	02/01/13 15:58
cat bites - living alone	blah blah	David Hanauer	02/01/13 15:36	02/01/13 15:36
HIM demo	for HIM	David Hanauer	02/01/13 12:57	02/01/13 13:09
December 2012	December 2012	David Hanauer	02/01/13 10:46	02/01/13 10:47
dog bite patients (additional patients)		David Hanauer	01/29/13 14:38	09/17/13 16:12
E906.9		David Hanauer	01/29/13 13:50	01/29/13 13:50
E906.8		David Hanauer	01/29/13 13:41	01/29/13 13:41
E906.5		David Hanauer	01/29/13 13:29	01/29/13 13:30
E906.4 (2)	rest of list	David Hanauer	01/29/13 13:15	01/29/13 13:15
E906.4	for cat bite and depression study	David Hanauer	01/29/13 13:14	01/29/13 13:14
E902.2	for cat bite and depression study	David Hanauer	01/29/13 13:11	01/29/13 13:11

**Patients** Animal Bites from ICD codes (285 Patients) User: hanauer **EMERSE**  
**Dates** All  
**Terms** "cat bite" "dog bite"

**Search** [Heat Map](#)

Patient 4 of 196

		NURSING NOTE	BHC	HC	N
		PHONE NOTE	NEU	NEU	N
		LET/NOTE-RV	BHC	HC	N
...sustained a <b>cat bite</b> to her left hand while working at an... ...from a <b>cat bite</b> . The patient was instructed to continue...		LET/NOTE-RV	SPLA	SUR	N
...consult for <b>cat bite</b> on hand per nursing. There is 3 superficial...		CONSULT-IP-NEW	WOUND	NURS	N
...1. <b>Cat bite</b> SECONDARY DIAGNOSES: COMPLICATION:... ...worsening <b>cat bite</b> wound. Pt was bitten in her Lt index... ...Contacted: 1) <b>Cat bite</b> : -wear splint and keep your arm elevated...		D/C SUMMARY	MGM	MED	N
...PHYSICAL CC: <b>cat bite</b> HPI: Mrs. [REDACTED] is a 43-year-old... ...worsening <b>cat bite</b> wound. Pt was bitten in her Lt index... ...presenting with <b>cat bite</b> presenting with worsening edema and... ...erythema. 1. <b>Cat bite</b> of Lt index finger. Xray neg fo bone...		ADM H&P	MGM	MED	N
...Complaint: <b>Cat bite</b> to left hand. History of Present Illness:... ...sustaining a <b>cat bite</b> on [REDACTED]. The patient presented... ...status post <b>cat bite</b> to the index finger with increasing...		CONSULT-ED	SPLA	SUR	N
...Complaint: <b>Cat bite</b> . History of Presenting Illness: [REDACTED]... ...with a <b>cat bite</b> to her left index finger that occurred... ...with a <b>cat bite</b> to her left index finger that occurred... ...Diagnosis: <b>Cat bite</b> to left hand with cellulitis. Disposition:...		ED NOTE	AER	ER	Y
...extremity <b>cat bite</b> . The patient's rabies status is up to...		ED NOTE	MPTH	ER	N
		LET/NOTE-RV	BHC	HC	N
		PHONE NOTE	MALL	MED	N
		PHONE NOTE	BHC	HC	N
		PHONE NOTE	BHC	HC	N



# EMERSE is **≡**fast

Query to identify all patients with the following	Epic Clarity time (s)	EMERSE time (s)	EMERSE advantage
cavernous hemangioma	14,652	2	7,320x
gray platelet syndrome	14,940	2	7,470x
inferior lingular segment of the left upper lobe	17,784	9	1,980x

...enabling real-time querying



<http://project-emerse.org/presentations.html>

# Publications using EMERSE

348 papers

52 abstracts



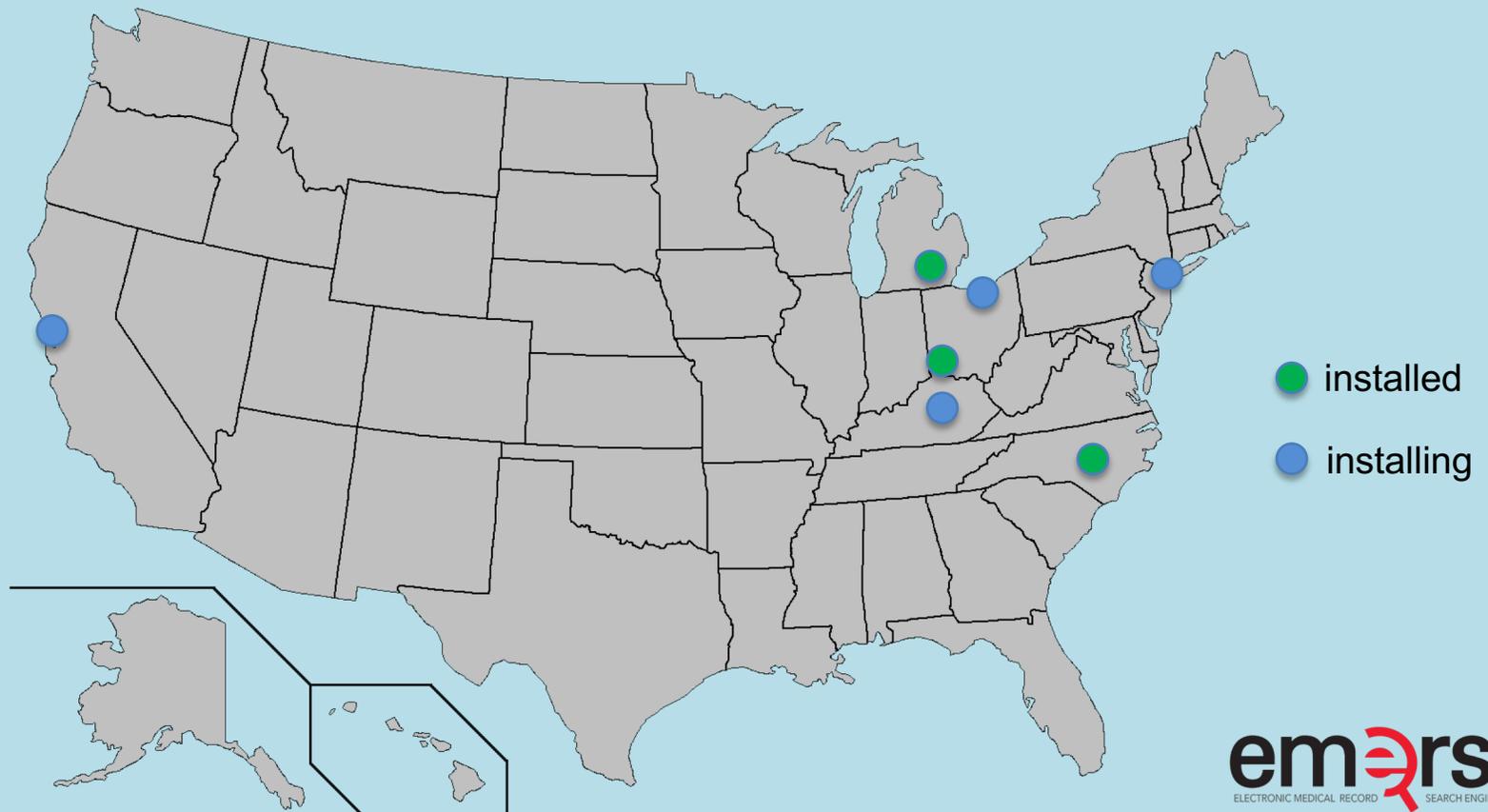
Full list can be found at:

<http://project-emerse.org/publications.html>

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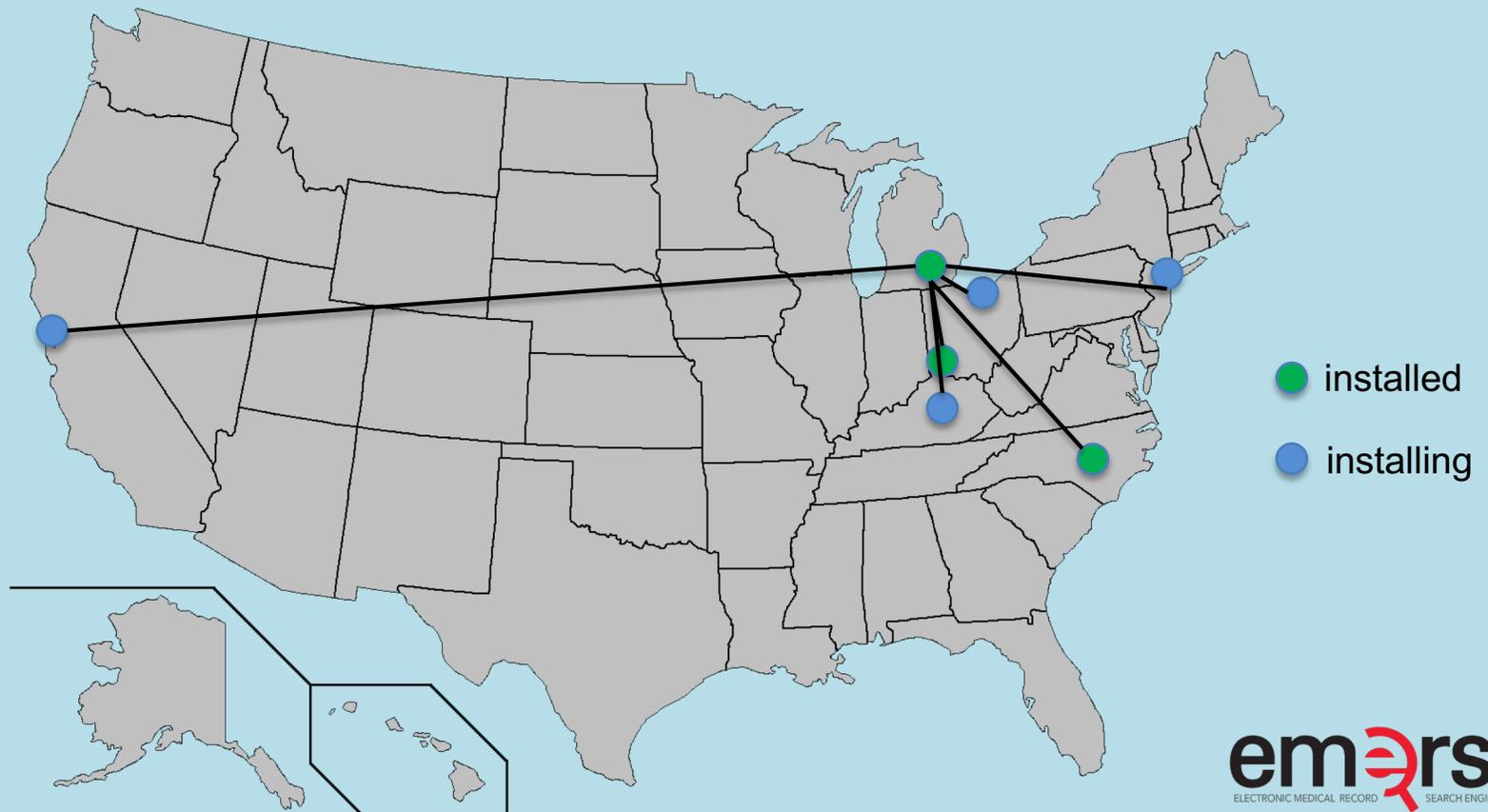
<http://project-emerse.org/presentations.html>

# Where is EMERSE?



<http://project-emerse.org/presentations.html>

# The future...



<http://project-emerse.org/presentations.html>

# Getting EMERSE



- local installation required
  - need support of IT team
- EHR-agnostic
  - runs independent of EHR
  - need a way to extract documents to send to EMERSE



<http://project-emerse.org/presentations.html>

# Under the Hood



EMERSE application  
(Java, Javascript)



Apache Solr



Apache ActiveMQ



Oracle



**emrse**  
ELECTRONIC MEDICAL RECORD SEARCH ENGINE

<http://project-emerse.org/presentations.html>

# Test driving EMERSE

online demo

videos on website

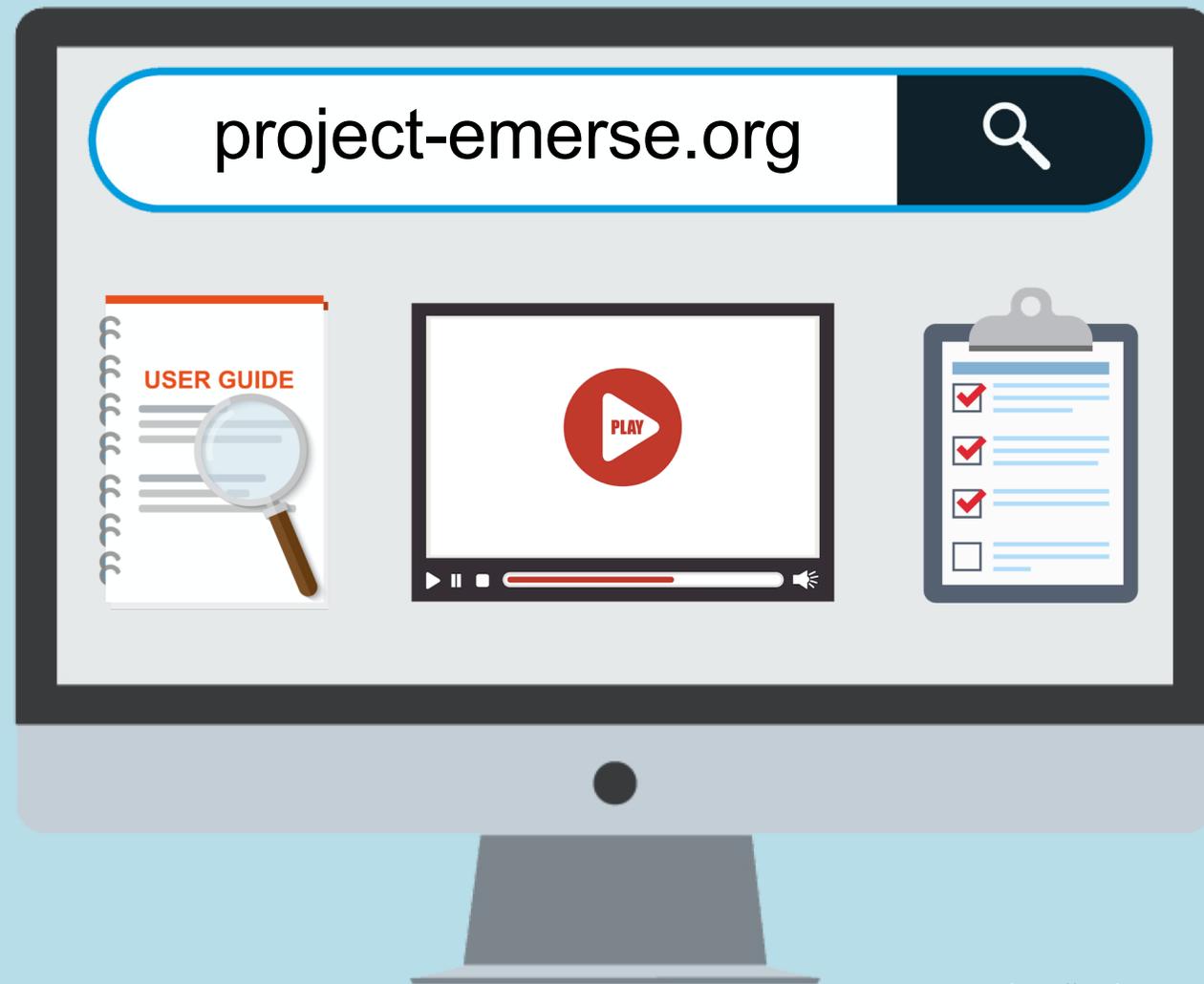
virtual machine

- could be used for  
individual projects



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<http://project-emerse.org/presentations.html>



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# Acknowledgements

