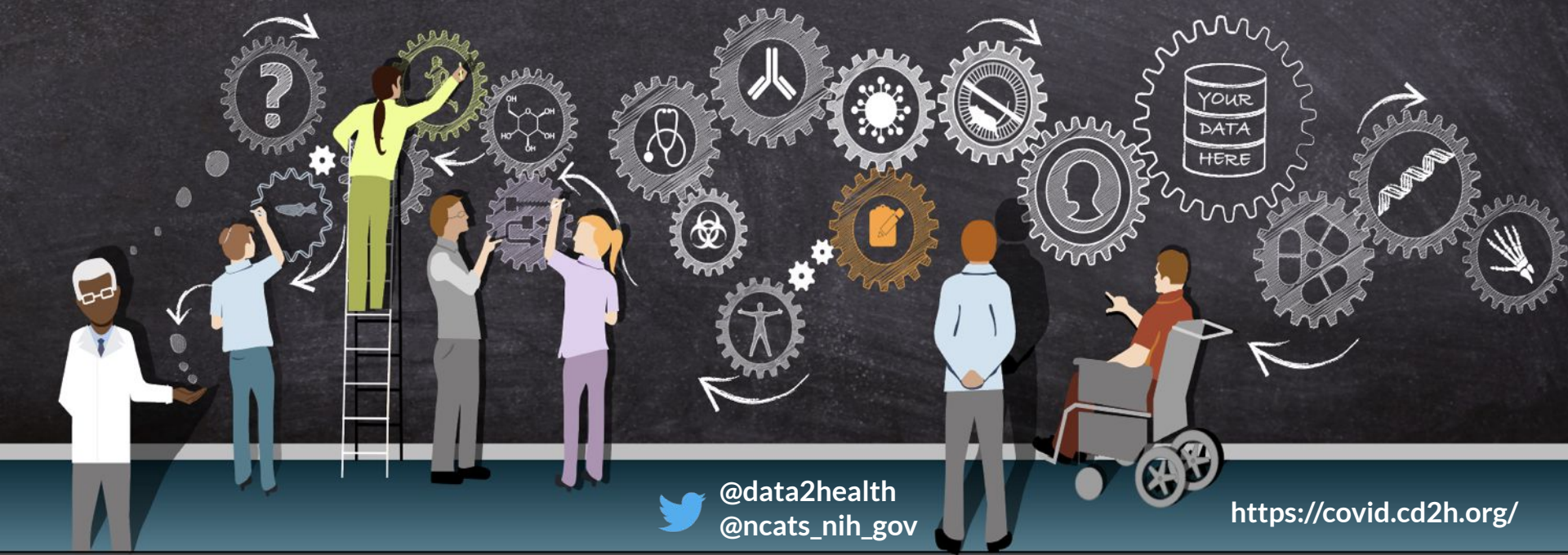
Extracting OMOP Concepts from Clinical Narratives to Empower Clinical Research

January 25, 2022



@data2health
@ncats_nih_gov

https://covid.cd2h.org/

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Outline

- N3C Overview
- Open Health Natural Language Processing (OHNLP)
  - Ethical AI framework
  - Scientific rigor
  - OHNLP Toolkits
  - PASC NLP algorithms
- Join the journey for NLP-empowered RECOVER
  - Contribute to the development effort
  - Implement the N3C NLP Infrastructure
  - Augment data with NLP for N3C
  - Collaboration and Partnership

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N3C Overview

Chris Chute

N3C Enclave: The largest public HIPAA- limited longitudinal-EHR data set in US history

(1/20/22 release)

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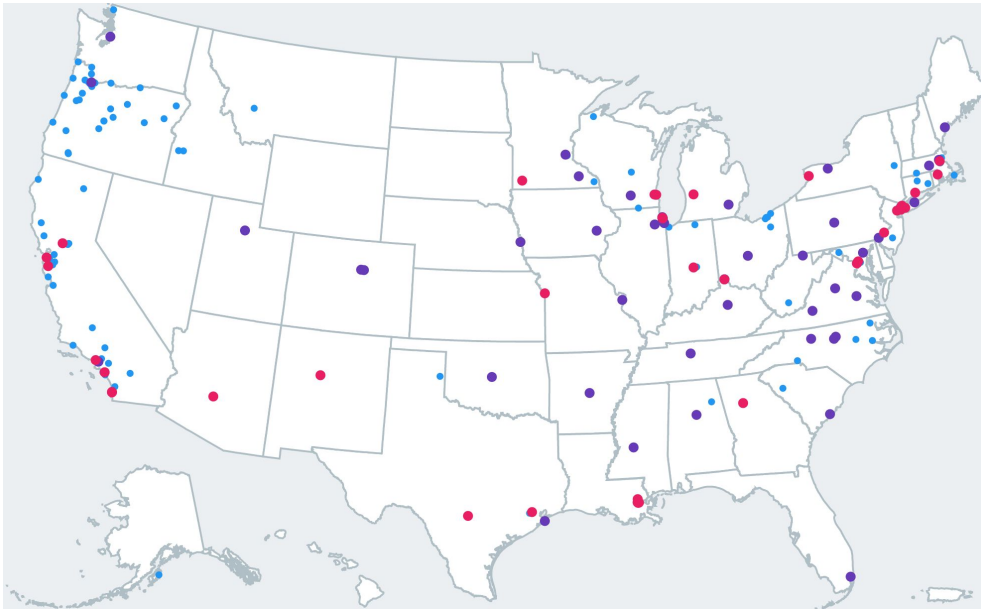
Hub Sites: 69

Persons: 10.7 million

COVID+: 3.8 million

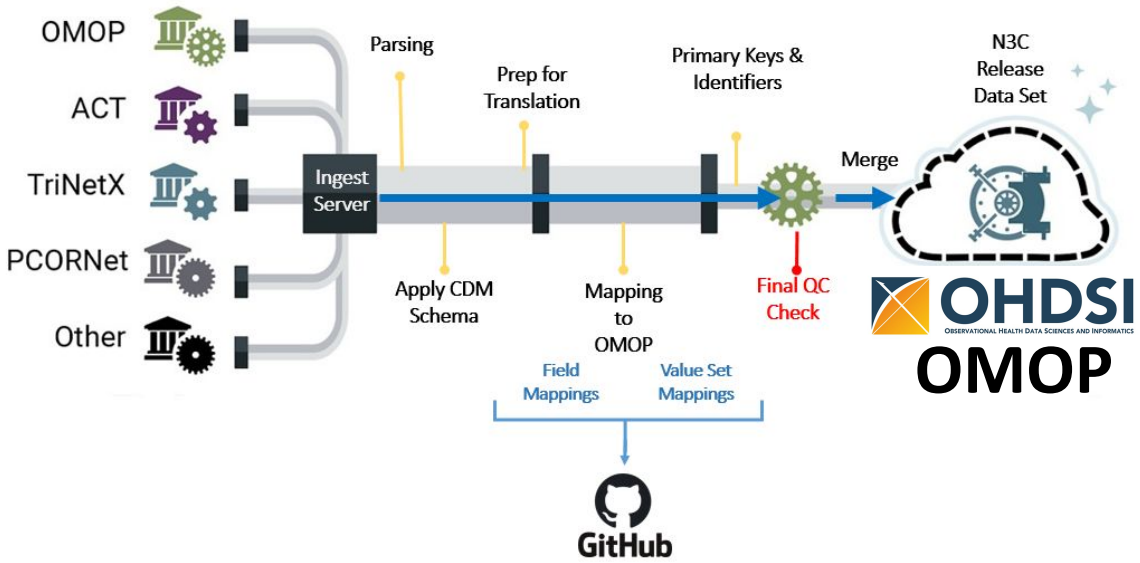
Rows Data: 12.0 billion

Rows/Patient: ~1,120



https://covid.cd2h.org/dashboard/

N3C EHR Data Overview



Row level data:

- Person
- Drug
- Procedure
- Condition (diagnoses)
- Measurement (labs)

Types of encounters:

- Inpatient, ED & Outpatient
- Longitudinal back to 2018

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Each of the 69 sites has a pipeline with 2M+ transformations

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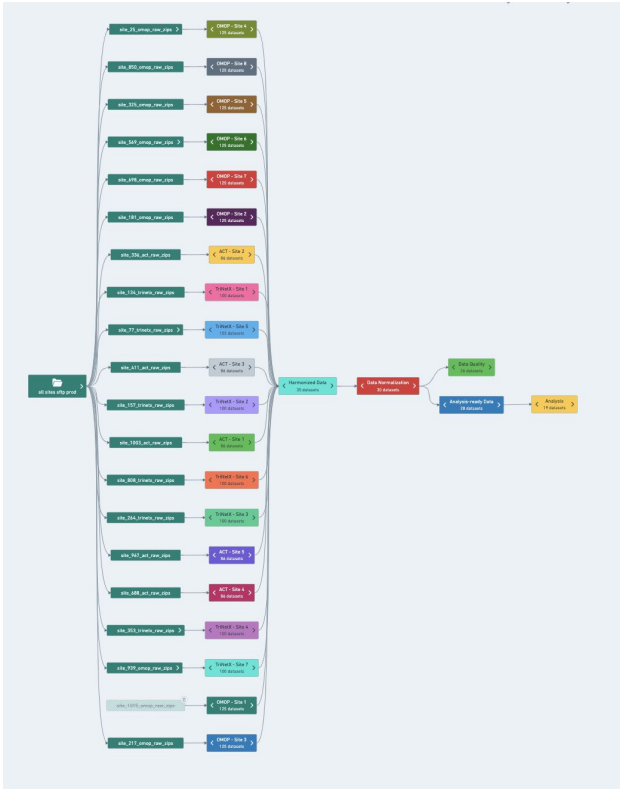

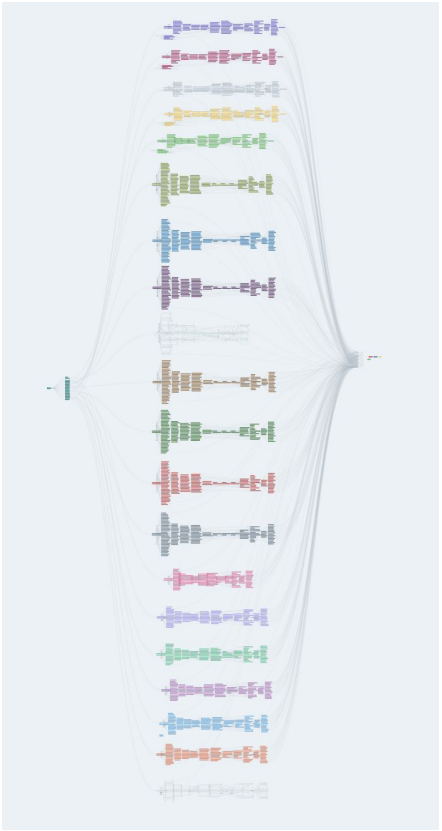

The provenance between 5000 syntactic transformations across the 69 sites is automatically tracked.

This enables:

- pipeline developers to very quickly identify the root cause of data quality issues
- data pipelines can be **refreshed** in <20 minutes whenever the source data updates

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Open Health Natural Language Processing

Hongfang Liu

OHNLP - 2009 (Mayo and IBM)

03 Apr **Mayo Clinic and IBM to move beyond EMR's to deliver knowledge at the point of care**

Posted at 07:26h in Health Technology, IT by WTN News • 0 Comments

2009

https://wtnnews.com/2009/04/03/5840/

Madison – Biomedical informatics researchers at Mayo Clinic and IBM have launched a Web site for the newly founded Open Health Natural Language Processing (NLP) Consortium. The consortium is establishing the open-source space to promote past and current development efforts, including participation in information extraction from electronic medical records. Mayo Clinic and IBM Healthcare released clinical NLP technologies into the public domain. The site will allow the approximately 2,000 researchers and developers working on clinical language systems worldwide to contribute code and further develop the systems. Additionally, the VA Boston Healthcare System and Seattle Group Health have strongly indicated their support of he concept according to IBM.

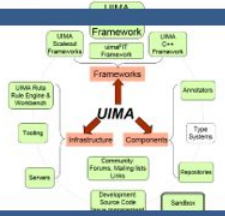
"We are inviting our international colleagues to help continue development of these valuable tools," says Christopher Chute, M.D., Dr.P.H., Mayo Clinic bioinformatics expert and senior consultant on the project. "By making it an open-source initiative, we hope to enable wide use of these NLP tools so medical advancements can happen faster and more efficiently."

cTAKES functionality recognizes whether a clinical concept is negated, relevant to the patient or to the patient's family, which are attributes critical to understanding patient-centered medical

IBM's medKAT systems (medical Knowledge Analysis Tool) is a system to extract structured information from unstructured data sources, such as pathology reports, clinical notes, discharge summaries and medical

APACHE HTTP SERVER PROJECT

cTAKES™



IBM and oncology

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OHNLP - 2009 to 2012 (ONC SHARP)

Strategic Health IT Advanced Research Projects (SHARP)

Research Focus Area 4 - Secondary Use of EHR Data

Increasing efficiency of patient care through electronic healthcare records

Face to Face Group Photo June 11, 2012

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OHNLP - 2013 - 2016 (NIGMS)

- Research on implementability of open source NLP systems (https://github.com/nlpie/nlp-adapt) (led by Dr. Serguei Pakhomov)
- Research on usability to deliver production-ready NLP (led by Hua Xu)
- Research on NLP utility and generalizability for clinical research and practice (led by Hongfang Liu)

OHNLP - 2017 - present

NIH National Center for Advancing Translational Sciences

Clinical and Translational Science Institute (University of Minnesota)

Center for Clinical and Translational Science (Mayo Clinic)

Irving Institute for Clinical and Translational Research (Columbia University)

Center for Clinical and Translational Sciences (UT Health)

U01TR002062
Open Health Natural Language Processing Collaboratory

Team

Partnership

OHDSI Observational Health Data Sciences and Informatics

emerge network Electronic Medical Records and Genomics

pcornet

All of Us SM The Precision Medicine Initiative® The Future of Health Begins with You

Rare Clinical Diseases Research Network
Initiative of the National Center for Advancing Translational Sciences (NCATS)

Aim 1: Obtain NLP artifacts across sites for improving NLP algorithm development
Aim 2: Generate a synthetic text corpus for exploratory analysis of clinical narratives

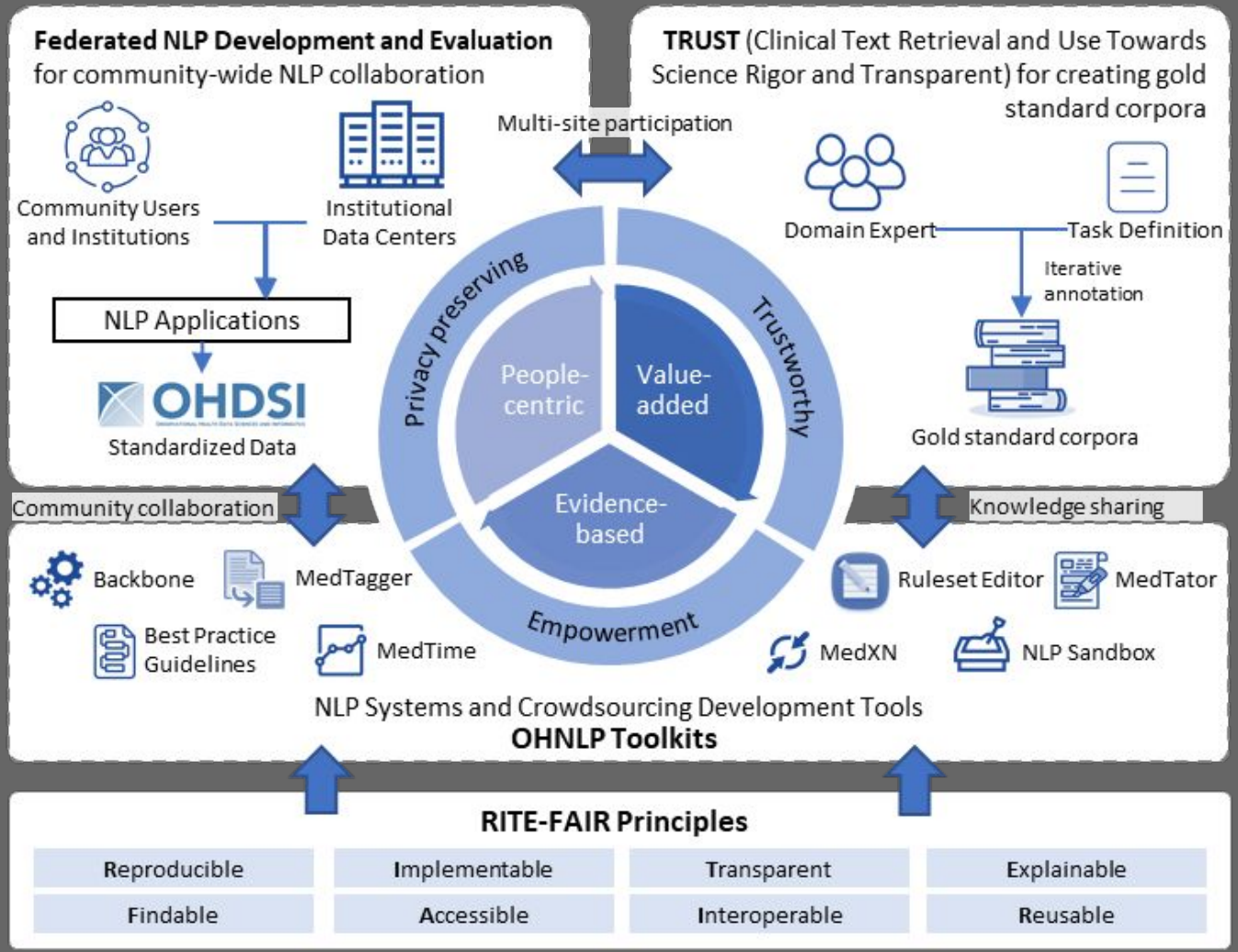
NLP Innovations

OHNLP

Privacy-Preserving Computing ⟷ Computational Phenotyping

Aim 3: Develop privacy-preserving computational phenotyping enhanced with NLP
Aim 4: Partner with diverse communities for translation science excellence leveraging EHR

Overall Architecture



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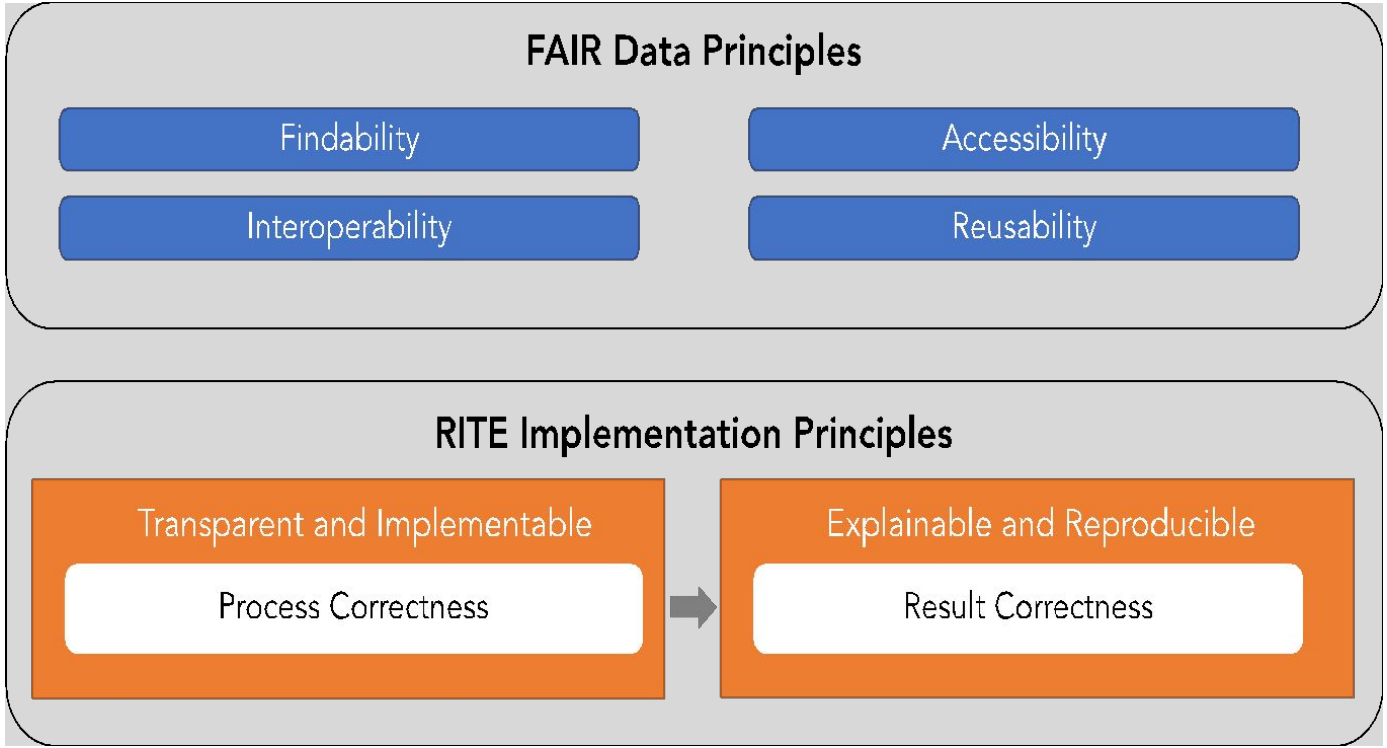
Human-centric Ethical AI Framework



Human-centric Ethical AI Framework

The Use of AI for Health Guiding Principles

- Protecting human autonomy
- Promoting human well-being and safety and the public interest
- Ensuring transparency, explainability and intelligibility
- Fostering responsibility and accountability
- Ensuring inclusiveness and equity
- Promoting AI that is responsive and sustainable

Human-centric Ethical AI Framework

MIT Technology Review Topics Maga

Opinion

Too many AI researchers think real-world problems are not relevant

The community's hyperfocus on novel methods ignores what's really important.

by **Hannah Kerner** August 18, 2020

IBM is selling off its Watson Health assets

By Clare Duffy, CNN Business

Updated 2:29 PM ET, Fri January 21, 2022

- Language plays an unique role in humanity and society.
- Need to follow a social and ethical framework when working on health language.

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Federated Development and Evaluation

About 4,240,000,000 results (0.80 seconds)

The concept behind “data is the new oil” is that just like oil, raw data isn't valuable in and of itself, but, rather, the value is **created** when it is gathered completely and accurately, connected to other relevant data, and done so in a timely manner. ... COVID-19 related data is being generated quickly. Apr 27, 2020

https://www.kenwayconsulting.com › blog › data-is-the-n...

Is Data Really “The New Oil”? | Kenway Consulting

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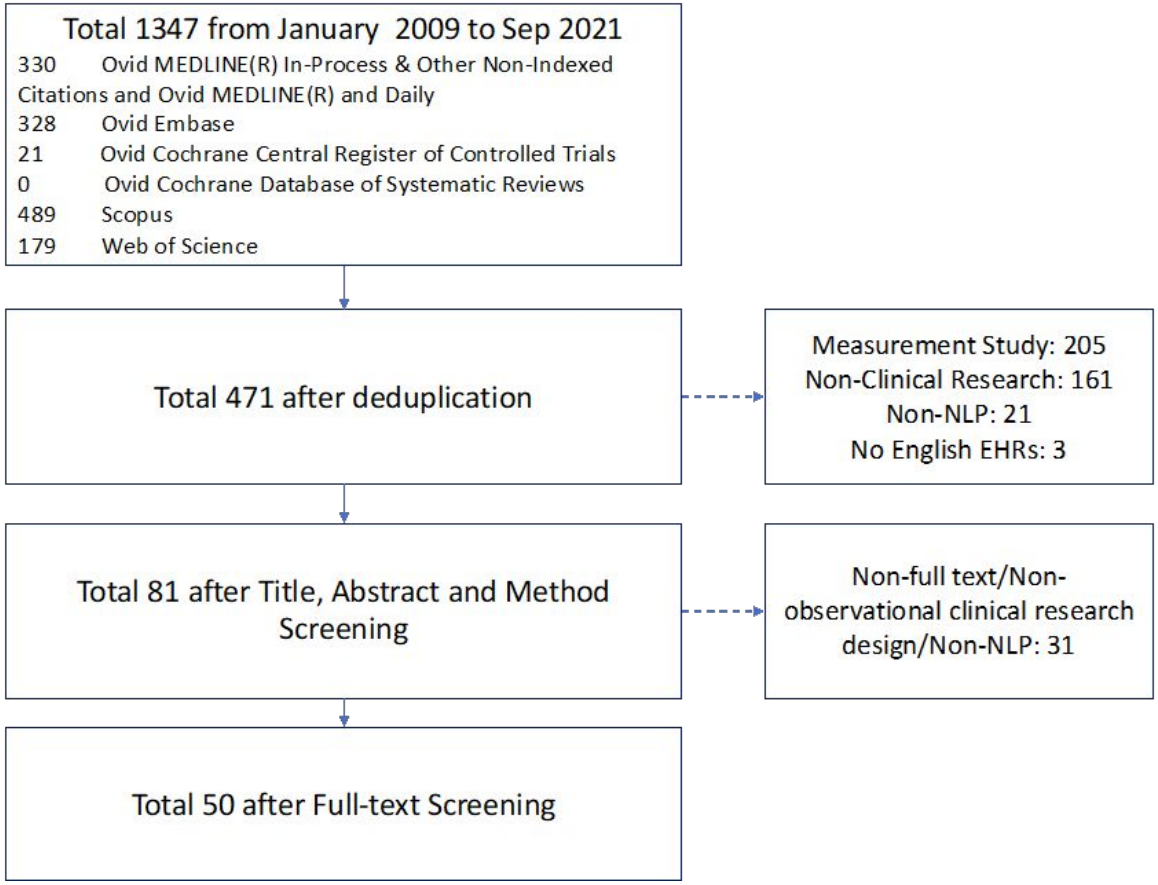
Reproducibility and Methodology Rigor

Scientific Rigor

- How is NLP evaluation conducted in clinical research?
- What's the current reporting practice of the NLP component in the traditional clinical research?
- What is the degree of granularity when reporting NLP methodology and evaluation?
- What are the potential barriers to adopt clinical NLP to clinical research?
- What are the lessons learned from the existing evaluation and reporting practices



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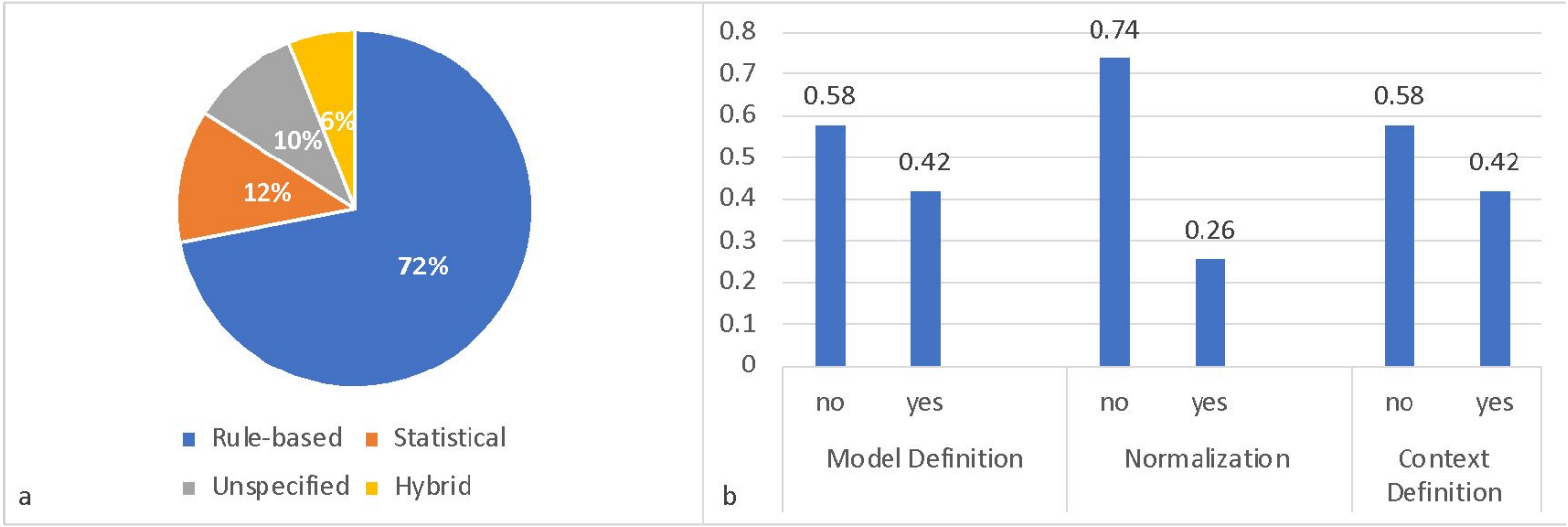
Reproducibility and Methodology Rigor

Scientific Rigor



TRUST ME

We observed high heterogeneity in the reporting practice: 14% of studies did not report NLP methodology and evaluation, 22% of studies did not report evaluation design, and 10% of studies did not report NLP methodology. A few studies claimed that ‘NLP has been evaluated prior to release’. However, no additional details can be found to justify the validity of the NLP results and clinical findings.

Reproducibility and Methodology Rigor

Evaluation Challenges

- Only mention cohort duration but not NLP evaluation duration
- EHR system migration, change of definition, ETL process
- Study setting and EHR environment
- Definition variation between cohort and disease
- Commercial vs open source
- Evaluation performance/matrix

Implication to Clinical Research

- Most data elements identified by NLP are either comprised of risk factors (48%) or outcome (42%), which have strong implication to the outcome of the study.
- The validity of the study is thus dependent on the rigor of NLP methodology and evaluation.

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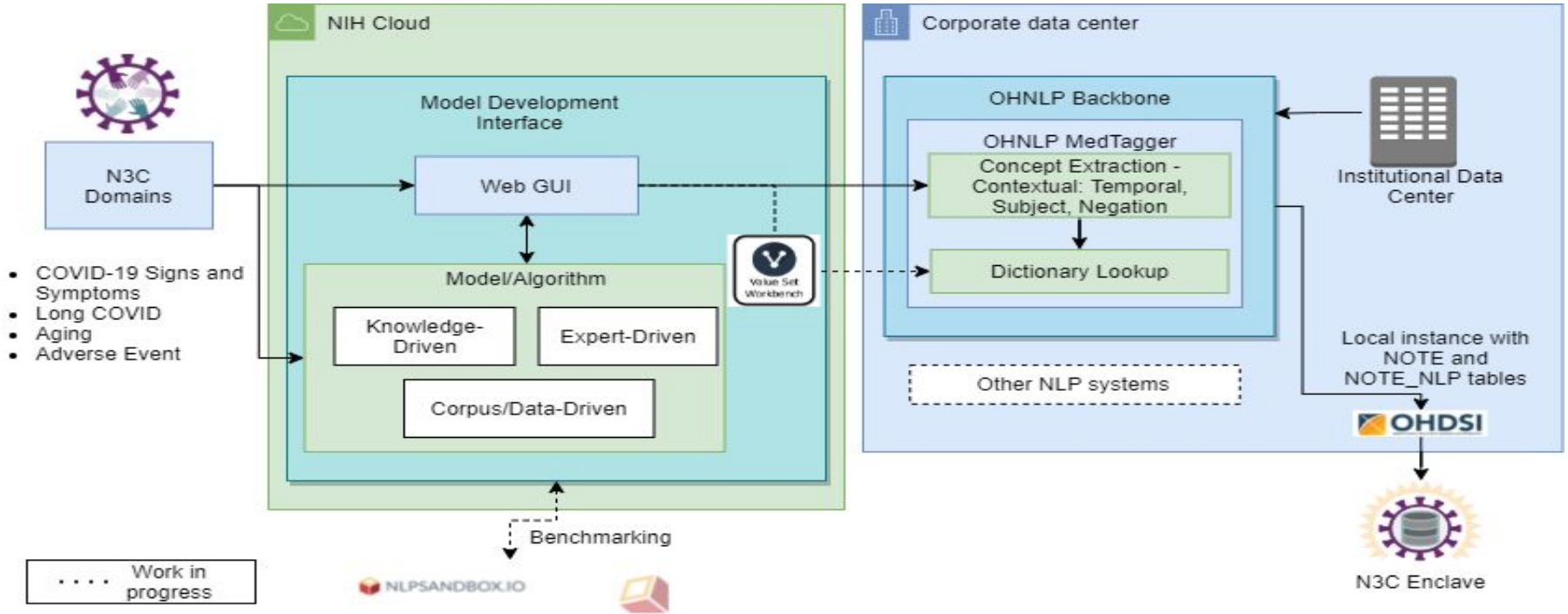
A Collaborative Framework for NLP Development

OHNLP Toolkits



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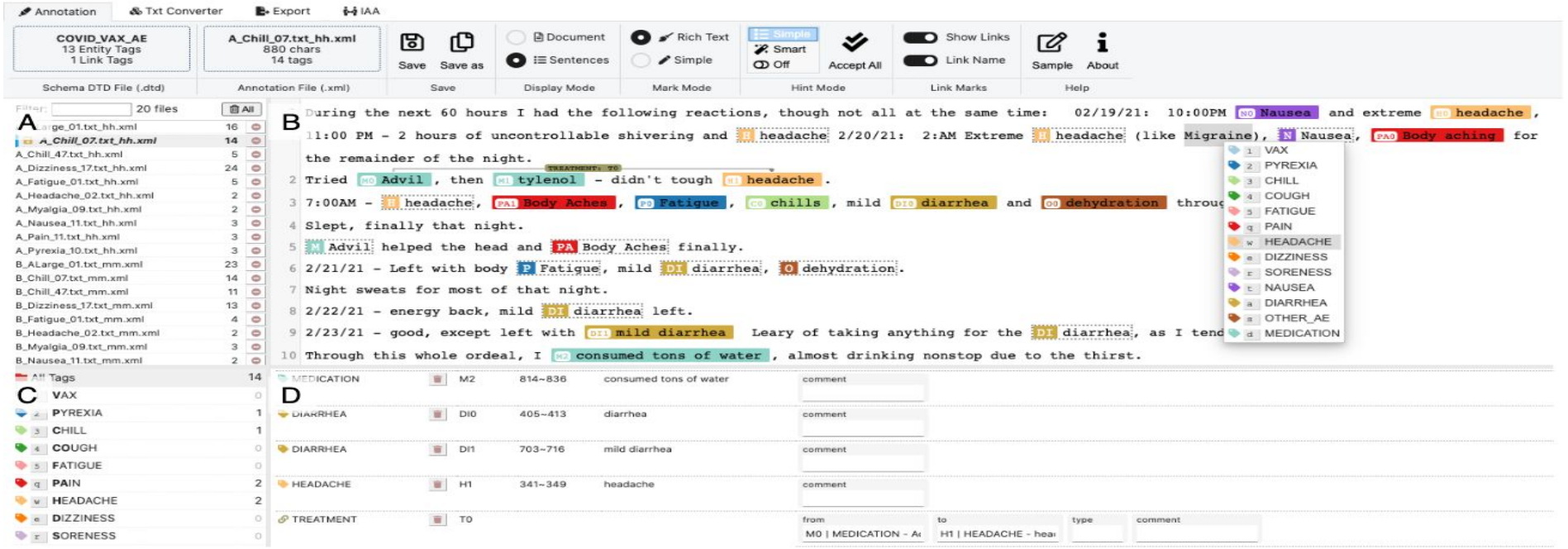
A Federated Framework for NLP Evaluation

OHNLP Toolkits



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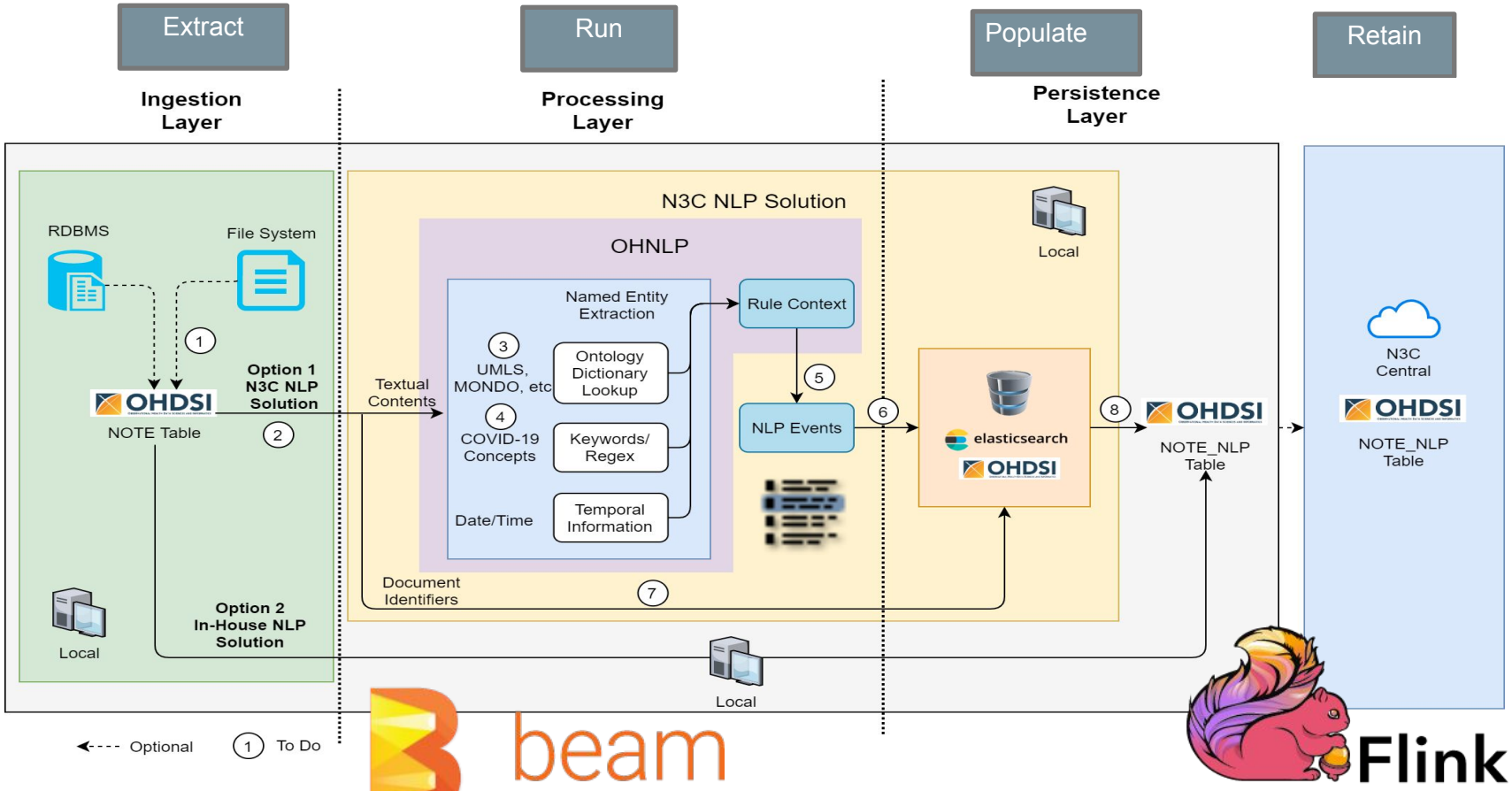
A Minimal Viable Product (MVP) for NLP Deployment

OHNLP Toolkits



N3C NLP Release 2.0

- Incorporate dictionary lookup for concept mentions
  - Default config includes COVID/ PASC relevant concepts
  - Dictionary resource for comprehensive NLP is available by request
    - A curated dictionary, MedLex, with OMOP Concept Identifiers mapped available
- Work on documentation for onboarding

MedLex Resource

AMIA Annu Symp Proc. 2012;2012:568-76. Epub 2012 Nov 3.

Towards a semantic lexicon for clinical natural language processing

Hongfang Liu [1], Stephen T Wu, Dingcheng Li, Siddhartha Jonnalagadda, Sunghwan Sohn, Kavishwar Wagholikar, Peter J Haug, Stanley M Huff, Christopher G Chute

Affiliations + expand

PMID: 23304329 PMCID: PMC3540492

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3540492/

PASC Resources

- 287 unique clinical findings mapped to Human Phenotype Ontology (HPO) terms with synonyms and Plain-language synonyms, (Deer, Rachel R., Madeline A. Rock, Nicole Vasilevsky, Leigh Carmody, Halie Rando, Alfred J. Anzalone, Marc D. Basson et al. "Characterizing long COVID: deep phenotype of a complex condition." *EBioMedicine* 74 (2021): 103722.)
- 355 high-level long COVID symptoms consolidated from 1520 UMLS concepts of 16,466 synonyms. (Wang, Liqin, Dinah Foer, Erin MacPhaul, Ying-Chih Lo, David W. Bates, and Li Zhou. "PASCLex: A comprehensive post-acute sequelae of COVID-19 (PASC) symptom lexicon derived from electronic health record clinical notes." *Journal of biomedical informatics* 125 (2022): 103951.)

Dictionary Resource Generation

- Map MedLex to the concept identifiers from the latest OMOP Vocabulary (through standard vocabulary)
- All terms from the two PASC articles were processed and mapped to the concept identifiers from the latest OMOP Vocabulary.
- For PASC terms could not be mapped, we manually reviewed and aligned with the closest OMOP concept identifiers if available or map to the HPO identifiers. .

Evaluation and Refinement (a single site - preliminary result)

- Refinement with 97 long hauler notes
  - Add 23 concepts not included in the initial PASC dictionary but mappable to OMOP or HPO Vocabulary
  - Add 4 concepts not mappable to OMOP or HPO Vocabulary
- The comparison with a human annotator on the PASC symptom section of long hauler sections. Among a total of 1500 annotations:
  - 1,022 (179 unique normalized text strings) were annotated by both.
  - 414 (251 unique normalized text strings) annotated by NLP but missed by human. Some are human omissions. Some are contextual interpretation.
  - 62 (48 unique) annotated by human but missed by NLP. About 8 out of the 48 unique annotations were not in either OMOP or the original PASC concepts. The remaining were caused by lexical variants or multi-span concept mentions (*smell was complete lost*).

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Join the journey for NLP-empowered RECOVER

Hongfang Liu and Emily Plaff

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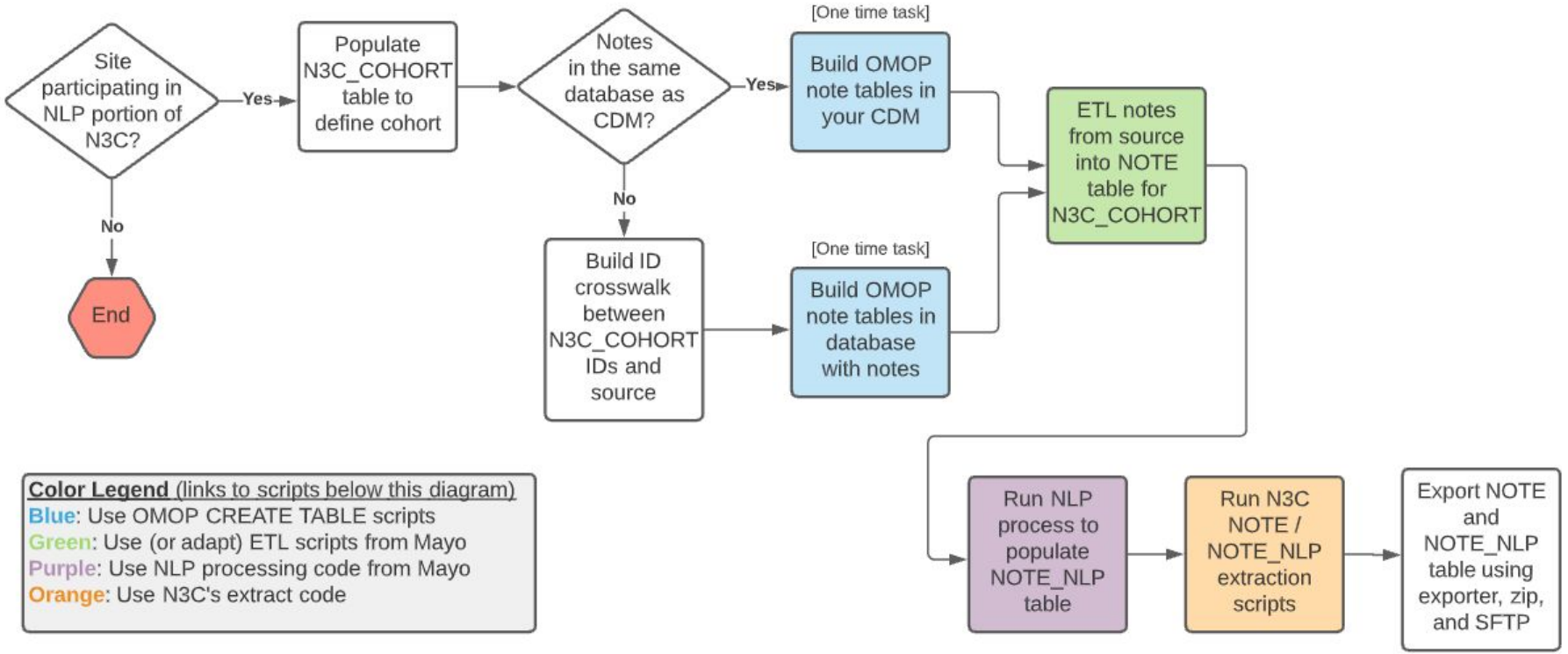
#jointhejourney

N3C Enclave NLP Data Contribution



https://github.com/National-COVID-Cohort-Collaborative/Phenotype_Data_Acquisition/wiki/NLP-Submission-Process

N3C/RECOVER NLP Onboarding

Sites who are interested in deploying the infrastructure, reach out to Katelyn Cordie (cordie.katelyn@mayo.edu)

Sites who are interested in contributing to the NLP releases, reach out to Sijia Liu (liu.sijia@mayo.edu)

N3C domain teams who have new NLP needs, reach out to Rafael Fuentes (rafael.fuentes@nih.gov)

All other questions, reach out to Hongfang Liu (liu.hongfang@mayo.edu)

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Planned Development

#jointhejourney

- Partnering with TriNetX
- NLP Knowledge Authoring and Concept Mapping Service empowered by Terminology Service and Large Language Models
- Incorporating Open Source NLP Algorithms available for:
    - Family History
    - Genetic Information
    - Context Classifier
    - Precision Oncology
    - SDoH Variables

Ongoing Community Collaboration

OHNLP Collaboration

- Open source tools and resources

Refinement and Evaluation

- Continuous improvement

Context Classification

- Documentation heterogeneity

Data Quality and Machine Learning

- Evaluate the contribution of NLP to data quality and research

Acknowledgement

#jointhejourney

- National Institute of Health
- The Mayo NLP Program
- The N3C NLP Community
- The OHNLP Community
- The CD2H Community
- The CTSA/iEC Community
- The OHDSI Community

Join the Journey in Translating Technology Innovation to Empower Clinical Research towards Better Health for Everyone.

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Join the journey

NATIONAL CENTER FOR DATA TO HEALTH

NIH National Center for Advancing Translational Sciences

NATIONAL CENTER FOR DATA TO HEALTH

Onboarding to N3C: bit.ly/cd2h-onboarding-form

Joining Workstreams:

N3C Data Ingestion & Harmonization Workstream
Slack Channel Harmonization
Google Group Harmonization

N3C Phenotype & Data Acquisition Workstream
Slack Channel Phenotype
Google Group Phenotype

N3C Collaborative Analytics Workstream
Slack Channel Analytics
Google Group Analytics

N3C Data Partnership & Governance Workstream
Slack Channel Governance
Google Group Governance

N3C Synthetic Clinical Data Workstream
Slack Channel Synthetic
Google Group Synthetic

Additional Information:
Onboarding N3C, Slack, Google | Finding and Joining a Google Group