Reproducible Research with Clinical Databases

Workshop

Wei-Hung Weng (courtesy of Alistair Johnson and Tom Pollard)

TMU
Sep 27, 2019

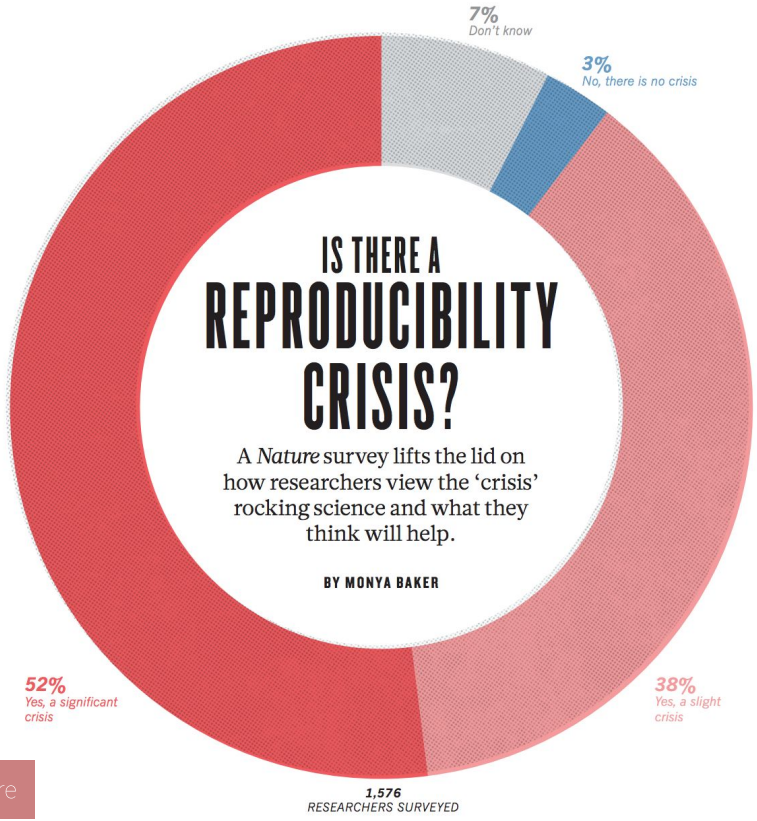
Massachusetts Institute of Technology

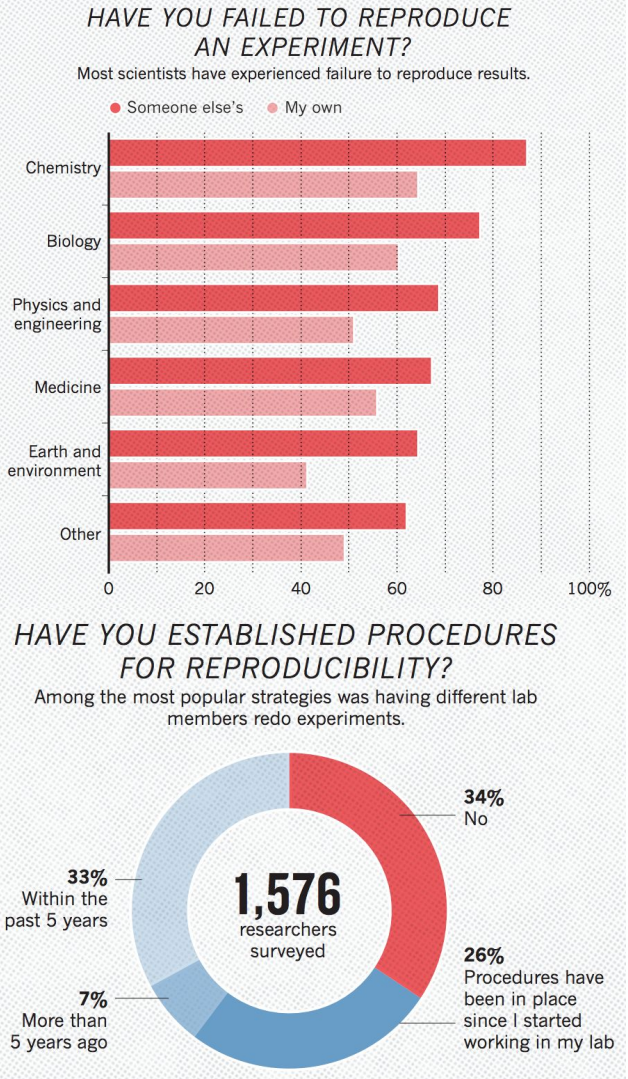
Outline

- Why reproducibility? How to make this happen?
- PhysioNet / eICU / MIMIC
- Collaboration

Reproducibility

Reproducibility





Baker, 2015 Nature

ICLR 2018 Reproducibility Challenge

Background:

One of the challenges in machine learning research is to ensure that published results are reliable and reproducible. In support of this, the goal of this challenge is to investigate reproducibility of empirical results submitted to the 2018 International Conference on Learning Representations.

We are choosing ICLR for this challenge because the timing is right for course-based participants (see below), and because papers submitted to the conference are automatically made available publicly on Open Review.

The Challenge is inspired by discussions at the ICML 2017 Workshop on Reproducibility in Machine Learning.

Task Description

You should select a paper from the 2018 ICLR submissions, and aim to replicate the experiments described in the paper. The goal is to assess if the experiments are reproducible, and to determine if the conclusions of the paper are supported by your findings. Your results can be either positive (i.e. confirm reproducibility), or negative (i.e. explain what you were unable to reproduce, and potentially explain why).

Essentially, think of your role as an inspector verifying the validity of the experimental results and conclusions of the paper. In some instances, your role will also extend to helping the authors improve the quality of their work and paper.

https://www.cs.mcgill.ca/~jpineau/ICLR2018-ReproducibilityChallenge.html

Reproducibility

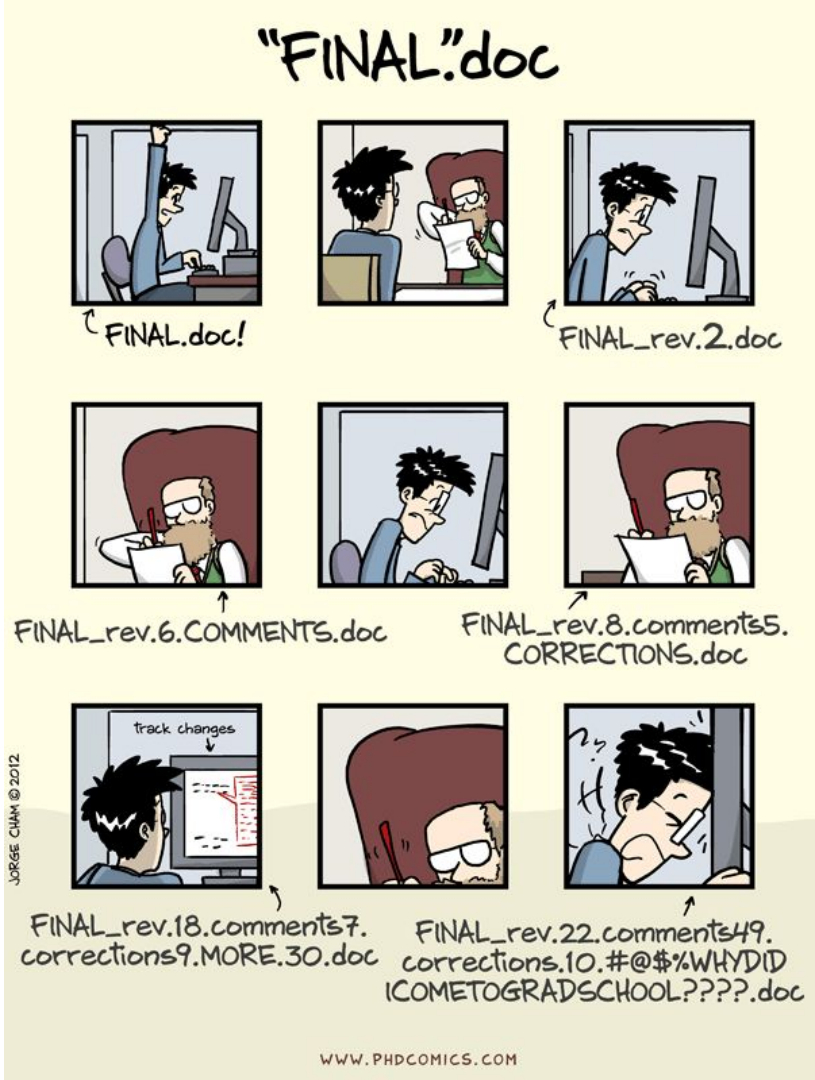
- Data + code (+ documentation!)
- For...
  - Validation
  - Learning
  - Collaboration

Tools

- Version control
  - Git
- Executable notebooks
  - Jupyter notebook
  - Google colab
- Code publishing platform
  - GitHub
  - Gitlab

Version Control

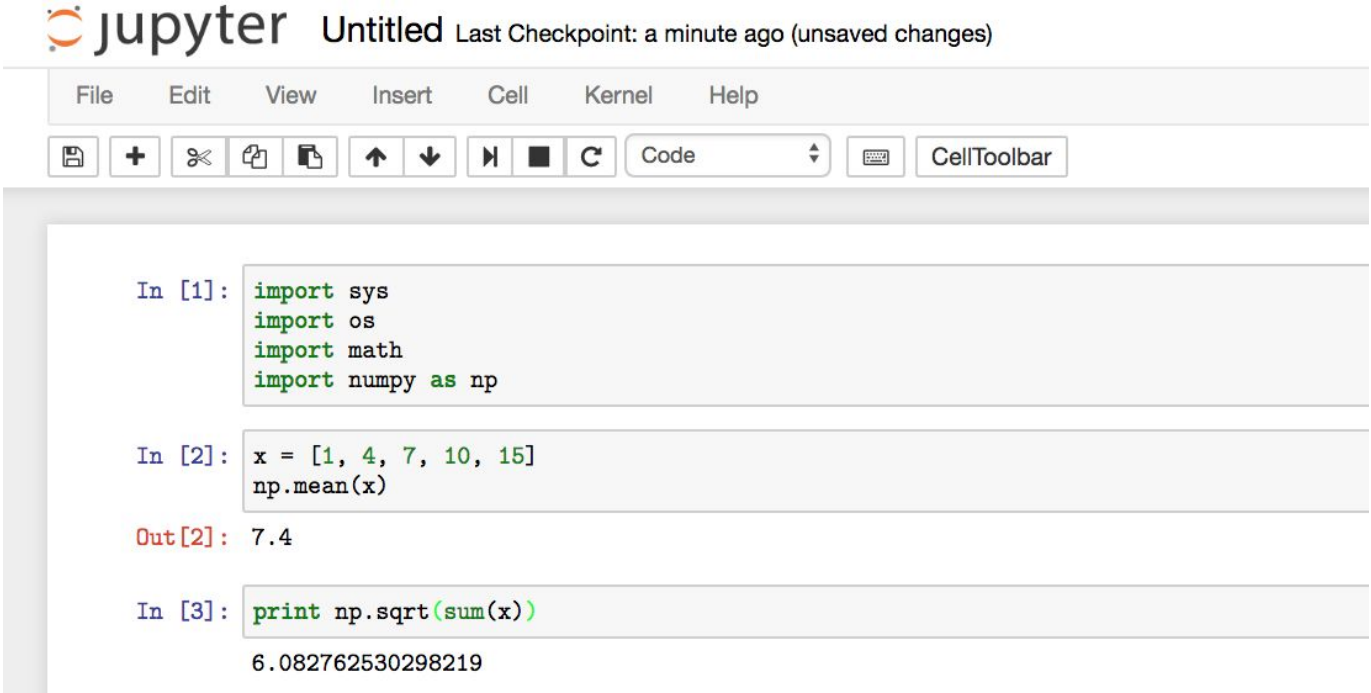
- `git add .`
- `git status`
- `git commit -m ‘first commit’`
- `git push`
- `git reset ‘.DS_Store’`
- `...`



http://phdcomics.com/comics/archive.php?comicid=1531

Jupyter Notebook

Execute (`Shift + Enter`) code cells and get your output underneath the cells



CoLab (CoLaboratory)

http://g.co/colab

Write code just as you would on a Jupyter Notebook

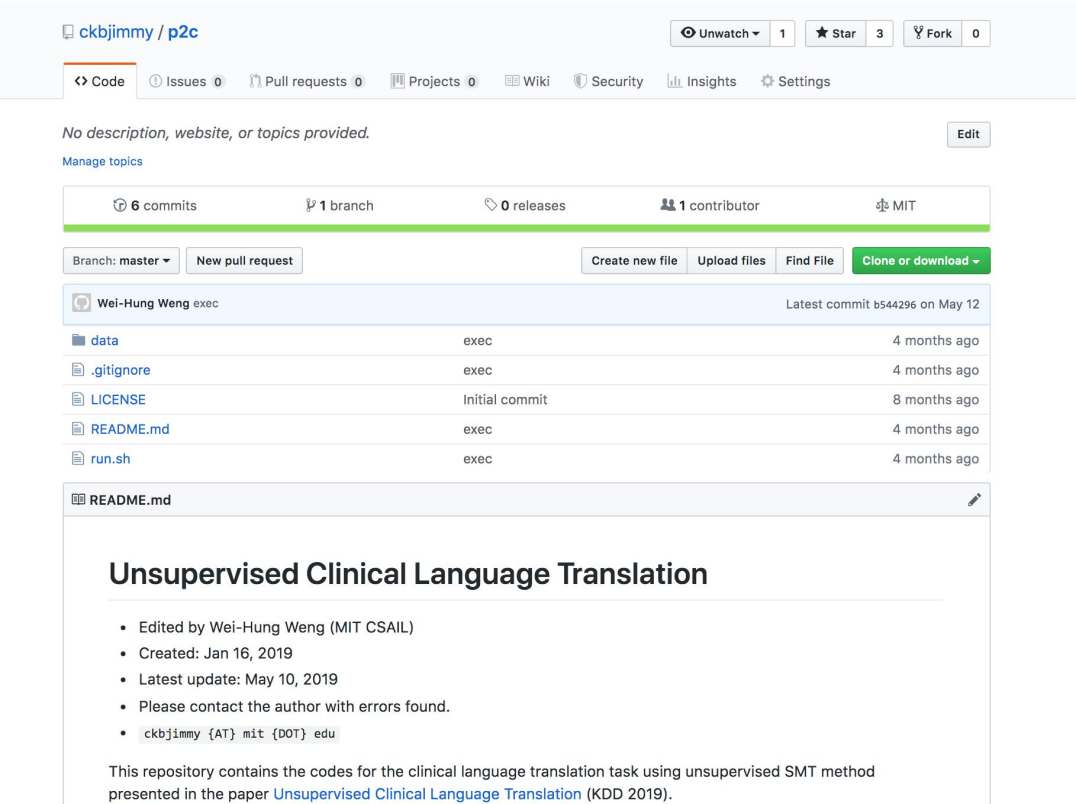
Use one of google's virtual machines to carry out your tasks

Free

Can write shell commands preceded with a `'!'`

- `!pip install gensim`
- `!ls`

Code Publishing (scary but worth it)



ckbjimmy / p2c

Unwatch 1 | Star 3 | Fork 0

Code | Issues 0 | Pull requests 0 | Projects 0 | Wiki | Security | Insights | Settings

No description, website, or topics provided.

Edit

Manage topics

6 commits | 1 branch | 0 releases | 1 contributor | MIT

Branch: master | New pull request | Create new file | Upload files | Find File | Clone or download

Wei-Hung Weng exec — Latest commit b544296 on May 12

data	exec	4 months ago
.gitignore	exec	4 months ago
LICENSE	Initial commit	8 months ago
README.md	exec	4 months ago
run.sh	exec	4 months ago

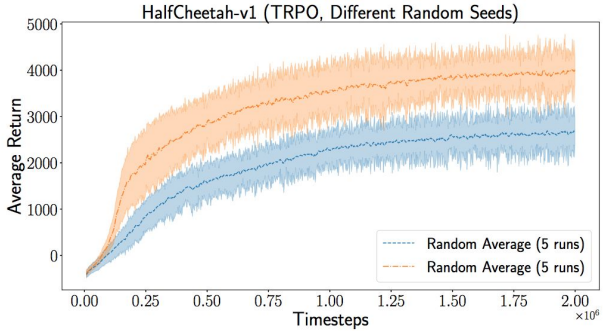
README.md

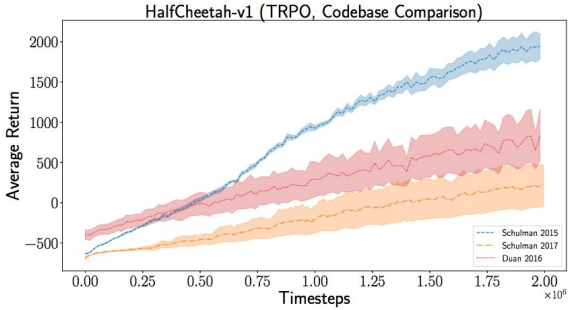
Unsupervised Clinical Language Translation

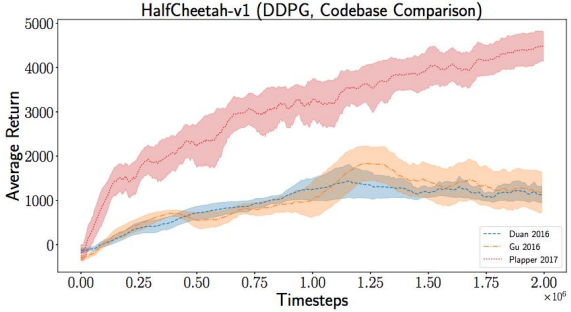
- Edited by Wei-Hung Weng (MIT CSAIL)
- Created: Jan 16, 2019
- Latest update: May 10, 2019
- Please contact the author with errors found.
- `ckbjimmy {AT} mit {DOT} edu`

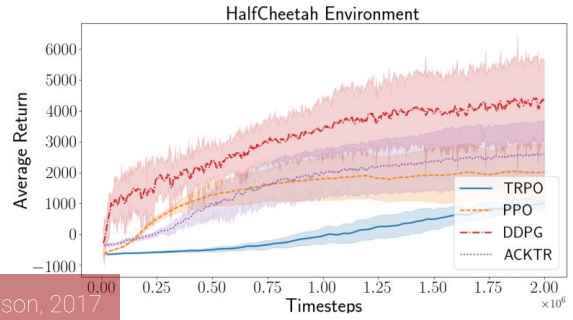
This repository contains the codes for the clinical language translation task using unsupervised SMT method presented in the paper Unsupervised Clinical Language Translation (KDD 2019).

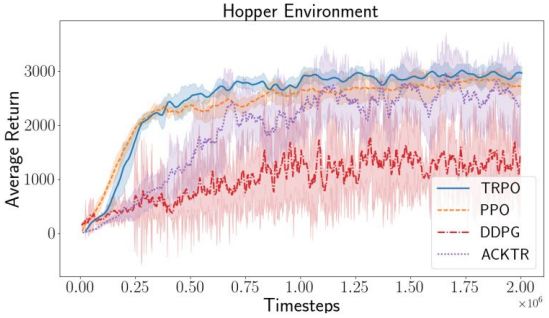
Model Robustness

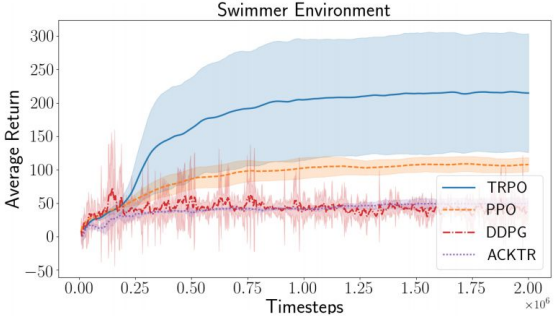








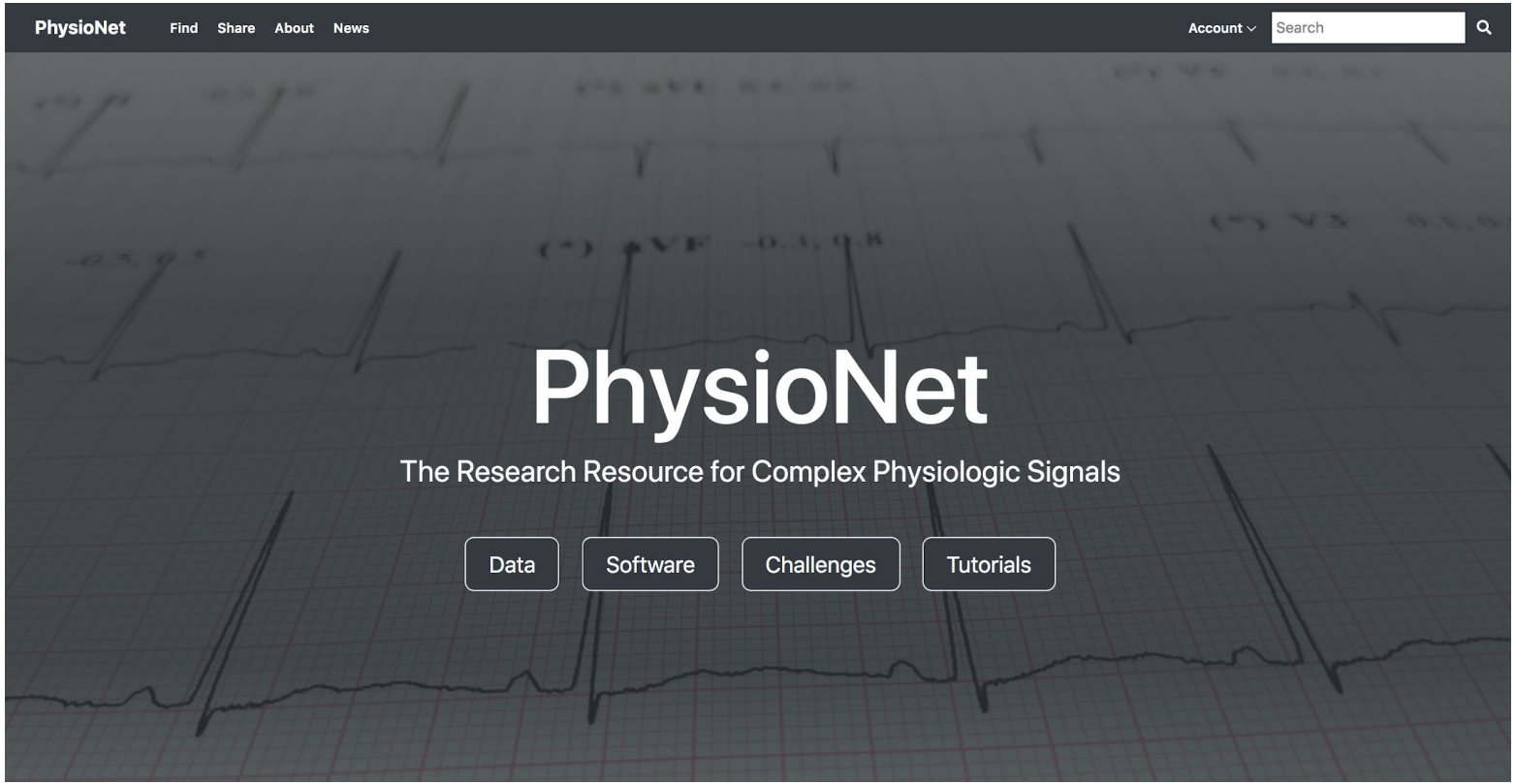




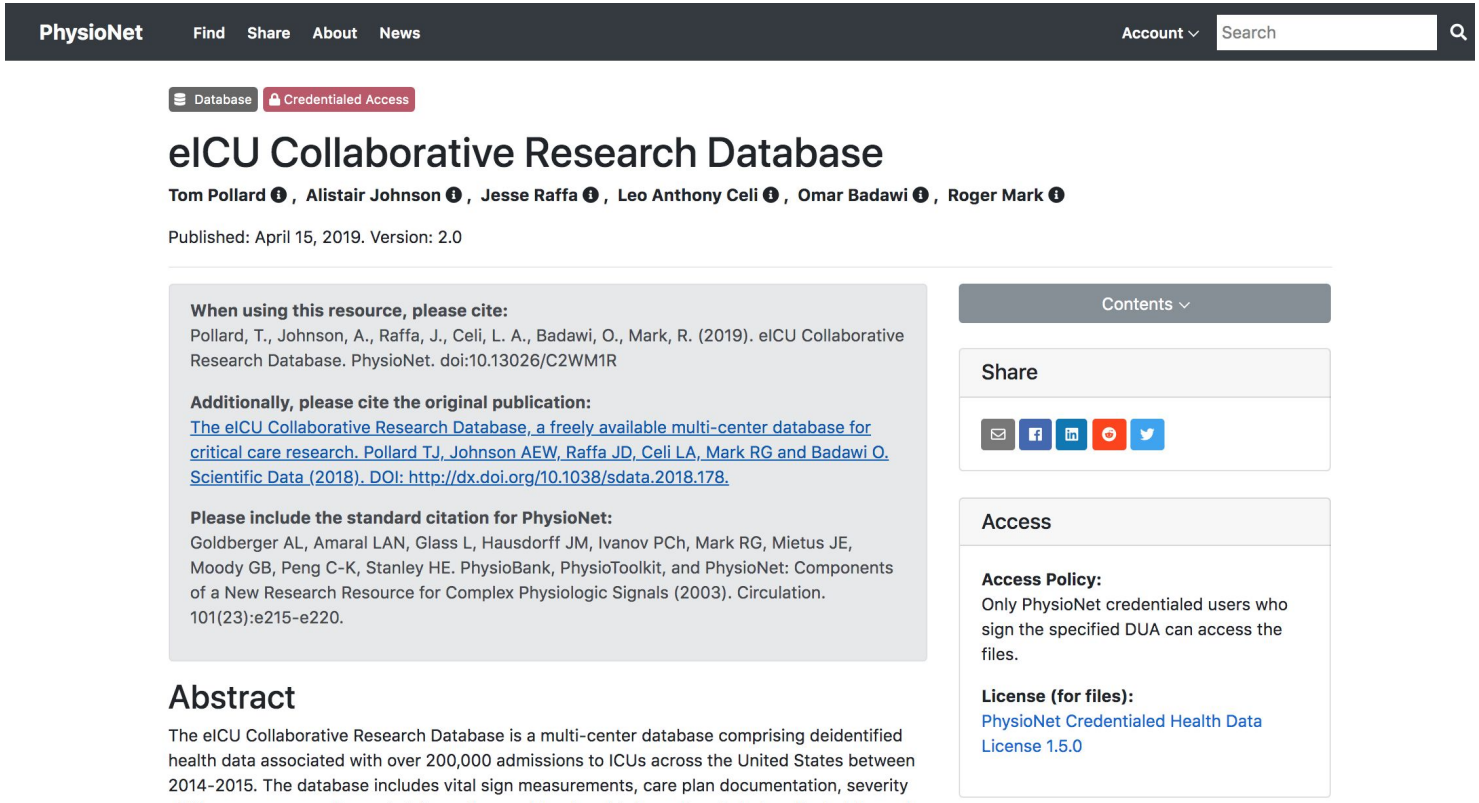
Henderson, 2017

PhysioNet / eICU / MIMIC-III

physionet.org



eICU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eICU Collaborative Research Database
Tom Pollard , Alistair Johnson , Jesse Raffa , Leo Anthony Celi , Omar Badawi , Roger Mark
Published: April 15, 2019. Version: 2.0
When using this resource, please cite:
Pollard, T., Johnson, A., Raffa, J., Celi, L. A., Badawi, O., Mark, R. (2019). eICU Collaborative Research Database. PhysioNet. doi:10.13026/C2WM1R
Additionally, please cite the original publication:
The eICU Collaborative Research Database, a freely available multi-center database for critical care research. Pollard TJ, Johnson AEW, Raffa JD, Celi LA, Mark RG and Badawi O. Scientific Data (2018). DOI: http://dx.doi.org/10.1038/sdata.2018.178.
Please include the standard citation for PhysioNet:
Goldberger AL, Amaral LAN, Glass L, Hausdorff JM, Ivanov PCh, Mark RG, Mietus JE, Moody GB, Peng C-K, Stanley HE. PhysioBank, PhysioToolkit, and PhysioNet: Components of a New Research Resource for Complex Physiologic Signals (2003). Circulation. 101(23):e215-e220.
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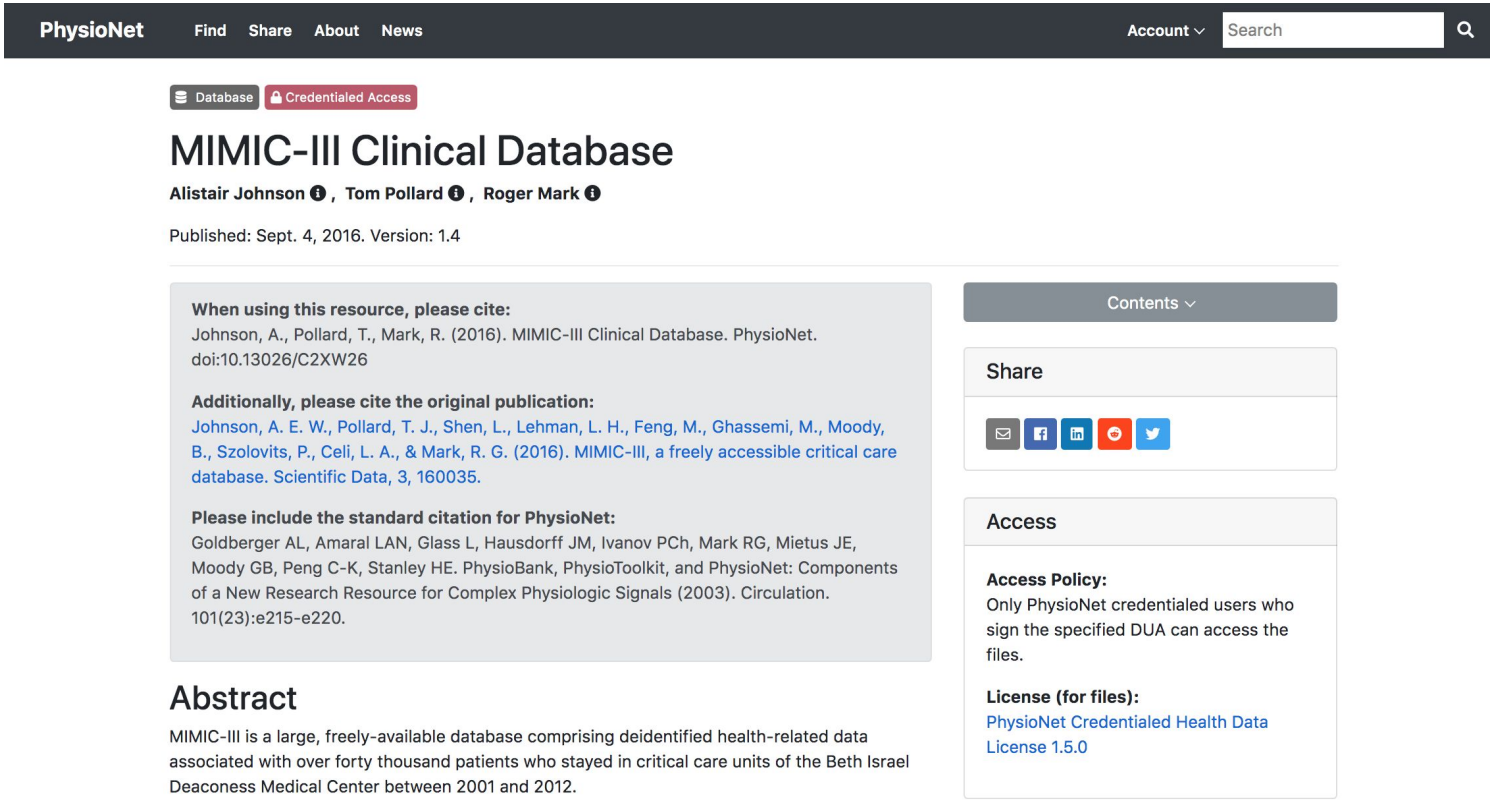
Abstract
The eICU Collaborative Research Database is a multi-center database comprising deidentified health data associated with over 200,000 admissions to ICUs across the United States between 2014-2015. The database includes vital sign measurements, care plan documentation, severity

MIMIC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MIMIC-III Clinical Database
Alistair Johnson , Tom Pollard , Roger Mark
Published: Sept. 4, 2016. Version: 1.4
When using this resource, please cite:
Johnson, A., Pollard, T., Mark, R. (2016). MIMIC-III Clinical Database. PhysioNet. doi:10.13026/C2XW26
Additionally, please cite the original publication:
Johnson, A. E. W., Pollard, T. J., Shen, L., Lehman, L. H., Feng, M., Ghassemi, M., Moody, B., Szolovits, P., Celi, L. A., & Mark, R. G. (2016). MIMIC-III, a freely accessible critical care database. Scientific Data, 3, 160035.
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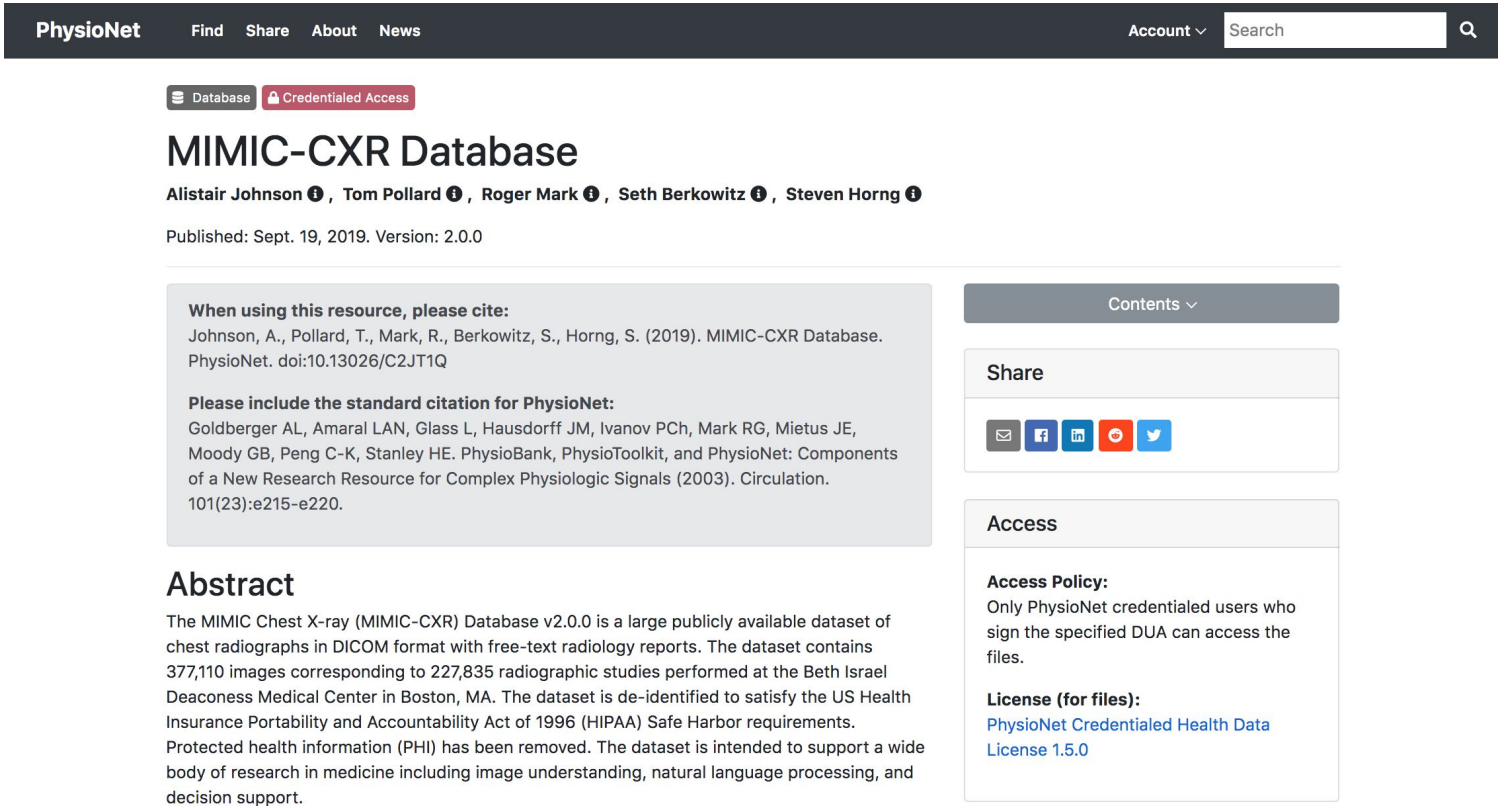
Abstract
MIMIC-III is a large, freely-available database comprising deidentified health-related data associated with over forty thousand patients who stayed in critical care units of the Beth Israel Deaconess Medical Center between 2001 and 2012.

MIMIC-CXR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Alistair Johnson , Tom Pollard , Roger Mark , Seth Berkowitz , Steven Horng
Published: Sept. 19, 2019. Version: 2.0.0
When using this resource, please cite:
Johnson, A., Pollard, T., Mark, R., Berkowitz, S., Horng, S. (2019). MIMIC-CXR Database. PhysioNet. doi:10.13026/C2JT1Q
Please include the standard citation for PhysioNet:
Goldberger AL, Amaral LAN, Glass L, Hausdorff JM, Ivanov PCh, Mark RG, Mietus JE, Moody GB, Peng C-K, Stanley HE. PhysioBank, PhysioToolkit, and PhysioNet: Components of a New Research Resource for Complex Physiologic Signals (2003). Circulation. 101(23):e215-e220.
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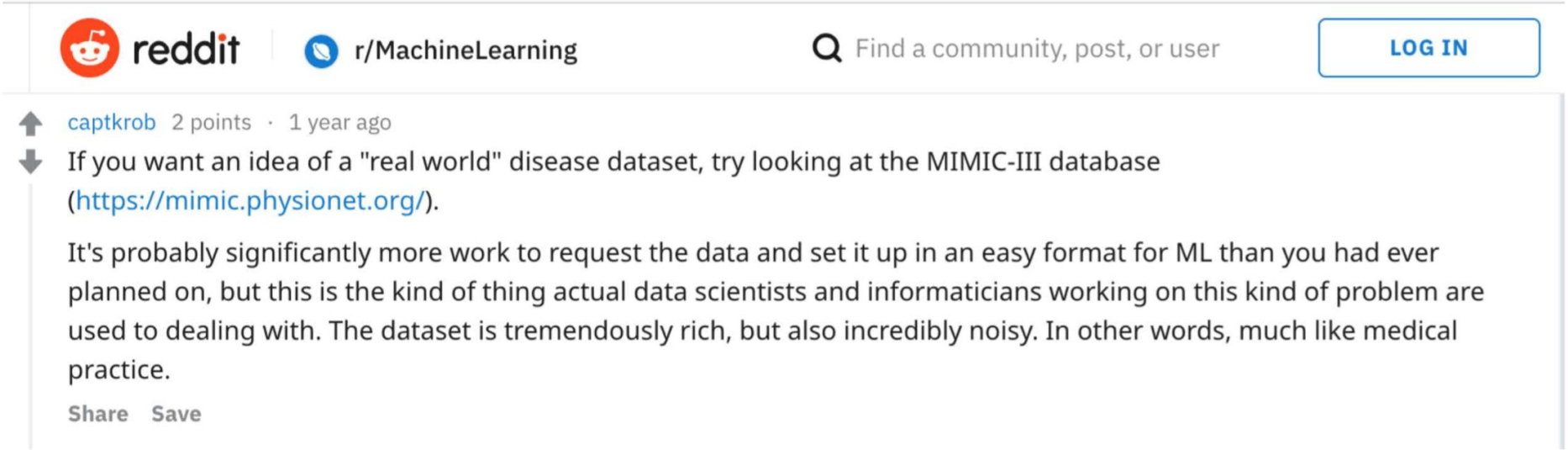
Abstract
The MIMIC Chest X-ray (MIMIC-CXR) Database v2.0.0 is a large publicly available dataset of chest radiographs in DICOM format with free-text radiology reports. The dataset contains 377,110 images corresponding to 227,835 radiographic studies performed at the Beth Israel Deaconess Medical Center in Boston, MA. The dataset is de-identified to satisfy the US Health Insurance Portability and Accountability Act of 1996 (HIPAA) Safe Harbor requirements. Protected health information (PHI) has been removed. The dataset is intended to support a wide body of research in medicine including image understanding, natural language processing, and decision support.

Warning

- Not in a clean, tidy spreadsheet
- Not generated for us to do research



Getting Access

- Sign data use agreement (DUA)
- Take online courses (citi)

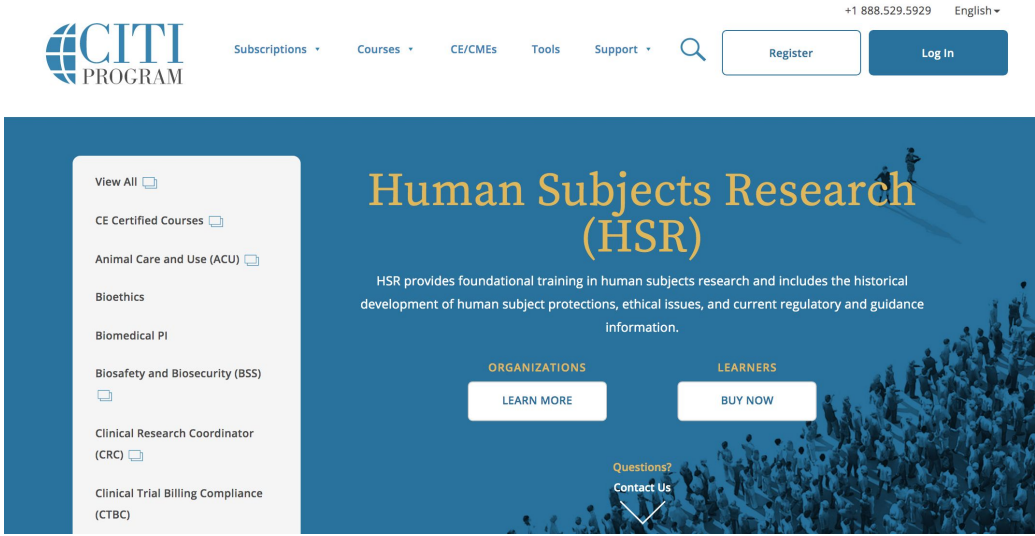
Sign Data Use Agreement - eICU Collaborative Research Database v2.0

Sign the following data use agreement to access the files in eICU Collaborative Research Database v2.0.

PhysioNet Credentialed Health Data Use Agreement 1.5.0

If I am granted access to the database:

1. I will not attempt to identify any individual or institution referenced in PhysioNet restricted data.
2. I will exercise all reasonable and prudent care to avoid disclosure of the identity of any individual or institution referenced in PhysioNet restricted data in any publication or other communication.
3. I will not share access to PhysioNet restricted data with anyone else.
4. I will exercise all reasonable and prudent care to maintain the physical and electronic security of PhysioNet restricted data.
5. If I find information within PhysioNet restricted data that I believe might permit identification of any individual or institution, I will report the location of this information promptly by email to PHI-report@physionet.org, citing the location of the specific information in question.
6. I have requested access to PhysioNet restricted data for the sole purpose of lawful use in scientific research, and I will use my privilege of access, if it is granted, for this purpose and no other.
7. I have completed a training program in human research subject protections and HIPAA regulations, and I am submitting proof of having done so.
8. I will indicate the general purpose for which I intend to use the database in my application.
9. If I openly disseminate my results, I will also contribute the code used to produce those results to a repository that is open to the research community.
10. This agreement may be terminated by either party at any time, but my obligations with respect to PhysioNet data shall continue after termination.



Data Sharing

- More people seeing the data → more knowledge
- Education
- Accelerating research
- You can also share the data through PhysioNet!

MIMIC-III

- Single center (>60K ICU stay, >40K patients)
- ICU data in details (almost everything incl. notes and waveforms)
- Limited out-of-ICU data (medication, DOD, ...)

If you use MIMIC data or code in your work, please cite the following publication:

MIMIC-III, a freely accessible critical care database. Johnson AEW, Pollard TJ, Shen L, Lehman L, Feng M, Ghassemi M, Moody B, Szolovits P, Celi LA, and Mark RG. Scientific Data (2016). DOI: 10.1038/sdata.2016.35.
Available from: http://www.nature.com/articles/sdata201635

eICU

- Multicenter (>200 hospitals, >200K ICU stay, 2 years)
- ICU data (no free text notes)
- Heterogeneous data (every hospital has their own input format)

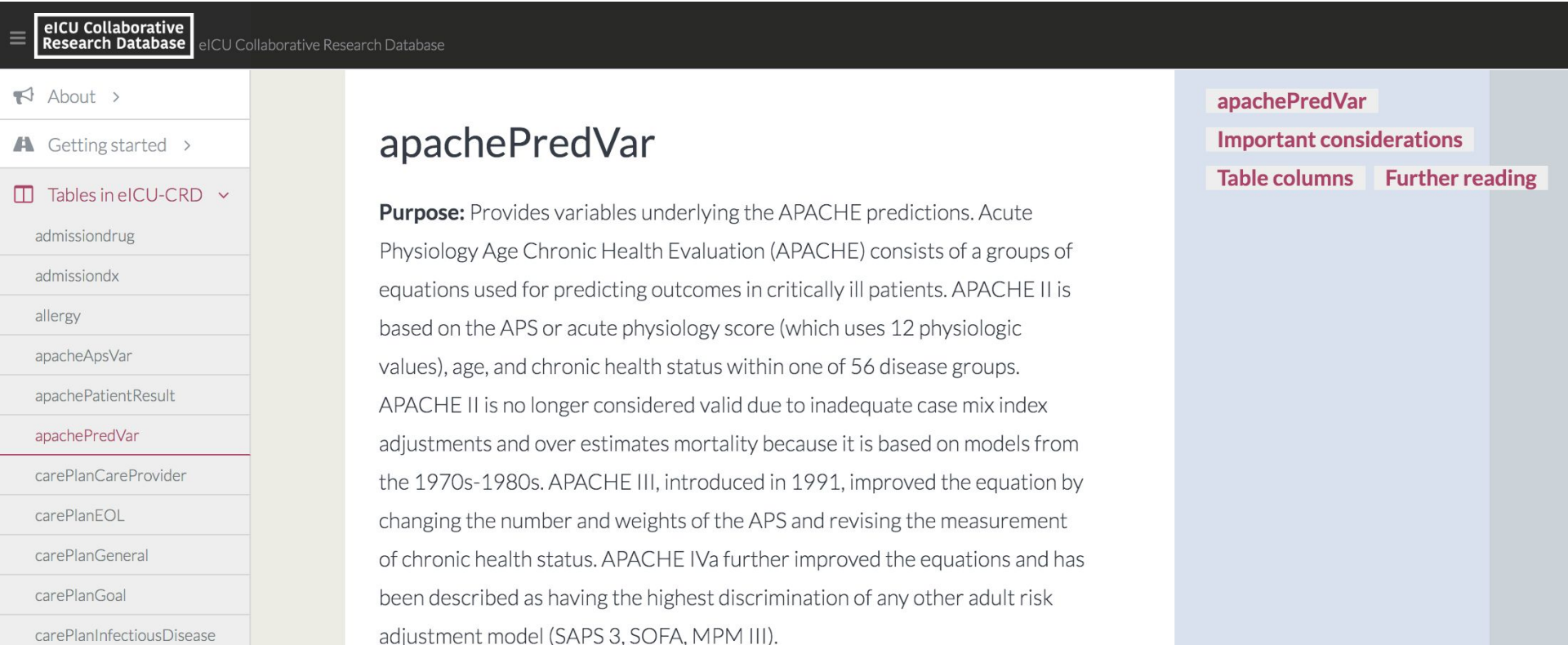
If you use the eICU Collaborative Research Database in your work, please cite the following publication:

The eICU Collaborative Research Database, a freely available multi-center database for critical care research. Pollard TJ, Johnson AEW, Raffa JD, Celi LA, Mark RG and Badawi O. Scientific Data (2018). DOI: http://dx.doi.org/10.1038/sdata.2018.178. Available from: https://www.nature.com/articles/sdata2018178

eICU [vs. MIMIC-III]

- Strengths
  - Latest data (2014-2015)
  - Larger dataset, multicenter
  - Severity score for all patients (APACHE)
  - Treatment plan in `carePlanGeneral` table
  - Diagnosis available during stay
- Limitations
  - Documentation, codebase and community support
  - Less literature
  - Varying between hospital
  - No clinical notes

Navigating eICU [eicu-crd.mit.edu]



Patient Tracking

- `patientunitstayid` → ICU stay
- `patienthealthsystemstayid` → hospital stay
- `uniquepid` → patient
- `hospitalid` → hospital

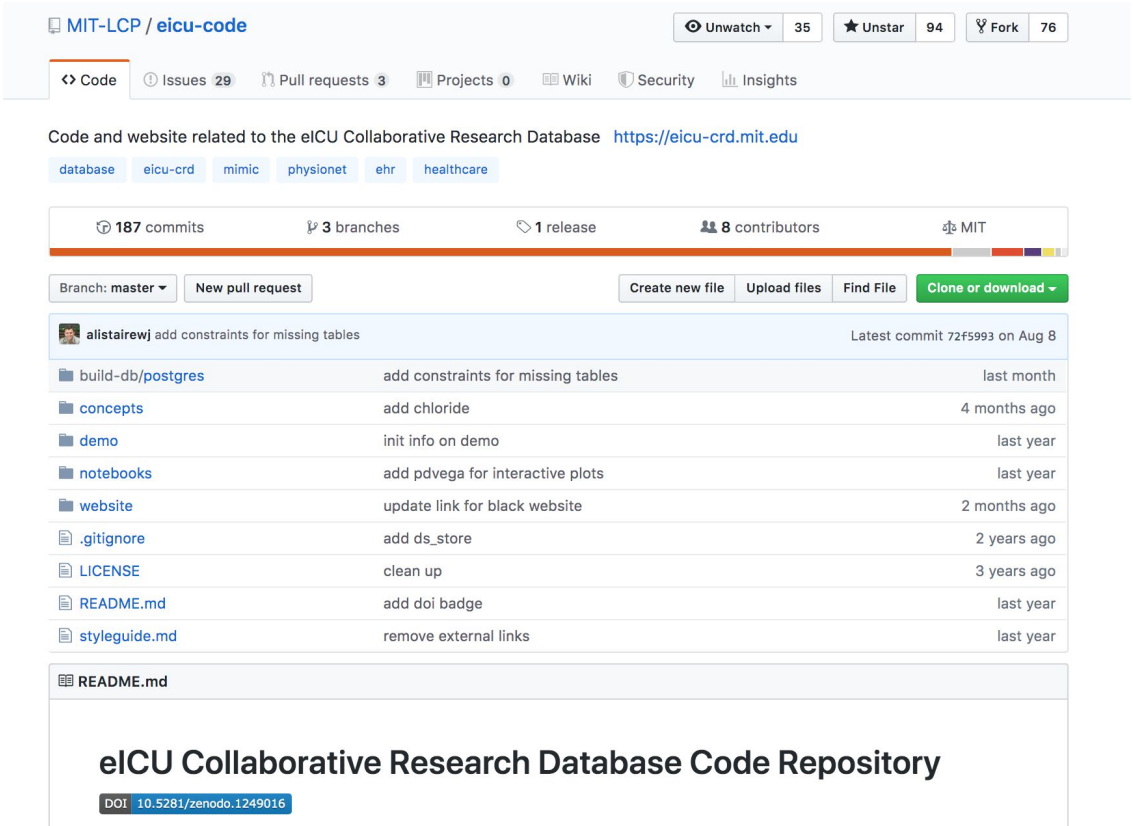
- `...offset`

Tables

- `apacheapsvar`
  - First day aggregated data for APACHE
- `apachepredvar`
- `diagnosis` → offset, string, ICD code
- `infusiondrug` → fluid, insulin, vasopressor, sedative
- `intakeoutput` → urine output
- `patient` → demographics
- `lab, medication, pasthistory, treatment` → offset, string
- `vitalperiodic, vitalaperiodic`

- `github.com/ckbjimmy/hst953_iomed`

Codebase [github.com/MIT-LCP/eicu-code]



MIT-LCP / eicu-code

Unwatch 35 | Unstar 94 | Fork 76

Code | Issues 29 | Pull requests 3 | Projects 0 | Wiki | Security | Insights

Code and website related to the eICU Collaborative Research Database https://eicu-crd.mit.edu

database | eicu-crd | mimic | physionet | ehr | healthcare

187 commits | 3 branches | 1 release | 8 contributors | MIT

Branch: master | New pull request | Create new file | Upload files | Find File | Clone or download

alistairewj add constraints for missing tables — Latest commit 72f5993 on Aug 8

build-db/postgres	add constraints for missing tables	last month
concepts	add chloride	4 months ago
demo	init info on demo	last year
notebooks	add pdvega for interactive plots	last year
website	update link for black website	2 months ago
.gitignore	add ds_store	2 years ago
LICENSE	clean up	3 years ago
README.md	add doi badge	last year
styleguide.md	remove external links	last year

README.md

eICU Collaborative Research Database Code Repository

DOI 10.5281/zenodo.1249016

Concepts

- In BigQuery
- Derived tables
  - `/eicu-code/concepts/pivoted/`

Branch: master ▾ **eicu-code** / concepts / **pivoted** /

Create new file | Upload files | Find file | History

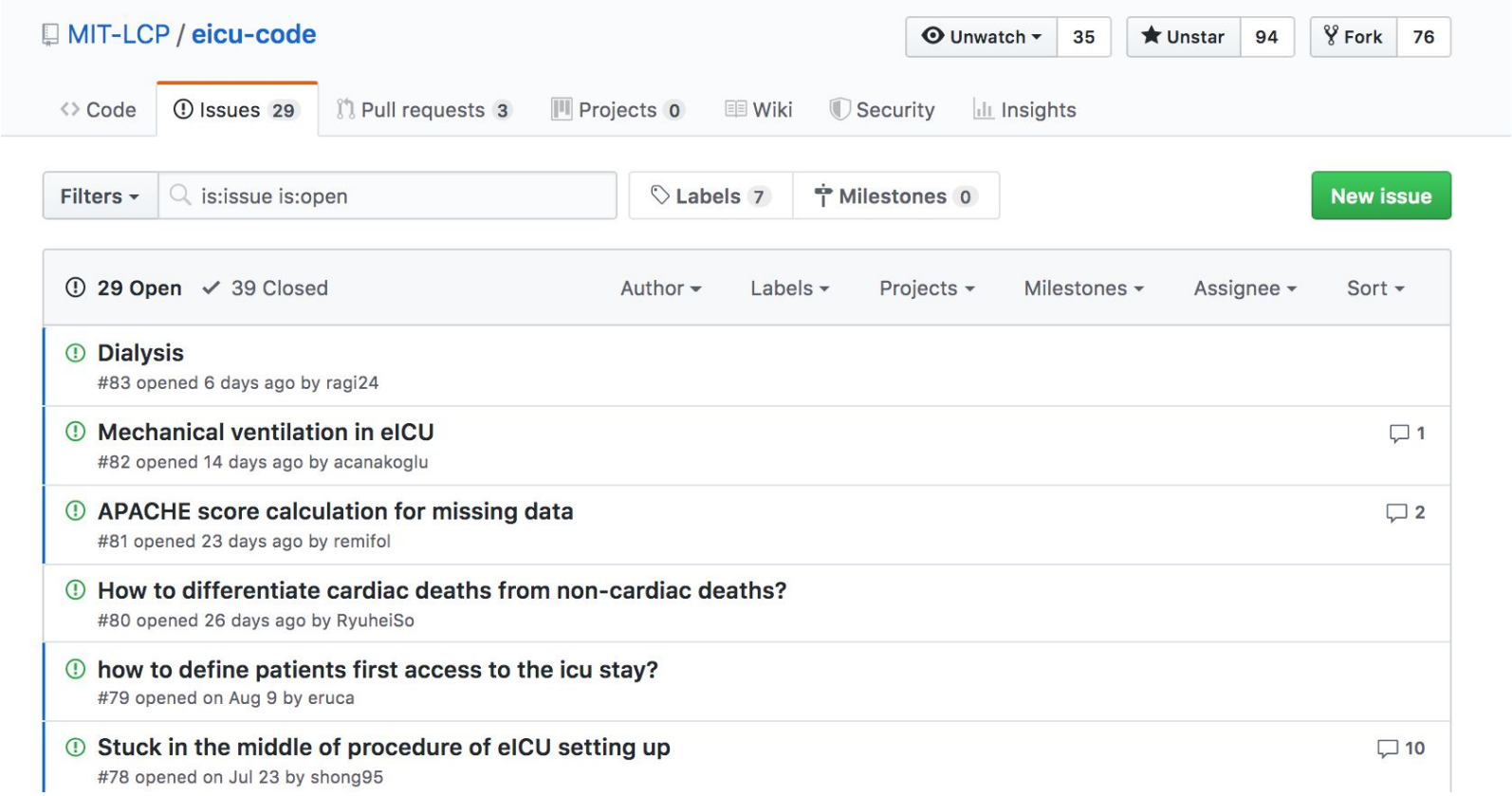
alistairewj add chloride — Latest commit c66c0fe on May 12

..

pivoted-bg.sql	add pivot tables	last year
pivoted-infusion.sql	add pivot tables	last year
pivoted-lab.sql	add chloride	5 months ago
pivoted-med.sql	remove superfluous column	last year
pivoted-o2.sql	add pivoted views	last year
pivoted-score.sql	add pivoted views	last year
pivoted-treatment-vasopressor.sql	add pivot tables	last year
pivoted-uo.sql	add pivot tables	last year
pivoted-vital-other.sql	add pivoted views	last year
pivoted-vital.sql	add pivoted views	last year

```
, max(case
      when drugname in
      (
          'EPI (mcg/min)'
        , 'Epinepherine (mcg/min)'
        , 'Epinephrine'
        , 'Epinephrine ()'
        , 'EPINEPHrine(Adrenalin)MAX 30 mg Sodium Chloride 0.9% 250 ml (mcg/min)'
        , 'EPINEPHrine(Adrenalin)STD 4 mg Sodium Chloride 0.9% 250 ml (mcg/min)'
        , 'EPINEPHrine(Adrenalin)STD 4 mg Sodium Chloride 0.9% 500 ml (mcg/min)'
        , 'EPINEPHrine(Adrenalin)STD 7 mg Sodium Chloride 0.9% 250 ml (mcg/min)'
        , 'Epinephrine (mcg/hr)'
        , 'Epinephrine (mcg/kg/min)'
        , 'Epinephrine (mcg/min)'
        , 'Epinephrine (mg/hr)'
        , 'Epinephrine (mg/kg/min)'
        , 'Epinephrine (ml/hr)'
      ) then 1 else 0 end)
    as epinephrine
```

Are You the First Person to Ask → GitHub Issues



https://github.com/ckbjimmy/gcp/blob/master/tutorial_py.ipynb

```
from google.colab import auth
from google.cloud import bigquery
auth.authenticate_user()

project_id='...'
os.environ["GOOGLE_CLOUD_PROJECT"]=project_id

def run_query(query):
  return pd.io.gbq.read_gbq(query, project_id=project_id,
verbose=False, configuration={'query':{'useLegacySql': False}})
```

Collaborative Data Science in Medicine

- Find good problems, collect reliable data > Big data and algorithms
- Collaboration > Expert or AI only
  - Expert: high-level integration, interpretation and decision making (learn Bayesian logic, statistics, and data science and be aware of other sources of information!)
  - AI: pattern recognition and massive repetitive tasks
- Sharing
  - AI researchers open-source platforms and algorithms
  - You can open-source data and knowledge
  - We can do nothing without sharing!
- Experience
  - Learning from AI
  - Communicating with AI

Collaborative Data Science in Medicine

- Courses, Workshops, Symposium, Datathon
- Japan, China, Singapore, Philippines, Denmark, Bhutan