



Medical Billing Virtual Assistant (MBVA)

The future of medical coding

MIDS Capstone Project Presentation (Aug, 2020)
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Berkeley SCHOOL OF INFORMATION

Why Do I Need to Pay for Medical Bill Errors?



80% bills with error*

\$68,000,000,000

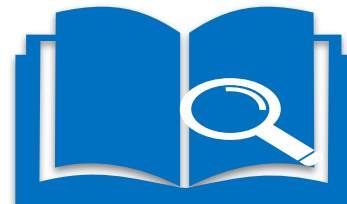
Cost of medical bill errors annually*

A Manual Process to Find Medical Billing Codes

Discharge Summary

History of Present Illness (HPI): Attention difficulties she will talk to him face to face and she is unable to pay attention to him. He was diagnosed with **Autism Spectrum Diagnosis** (he was diagnosed with PDD). He is going in the 5th grade. Treatment Options: 10 yo with history of developmental delays, meets criteria for **ADHD and ASD**. He also has anger issues and anxiety, and may meet criteria for OCD. Strong family history of mood and ADHD. Provided **psychoeducation about OCD** and anxiety and ADHD. Start Zoloft 25mg. r/b/a including black box warning discussed...

psychoeducation about OCD and anxiety and ADHD
Start Zoloft 25mg. r/b/a including black box warning discussed.



Medical Chapter



ICD 10 Code

What Do Medical Coders Say about Coding Error?



Our Goal

Reduce the error and time taken to code medical diagnosis

Our Approach



MBVA

Clinical BERT embeddings

Web App: AWS



Data



Preprocess



Model



UI

MIMIC-III

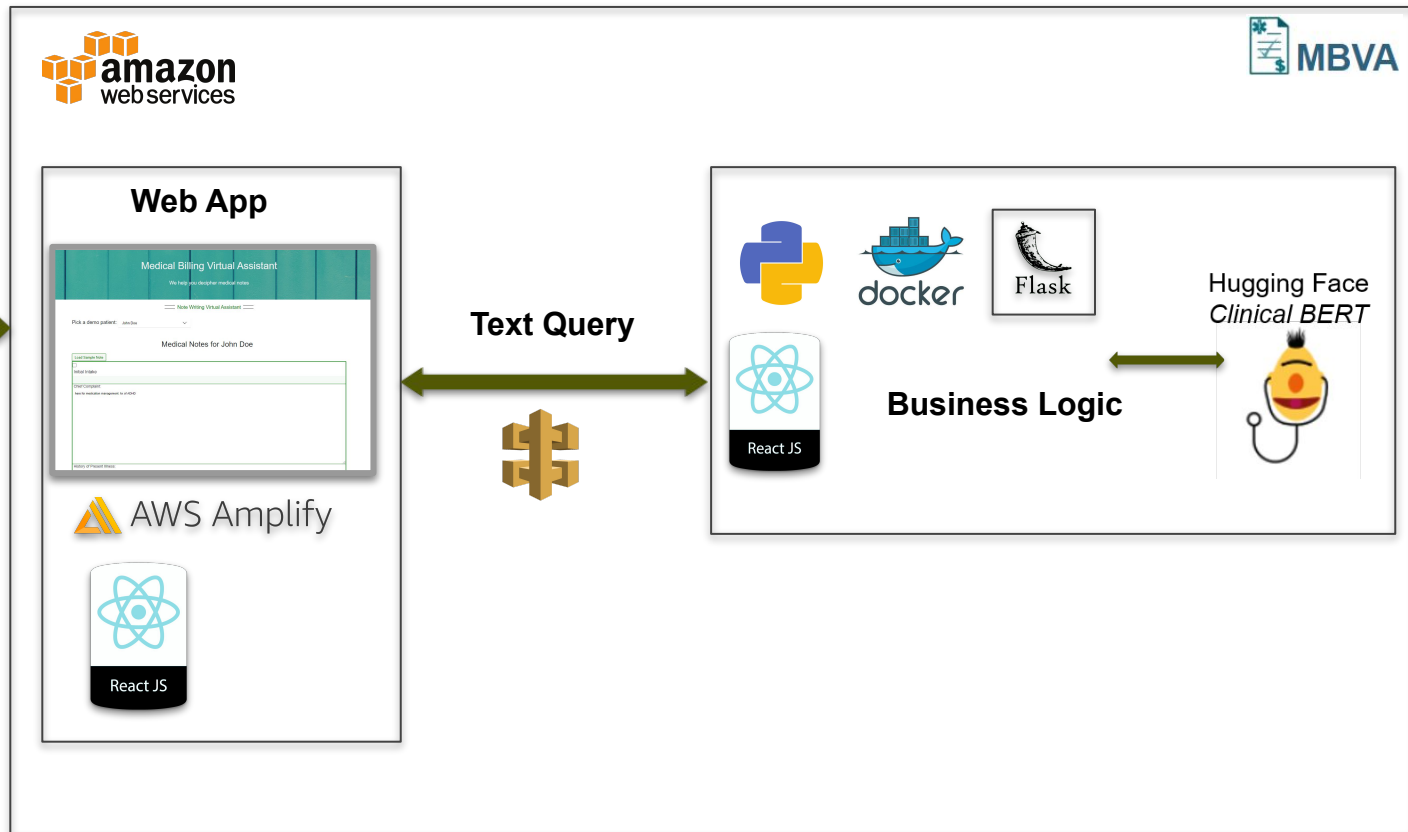
*Clinical notes and diagnosis
codes linked to each note*

CNN / Transfer learning

MBVA Application Architecture



- Medical Coder
- Physician Assistant
- Nurse Practitioner
- Doctor
- Patient

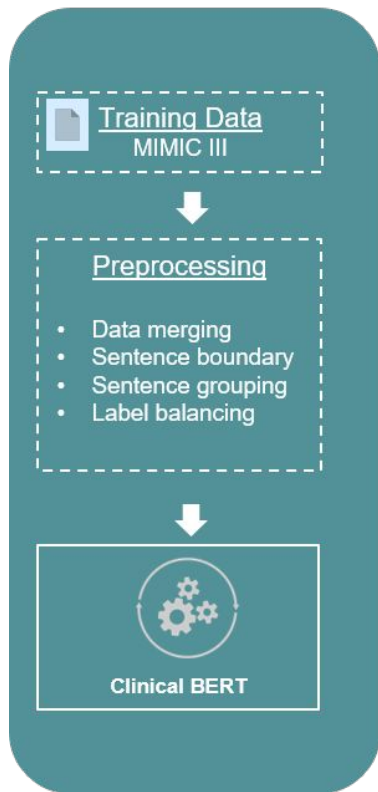


Divide and Conquer with An Ensemble of Multi-Label Classifiers

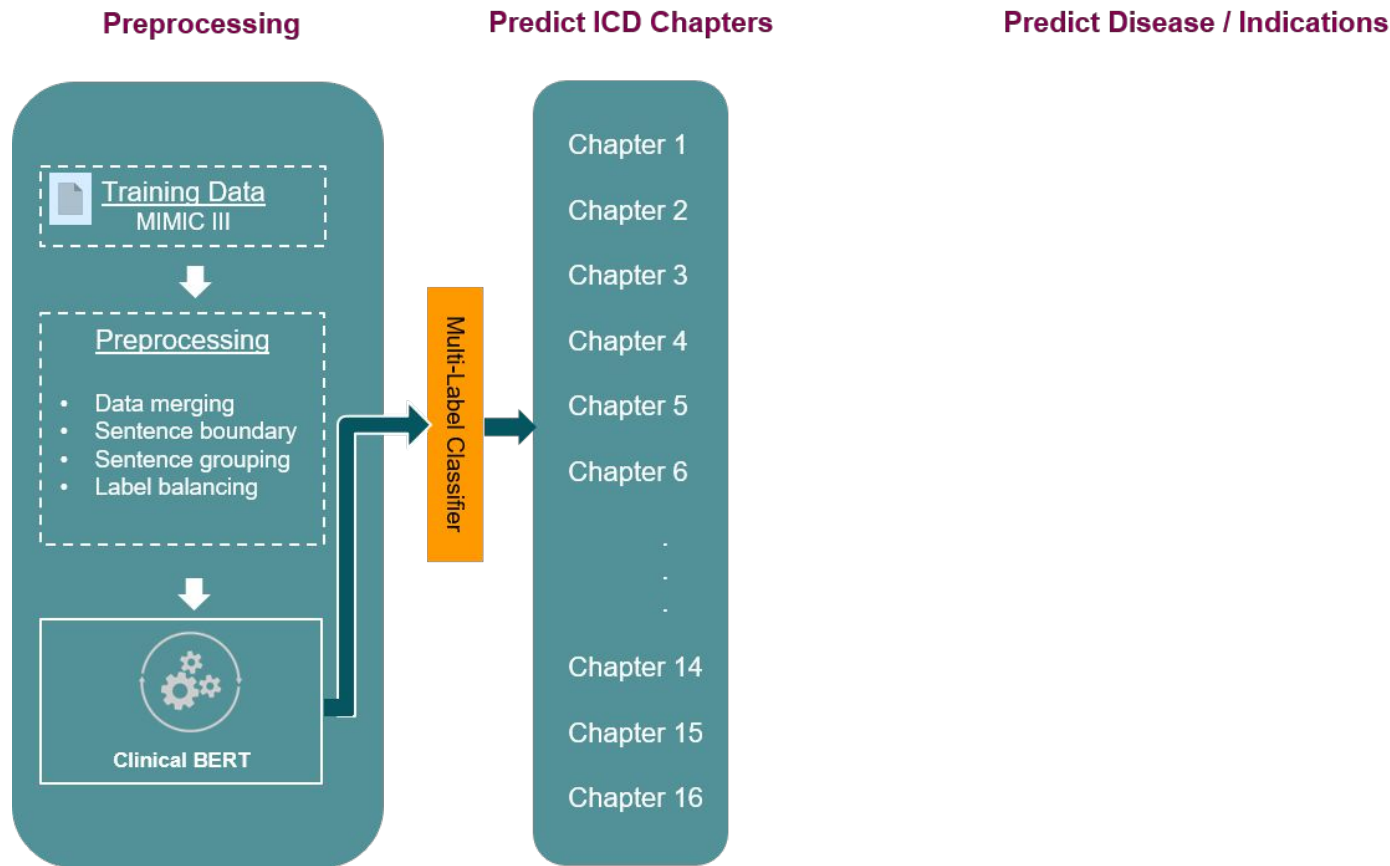
Preprocessing

Predict ICD Chapters

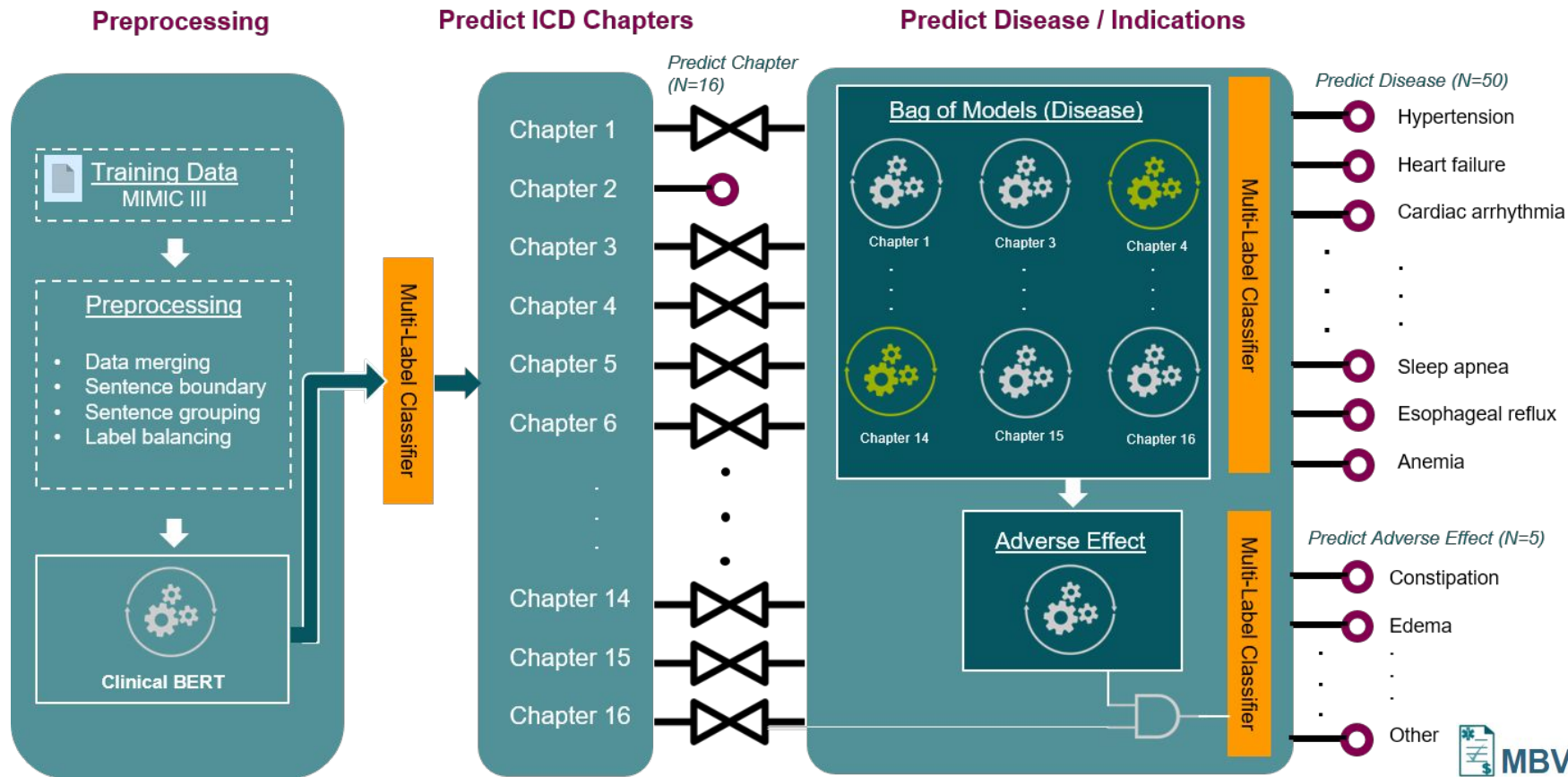
Predict Disease / Indications




Divide and Conquer with An Ensemble of Multi-Label Classifiers



Divide and Conquer with An Ensemble of Multi-Label Classifiers



Comparison to Others

Publications / Previous work	Prediction	F1 Scores
Explainable Prediction of Medical Codes from Clinical Text Association for Computational Linguistics, June 2018	Secondary prediction: Top 50 ICD codes	0.63
Tagging Patient Notes With ICD-9 Codes 29th Conference on Neural Information Processing Systems	19 High level ICD-9 Categories	0.71
An empirical evaluation of deep learning for ICD-9 code assignment using MIMIC-III clinical notes Computer Methods and Programs in Biomedicine, May 2019	Top-10 ICD-9 codes	0.72
Multimodal Machine Learning for Automated ICD Coding Proceedings of Machine Learning Research, Aug 2019	Top-32 ICD-9 codes	0.76
Medical Billing Virtual Assistant (MBVA) MIDS Capstone 2020 	<ul style="list-style-type: none">16 therapy areasMost prevalent Disease category across these therapy areas (N=50)	Chapter / Therapy Areas: 0.78 Disease category@50: 0.75



Medical Billing Virtual Assistant (MBVA)

Preparing to shape the future of medical coding



Sample Note
Neonatal Discharge Summary

Benefits of MBVA



MBVA



HOSPITAL BILLING TEAM

Fewer Error and Higher Productivity



PHYSICIAN/ NURSE

More time on patients



INSURERS

Low cost on Audit

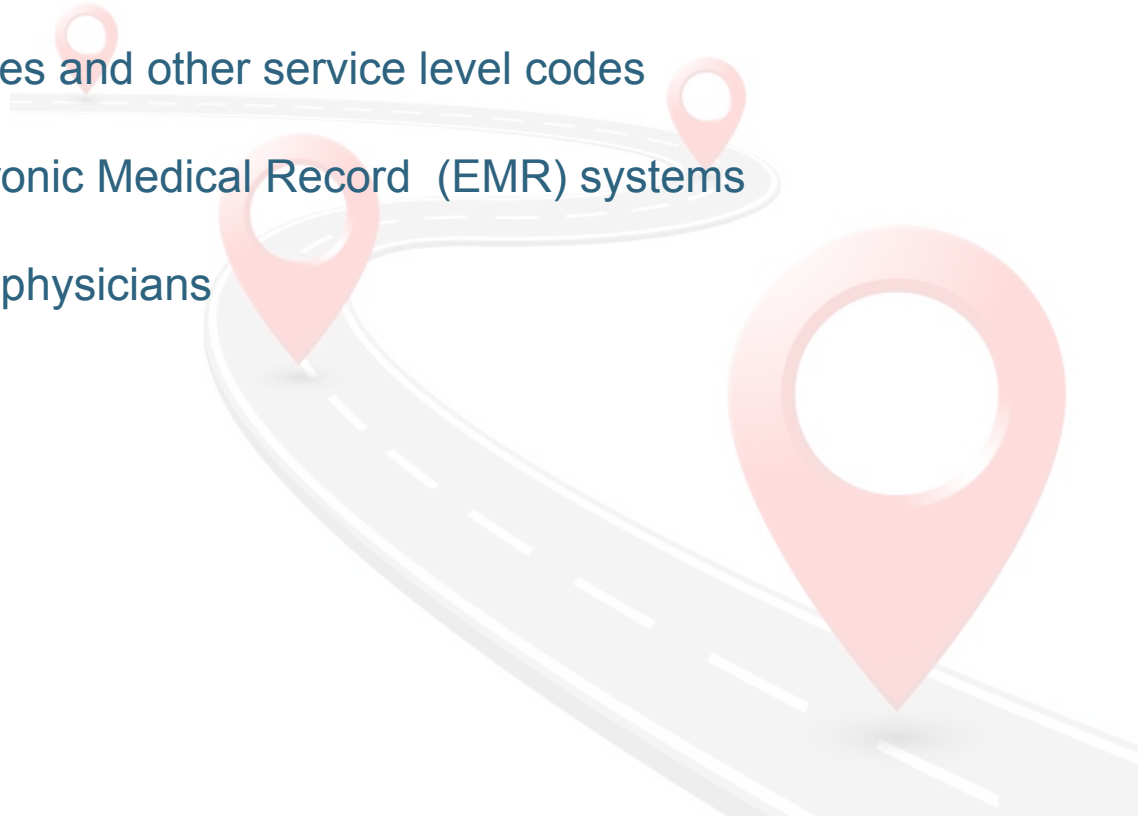


PATIENTS

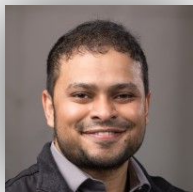
More transparency on medical charges

Future Roadmap

- Improve model predictions
- Expand to medical procedures and other service level codes
- Integrate with existing Electronic Medical Record (EMR) systems
- Build AI writing assistant for physicians

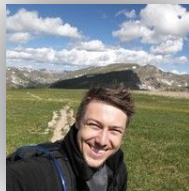


The Team



Anish Philip

Medical SME and Model Builder



Brent Biseda

Product Manager



Gaurav Desai

UI Developer



Haifeng Lin

Project Manager



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Q&A

Thank you

Team Responsibility

Team Member Accomplishment - Brent Biseda

01

Determine initial project scope

02

Obtain SME inputs

03

Decide product design and features

04

Create Flask Backend

Team Member Accomplishment - Gaurav Desai

01

Create UI

02

Decide product design and features

03

Setup AWS environment for the project

Team Member Accomplishment - Anish Philip

01

Conduct EDA and feature engineering

02

Build, run, and decide ML models

03

Our SME in healthcare industry

Team Member Accomplishment - Haifeng Lin

01

Construct ppt for regular update and graded presentation

02

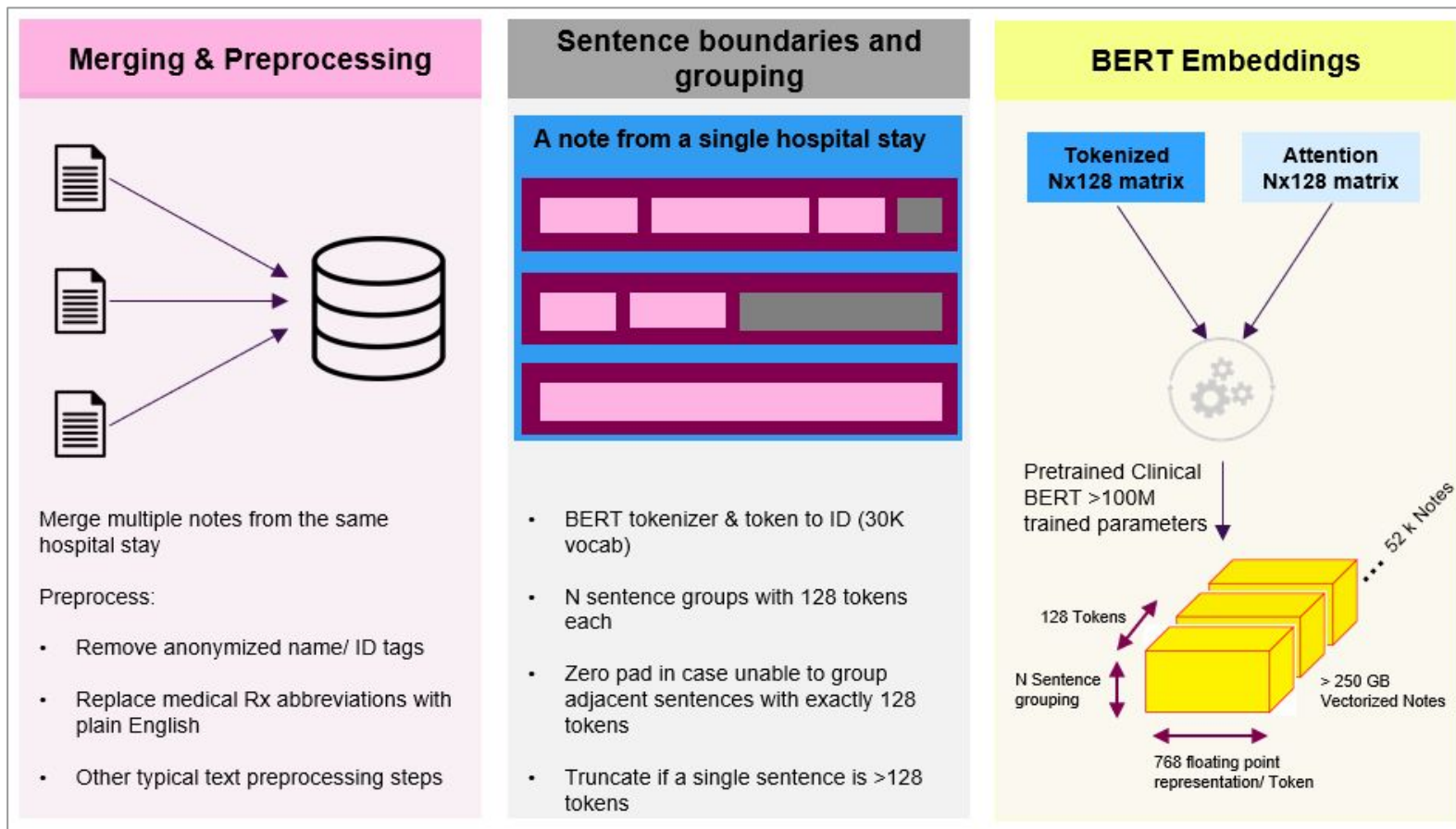
Manage project and coordinate meetings

03

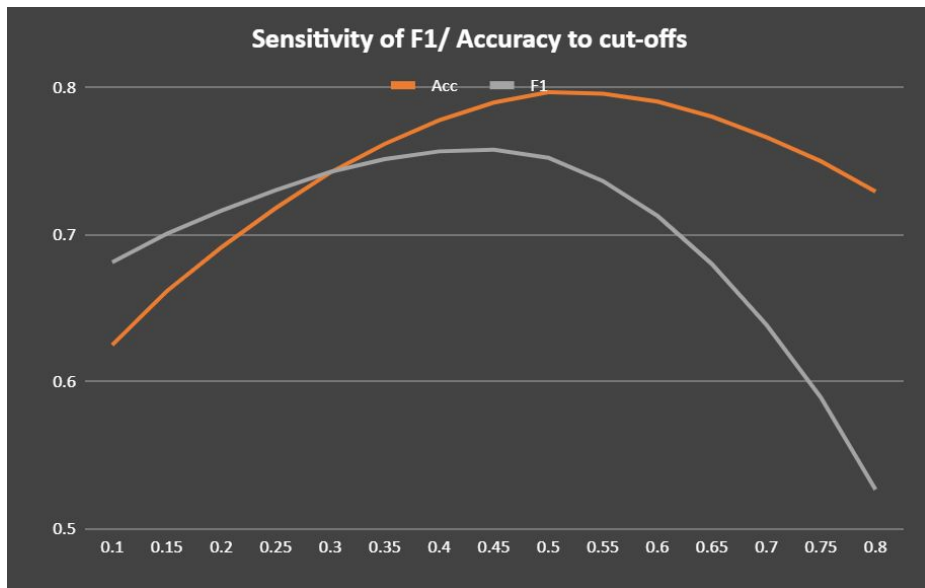
Create contents for the UI

Appendix

Preprocessing Clinical Text from MIMIC-III

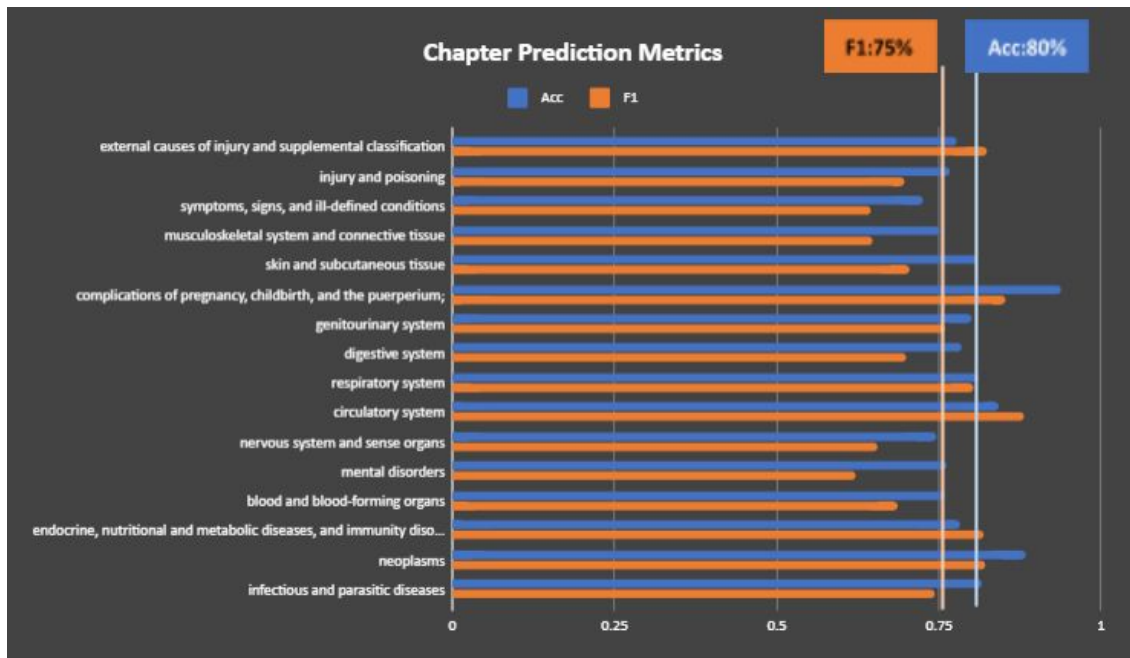


Results and Evaluation



Cut-offs at 0.5 yields the best model performances

Results and Evaluation



Model performances are relatively consistent across 16 chapters, with average F1 score of **75%** and Accuracy of **80%**

Individual Model Performance

Therapy Area/ Chapter	Chapter Description	# of Labels	Training		Test	
			Acc	F1	Acc	F1
001 139	infectious and parasitic diseases	4	88%	80%	78%	62%
140 239	neoplasms	3	85%	82%	78%	73%
240 279	endocrine, nutritional and metabolic diseases, and immunity disorders	4	80%	70%	73%	57%
280 289	blood and blood-forming organs	3	86%	78%	75%	62%
290 319	mental disorders	4	81%	59%	73%	31%
320 389	nervous system and sense organs	6	86%	53%	80%	32%
390 459	circulatory system	6	81%	64%	75%	52%
460 519	respiratory system	5	78%	52%	75%	45%
520 579	digestive system	5	84%	60%	82%	57%
580 629	genitourinary system	3	77%	74%	69%	63%
630 679 740 759 760 779	complications of pregnancy, childbirth, and the puerperium;	4	77%	71%	76%	71%
680 709	skin and subcutaneous tissue	-	-	-	-	-
710 739	musculoskeletal system and connective tissue	2	82%	83%	58%	60%
780 799	symptoms, signs, and ill-defined conditions	5	85%	54%	82%	48%
800 999	injury and poisoning	4	88%	73%	82%	57%
E V	external causes of injury and supplemental classification	7	88%	70%	84%	64%
Adverse Effect		4	74%	45%	72%	37%

Medical Billing Virtual Assistant

We help you decipher medical notes

Paste your medical notes here

Get Codes

ICD Code Prediction

ICD 9 Chapter/s	ICD 10 Chapter/s	Description	Probability
<div>> 0.35</div>			
Adverse	Adverse	Adverse effect diseases	1
320-389	H00-H59; G00-G99	Diseases of the nervous system and sense organs	0.55
Diseases			
Name	ICD 9 Code	ICD 10 Code	Probability
Paralysis	5601	B0601	0.52
Iritis or other eye disorder	37963	H5943	0.44
Sleep apnea	51881	J9600	0.42
Neuropathy in diabetes	3572	E0842	0.41
460-519	J00-J99	Diseases of the respiratory system	0.48
001-139	A00-B99	Infectious and parasitic diseases	0.46
290-319	F01-F99	Mental disorders	0.44
780-799	R00-R99	Symptoms, signs, and ill-defined conditions	0.43
800-999	S00-T88	Injury and poisoning	0.38
E-V	S00-T88; V00-Y99; Z00-Z99	External causes of injury and supplemental classification	0.37
390-459	I00-I99	Diseases of the circulatory system	0.36

Pick a demo patient:

Medical Notes

Load Sample Note

☐

Initial Intake

Chief Complaint:

Chief Complaint

History of Present Illness:

HPI