AWS re:Invent

NOV. 29 – DEC. 3, 2021 | LAS VEGAS, NV

HLC301

Predicting patient outcome with AWS machine learning

Shuai Cao
Data Scientist
AWS

Kartik Kannapur
Data Scientist
AWS

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Agenda

Introductions: 5 minutes

Machine learning for patient outcome prediction (POP): 5 minutes

Amazon HealthLake service introduction and feature highlights: 10 minutes

Solution overview, architectures, demo, and Q&A: 40 minutes

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Introduction

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

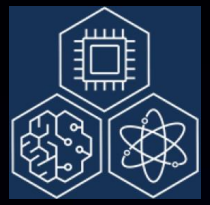
Speaker introductions



Shuai Cao
Data Scientist



Kartik Kannapur
Data Scientist



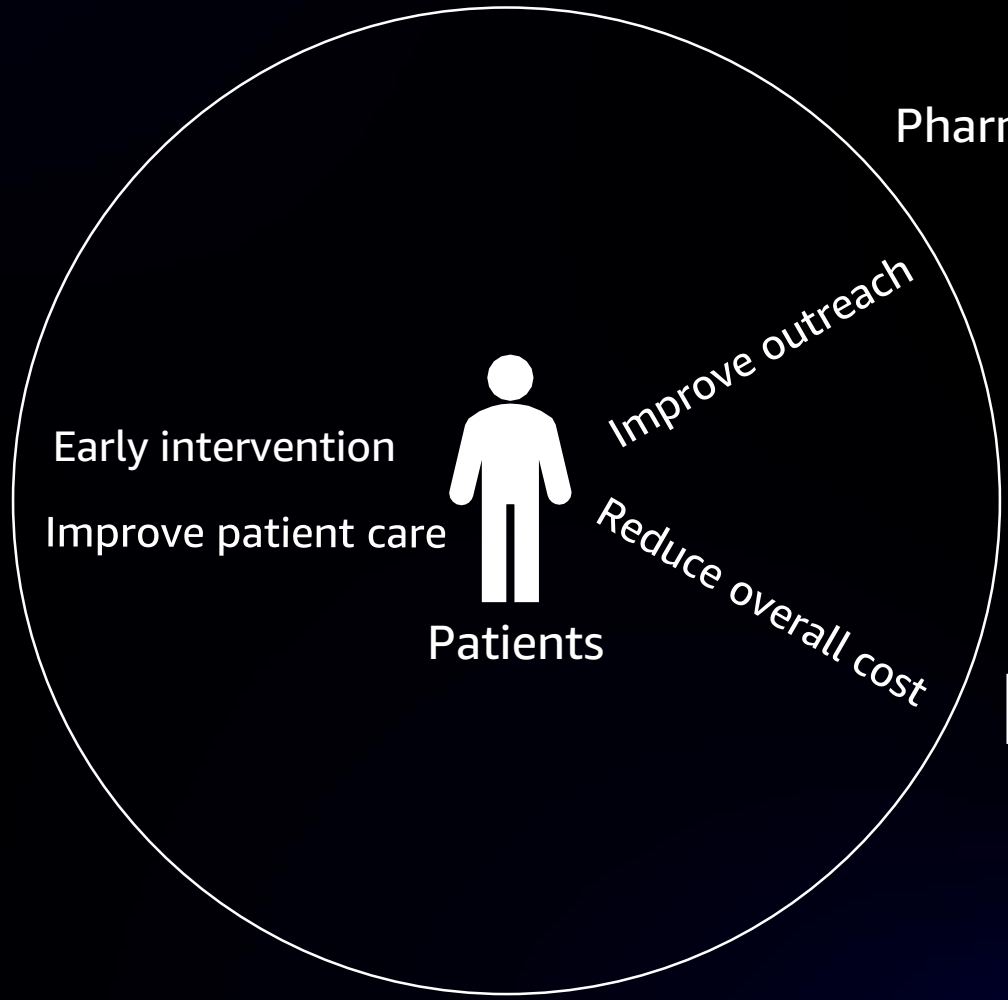
IACT
AWS Professional Services
Intelligent and Advanced
Computing Technologies

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

POP – Solution overview

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Healthcare challenges



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Application areas

Commercial outreach strategy

- Sales outreach prioritization
- New drug launch support

Chronic condition management

- Heart failure hospitalization/re-admission prediction
- Chronic kidney disease progression prediction

Acute condition management

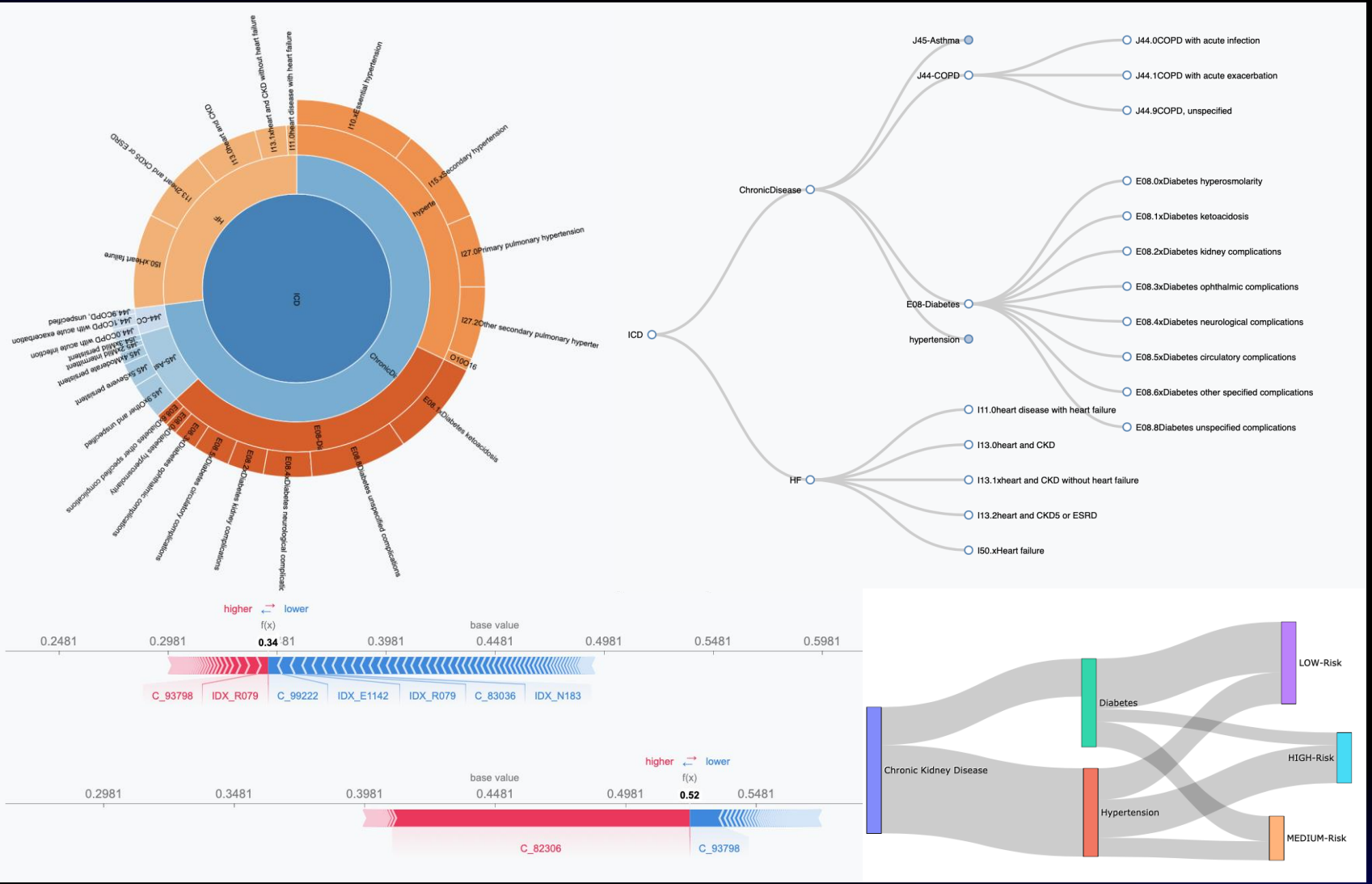
- Asthma/COPD exacerbation prediction
- ICU discharge 90-day mortality prediction



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How business users can leverage POP solution

ICD hierarchies & population size



Therapeutical hierarchies

Prediction drivers

Prediction risk L/M/H buckets

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

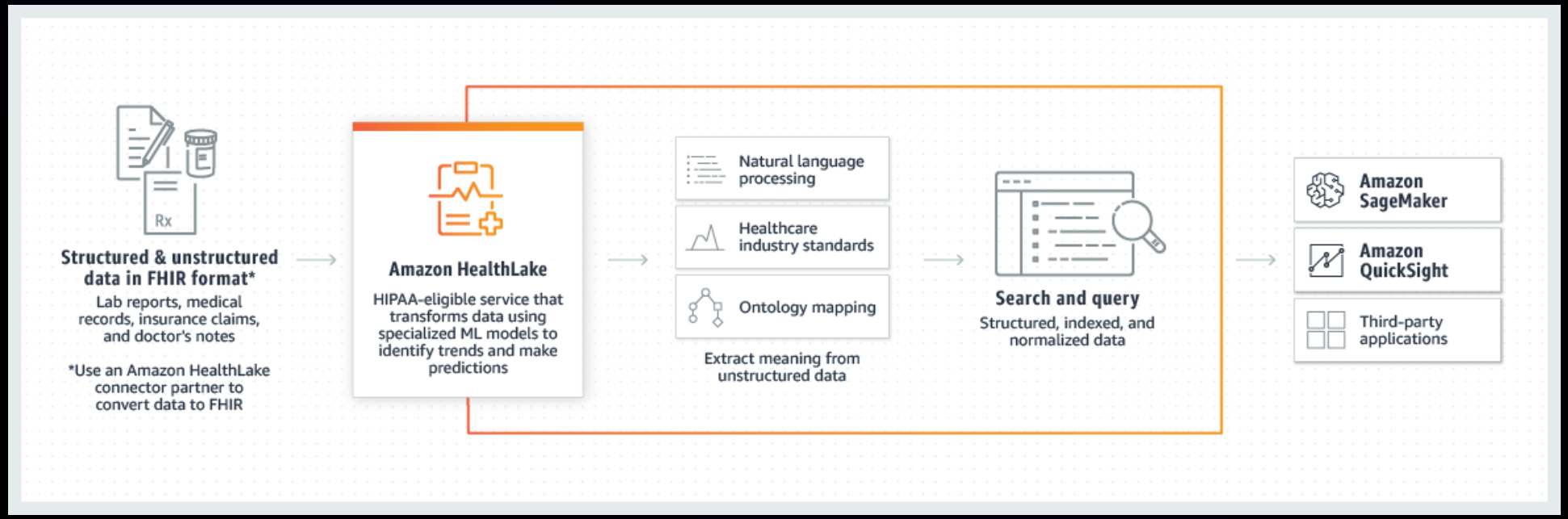
Technical challenges

- Leveraging structured/unstructured health data
- Data wrangling and feature engineering to get a complete view of patients' medical history
- Ontology mapping
- Fast and reliable modeling training
- Seamless model deployment process
- Intuitive interpretation of the prediction results
- Generate value and earn trust from the downstream users



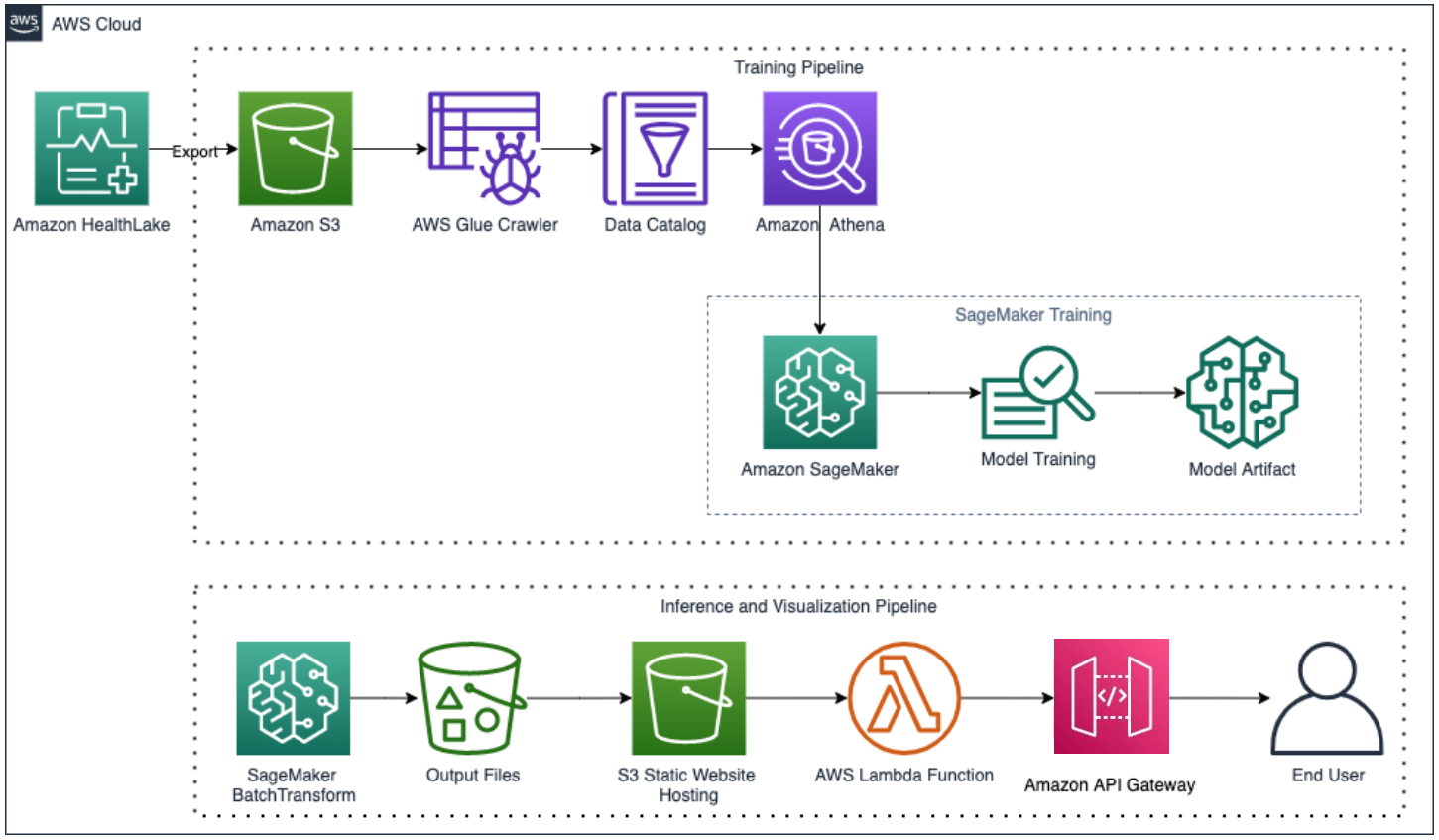
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

How AWS AI Services can help machine learning workflow



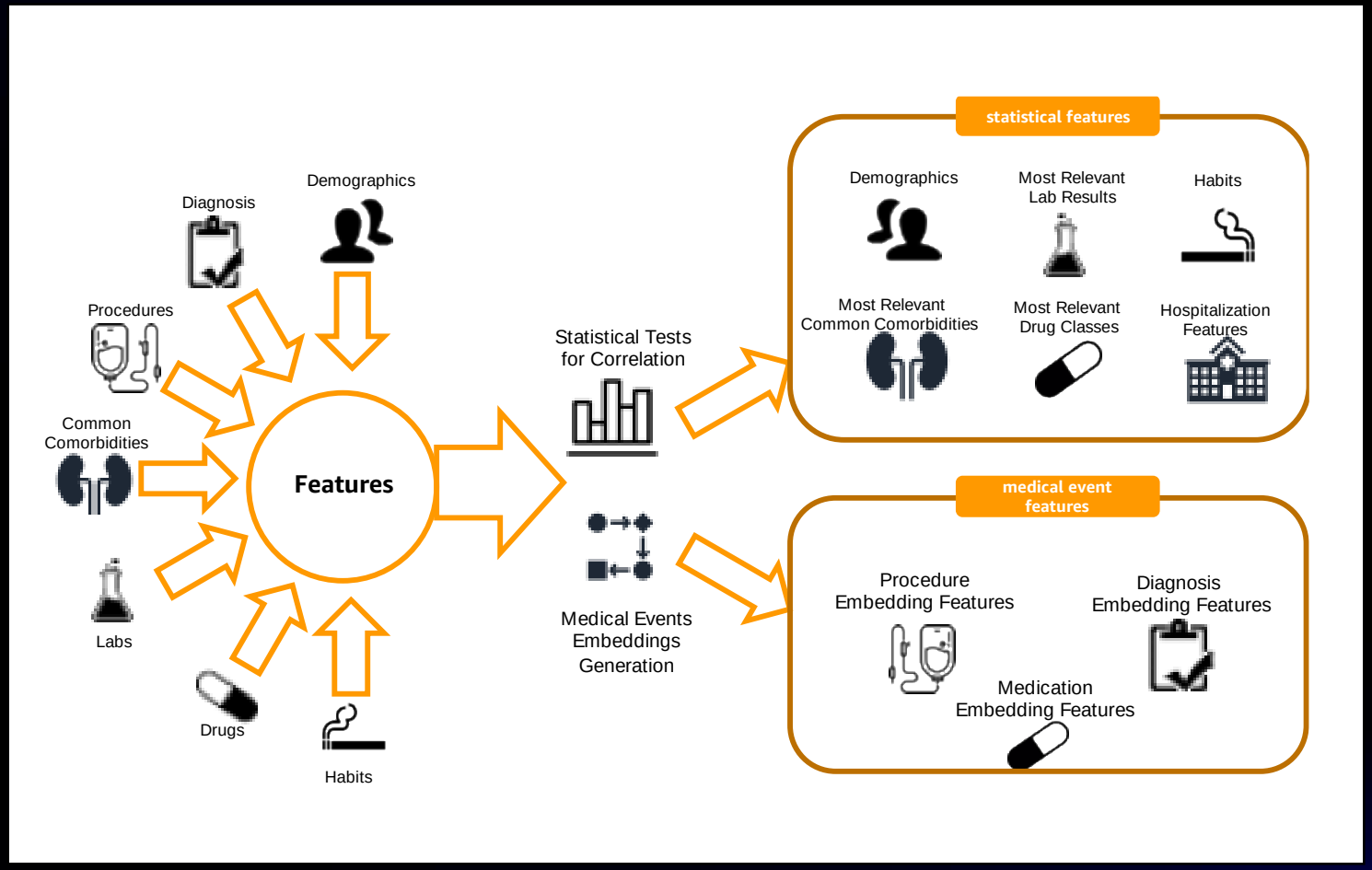
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Solution details: AWS architectural design



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Solution details: Zoom-in view of data processing



© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Whiteboard discussion – 1

DATA INGESTION AND EXPORT WITH HEALTHLAKE

1. Create HealthLake Data Store

```
aws healthlake create-fhir-datastore --region us-east-1 --datastore-type-version R4
--preload-data-config PreloadDataType="SYNTHEA" --datastore-name pop-synthea
```

2. (Optional) Run a sample query

```
GET /datastore/<your-data-store-id>/r4/Procedure?code=<code> HTTP/1.1
Host: healthlake.us-east-1.amazonaws.com
Content-Type: application/json
Authorization: AWS4-HMAC-SHA256 Credential=<your-credential>
```

3. Export the data store to an S3 bucket

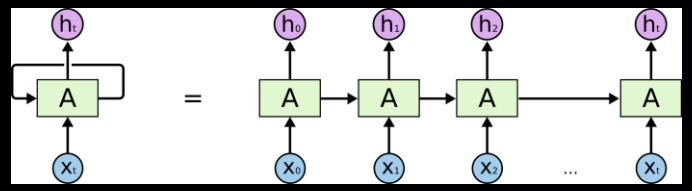
```
aws healthlake start-fhir-export-job \
    --output-data-config S3Uri="s3://<your-data-export-bucket-name>" \
    --datastore-id <your-data-store-id> \
    --data-access-role-arn arn:aws:iam::<your-account-id>:role/<your-role>
```

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

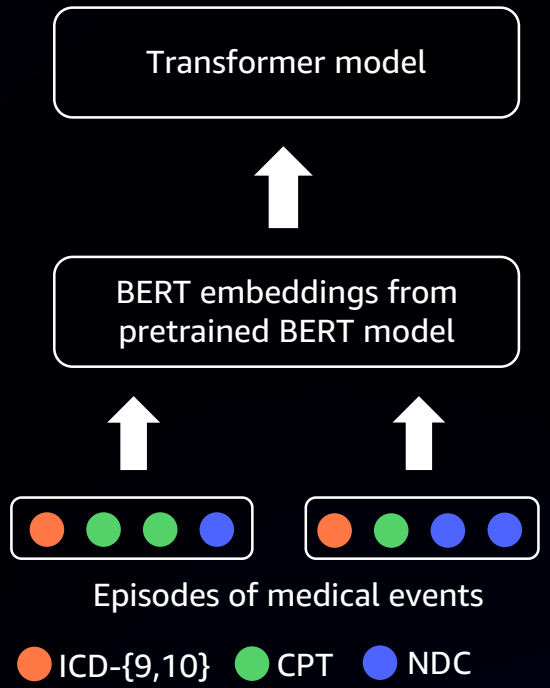
Whiteboard discussion – 2

PATIENT OUTCOME PREDICTION AND MODEL ARCHITECTURES

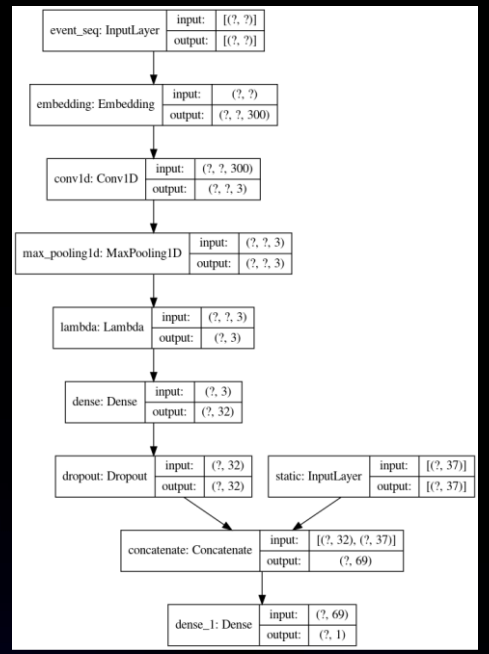
LSTM model



BERT model



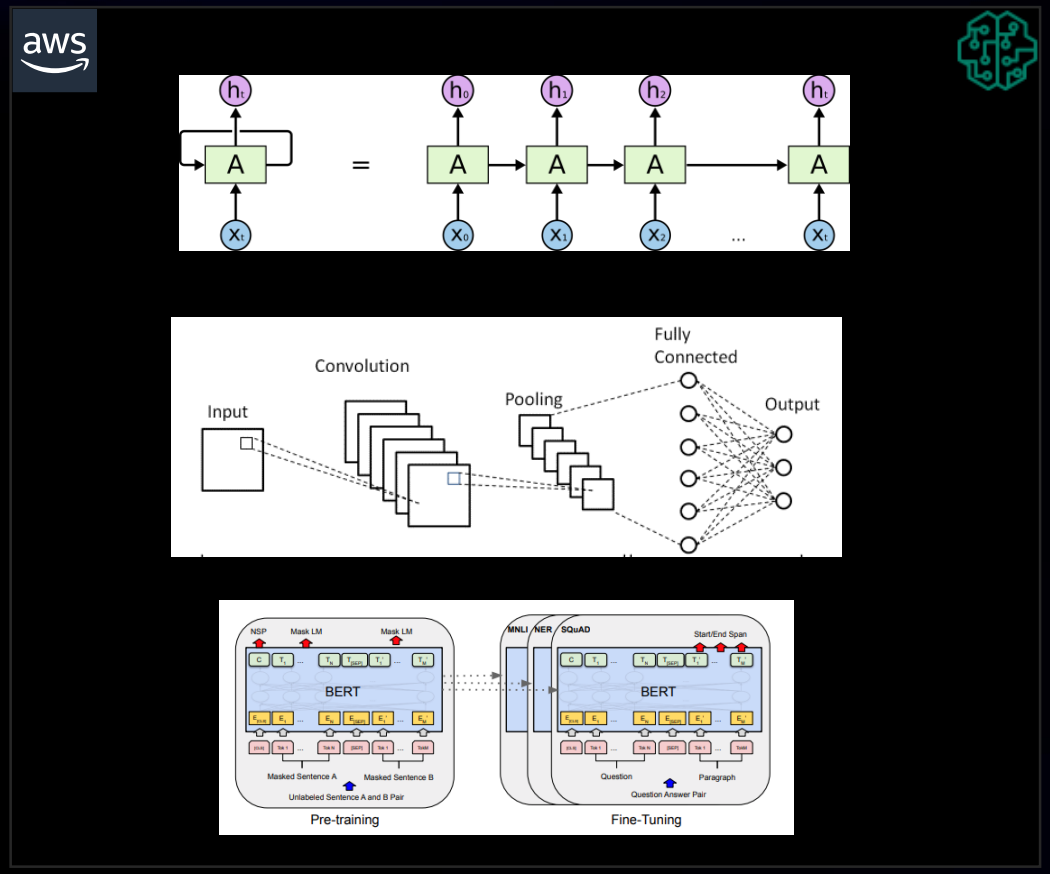
CNN model



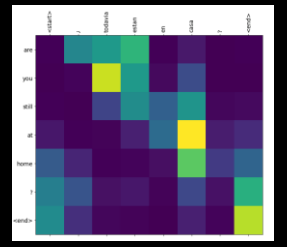
© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Whiteboard discussion – 3

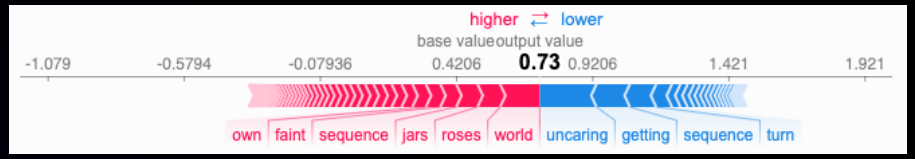
METHODS FOR MODEL EXPLAINABILITY IN DEEP LEARNING



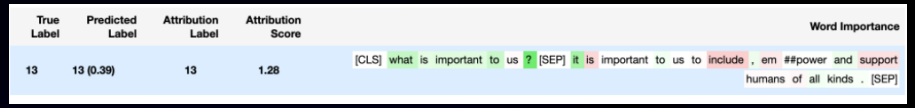
Attention weights



SHAP (SHapley Additive exPlanations)



Integrated gradients



True Label	Predicted Label	Attribution Label	Attribution Score	Word Importance
13	13 (0.39)	13	1.28	[CLS] what is important to us ? [SEP] it is important to us to include , em ##power and support humans of all kinds . [SEP]

- SHAP: https://github.com/slundberg/shap
- PyTorch Captum: https://captum.ai/

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Visit our other healthcare sessions

Breakout

HLC202: Anthem HealthOS platform: The future of health data interoperability

HLC210: Revolutionizing colorectal cancer with detection innovation at Medtronic

HLC308: Accelerate pediatric research with ML and healthcare interoperability

Chalk Talk

HLC303: A guide to expediting EHR migration

HLC305: Powering virtual patient care and communications with AWS

HLC306: Healthcare data center migration: Best practices and approaches

Workshop

HLC307: Using Fast Healthcare Interoperability Resources (FHIR) on AWS

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Healthcare & Life Sciences Lounge

Join us at our networking lounge every day for post-session speaker meet-and-greets, ask-the-experts, featured topic deep dives, and informal discussions

---



Wynn, Level 1

aws

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Additional resources

THESE ARE GENERAL PRESENTATION INDUSTRY RESOURCES AND ARE NOT ENDORSED BY AWS OR AMAZON

POP AWS blog post
Build patient outcome prediction applications using Amazon HealthLake and Amazon SageMaker
https://go.aws/3k6gmH5

Merck HF paper
Using deep learning to Identify high-risk patients with heart failure with reduced ejection fraction
https://bit.ly/3BQFUxY

POP GitHub repo
Code repo associated with POP blog post
https://bit.ly/3GWSBLo

AWS HealthLake
Securely store, transform, query, and analyze health data in minutes
https://aws.amazon.com/healthlake/

MIMIC data
Medical information mart for intensive care
https://mimic.mit.edu/

Synthea data
Synthetic patient generation
https://synthetichealth.github.io/synthea/

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.

Thank you!

Shuai Cao
shuaicao@amazon.com

Kartik Kannapur
kannapur@amazon.com

© 2021, Amazon Web Services, Inc. or its affiliates. All rights reserved.