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Learn How Artificial Intelligence Simplifies Care and Reduces Physician Workload

Next-Gen Physician Assistant

Deep Learning Reinvent Speech Translation: Patient Voice to Text to Insights

Deep Learning Applied in Electronic Medical Records

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Our Client

SIMS Hospital (SRM Institutes for Medical Science) is a healthcare facility. It offers radiology, physiotherapy, dietetics, health screening, and multi-organ transplant services. The company provides treatments in the areas of endocrinology, dermatology, infectious disease, ophthalmology, psychiatry, trauma and emergency, and other surgeries.

SIMS Hospital
No.1, Jawaharlal Nehru Rd,
Vadapalani, Chennai, India - 600026

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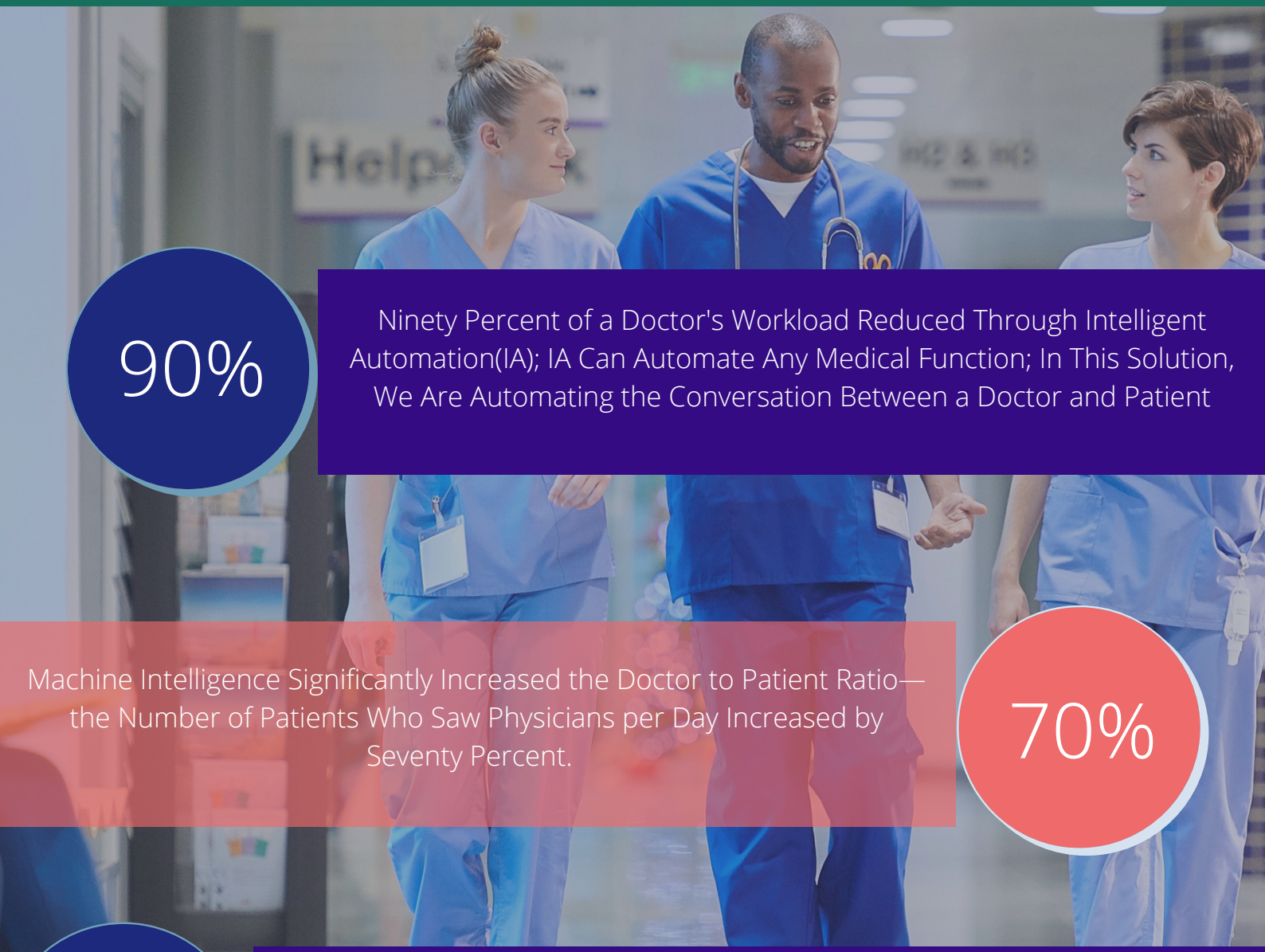
Measurable Values of Data Science and Intelligent Automation



90%

Ninety Percent of a Doctor's Workload Reduced Through Intelligent Automation(IA); IA Can Automate Any Medical Function; In This Solution, We Are Automating the Conversation Between a Doctor and Patient

Machine Intelligence Significantly Increased the Doctor to Patient Ratio—the Number of Patients Who Saw Physicians per Day Increased by Seventy Percent.

70%

360 View

Applying Data Science Techniques to the Patient Voice Can Extract Patient Sentiment, Symptoms, Warning, and Other Patient Clinical and Nonclinical Insights. These Insights Provide 360 Views on the Patient for Physicians to Analyze the Whole Person Care Delivery.

The Combination of Intelligent Automation and Data Science Significantly Increased the Overall Care Delivery Efficiency While Maintaining the Data Security and Compliance a Hundred Percent.

100%

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Our AI Research Team

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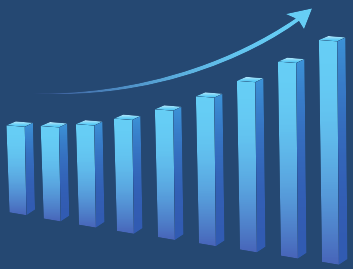
The Problem: Deep Learning Reinvents Medical Transcription

Patient Voice

Text

Insights



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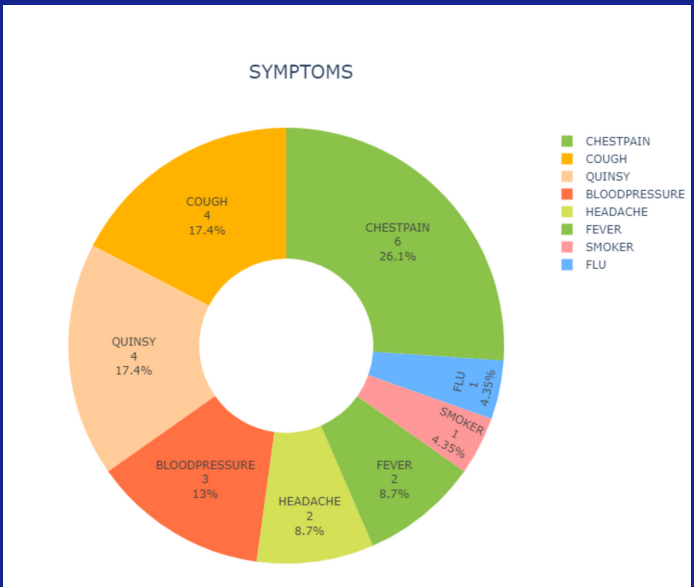
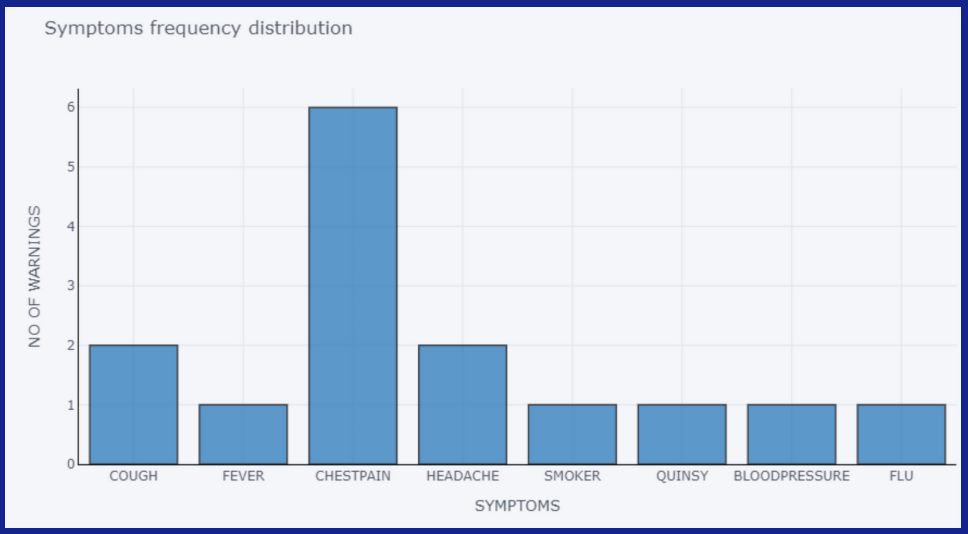
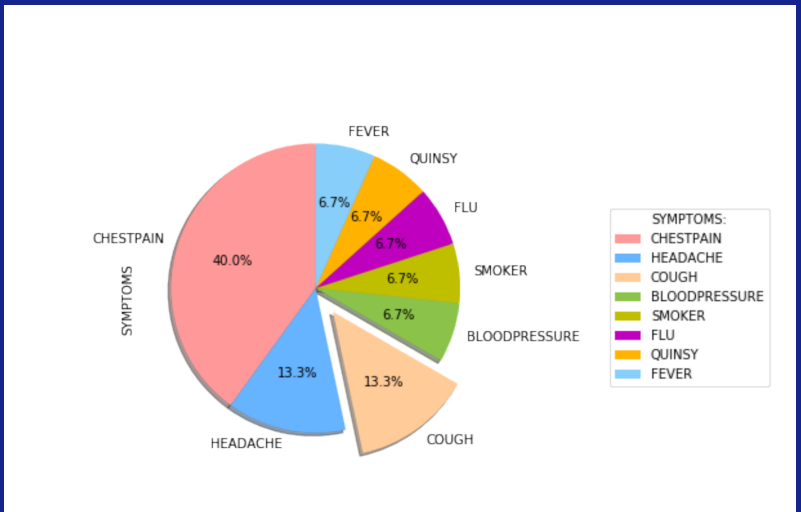
Patient Voice to Text to Insights



Most Spoken Words From the Conversation Between a Patient and Physician

Patient Symptoms and Warning Signs of Health Condition





Frequency of Patient Symptoms and Warning Signs of Health Condition

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Disclaimer

All software and hardware used or referenced in this guide belong to their respective vendor. We developed this guide based on our development infrastructure, and this guide may or may not work on other systems and technical infrastructure. We are not liable for any direct or indirect problems caused by users using this guide.

"THE BEGINNING OF HEALTH IS TO KNOW THE DISEASE"

Executive Summary

The purpose of this document is to provide adequate information to users to implement a deep learning model. To achieve this, we use one of the most common Medical-Healthcare Problems, which is Transcribing the conversation between a physician and a patient from voice to text and visualizing Symptoms using text analytics.

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Problem Statement

- Transcribing the conversation between a physician and a patient from a voice-based input into text - voice to text
- Extract the hidden insights on the text such as patient symptoms and warning signs of depression
- Perform in-depth analysis and research on the text and present the analysis outcome in the form of data visualization

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Business Context

Business Challenges

- Typically, it takes around thirty to ninety minutes to document the conversation between a patient and physician to meet compliance. Here are some of the most demanding business challenges and a need for an alternate solution - artificial intelligence
    - Inefficient manual work
    - Time-consuming human-oriented task
    - Lack of accuracy
    - Difficulties in adopting changes

Business Benefits

- Increased Productivity: The doctors should be able to consult and diagnose more patients in a given day and time. The solution reduces the time it takes to analyze and document a patient's mental and health condition.
- Increased Efficiency: No more time consuming manual task and a fully automated end to end digital health solution
- Increased Accuracy and Compliance
- Health Data Interoperability
- Immediate Change Adoption

Deep Learning Technologies in Scope

There are several deep learning technical and functional components involved in implementing this model. Here are the critical building blocks to implement the deep learning model.

Google Cloud Platform

Kubeflow

APACHE Spark

PySpark

Python

Pandas

Matplotlib

DeepSpeech

NLTK

Wave

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Deep Learning Model & Data Pipeline in Scope

Google Cloud Platform (GCP)

Model Pipeline

- GCP Bucket
- Jupyter Notebook
- Kubeflow
- Kubernetes
- Docker

- The Model and Data Pipeline Plays a Crucial Role in Deep Learning Implementation; Without Pipeline Components, It Would Be Impossible to Productionalize Any Model. We Are Using Several Key Technologies to Develop Model Pipeline and Data Pipeline; Here Are the Key Technologies That Someone Should Need to Understand to Develop the Data and Model Pipeline

Data Pipeline

- Pyspark
- HADOOP
- Big Data Technologies
- MySQL

Amazon Web Services(AWS)

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High Level Solution Flow

A deep learning model implementation to address a given problem involves several steps. Here are the key steps that are applied to implement a model. You can customize these steps as needed, and we developed these steps for learning purposes only.

1 PROBLEM STATEMENT

- Transcribing the conversation between a doctor and a patient from a voice to text
- To perform text analysis
- To visualize the analysis as statistics in the form of graphs and charts

2 MODEL SELECTION

- Voice to text – Deepspeech
- Language corpus- Language model
- Named entity recognition

3 VOICE DATA COLLECTION

- Conversation of a doctor and a patient in the form of audio data.

4 DATA PREPARATION

- Loading voice data
- Conversion of audio data to 16khz
- Extracting buffer rate and frame rate

5 DATA PREPROCESSING

- Audio processing- Fourier transform
- Audio feature extraction – MFCC

6 DEEPSPEECH TRAINING

- Fed through RNN and LSTM networks
- Calculation of CTC loss function
- Applying language model to generate accurate word sequences

7 TEXT DATA STORAGE

- Storing the output in a .txt file
- Transcription of audio data

8 TEXT PRE-PROCESSING

- Importing text file
- Tokenization
- Stop words removal

9 IDENTIFYING MEASURES

- Importing symptoms data file
- Matching symptoms from both text file
- List the matched symptoms form existing text file.
- Represent the occurrence of each word

10 ADVANCE ANALYTICS

- Visualize those word using pandas data frame

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Deep Learning Model Implementation Code Block

1. Deep Learning Architecture & Working With Configuration File
2. Working With Deep Learning & Text Analysis Libraries
3. Working With Deepspeech Model & Converting Voice to Text
4. Working With Text Classification and Text Analysis
5. Insights and Data Visualization

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Step 1: Deep Learning Architecture & Working With Configuration File

- We developed a separate guide to understanding deep learning architecture better; please refer to our in-depth learning architectural guide to implement any deep learning model such as CNN, ANN, RNN, and others.

- The configuration file controls the deep learning model run time components such as data preprocessing, training, testing, and deploying the model. The configuration file format varies by the operating system, such as windows, Unix, and Linux.

medical Transcript

```
1   import configparser
2   import os
3   vAR_read_config = configparser.ConfigParser(allow_no_value=True)
4   vAR_INI_FILE_PATH = os.environ.get('MEDICAL_TRANSCRIPT_INI_FILE_PATH')
5   vAR_read_config.read(vAR_INI_FILE_PATH)
6   vAR_Model_Path = vAR_read_config['PATH']['MODEL_FILE_PATH']
7   vAR_LM_Path = vAR_read_config['PATH']['LM_FILE_PATH']
8   vAR_Symptom_Path = vAR_read_config['PATH']['SYMPTOMS_PATH']
9   vAR_Text_Path = vAR_read_config['PATH']['TEXT_FILE']
10
```

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Step 2: Importing Required Libraries

NLTK

NLTK is a string processing library that takes strings as input. The output is in the form of either a string or lists of strings. This library provides a lot of algorithms that helps majorly in the learning purpose. One can compare among different variants of outputs.

Deepspeech

DeepSpeech is an open source embedded speech-to-text engine. using a model trained by machine learning techniques based on Baidu's Deep Speech research paper.

NumPy

NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays.

Configparser

The configparser module from Python's standard library defines functionality for reading and writing configuration files as used by Microsoft Windows OS. Such files usually have .INI extension.

Wave

The wave module provides a convenient interface to the WAV sound format. It does not support compression/decompression, but it does support mono/stereo.

Pandas

pandas is a software library written for the Python programming language for data manipulation and analysis. In particular, it offers data structures and operations for manipulating numerical tables and time series.

Plotly

Plotly's Python graphing library makes interactive, publication-quality graphs. Examples of how to make line plots, scatter plots, area charts, bar charts, error bars, box plots, histograms, heatmaps, subplots, multiple-axes, polar charts, and bubble charts.

Cufflinks

Cufflinks is another library that connects the Pandas data frame with Plotly enabling users to create visualizations directly from Pandas. The library binds the power of Plotly with the flexibility of Pandas for easy plotting.

Matplotlib

Matplotlib is a plotting library for the Python programming language and its numerical mathematics extension NumPy. matplotlib.pyplot is a collection of functions that make matplotlib work like MATLAB. Each pyplot function makes some change to a figure.

```
11
12  import nltk
13  import configparser
14  import matplotlib.pyplot as plt
15  from pandas import DataFrame
16  from nltk.tokenize import sent_tokenize
17  from nltk.tokenize import word_tokenize
18  from nltk.probability import FreqDist
19  from nltk.corpus import stopwords
20  from nltk.stem import PorterStemmer
21  from nltk.tokenize import sent_tokenize, word_tokenize
22  import cufflinks as cf
23  import plotly.offline
24  import pandas as pd
25  import numpy as np
26  from deepspeech import Model
27  import numpy as np
28  import wave
```

Step 3: Working With Deepspeech Model & Converting Voice to Text

Deep Speech Network Architecture

- **The network consists of five layers**
- **3 Feedforward layers - The first three layers are not recurrent**
- **1 bi-direction recurrent layer**
- **1 softmax layer**
- **FC layers use Relu activation function**
- **The RNN type is a LSTM cells with tenh activations.**

End to end steps followed while implementation

- **STEP 1 : Getting the input as audio data**
- **STEP 2 : Implementation of deep speech model**
- **Conversion of audio data(FT)**
- **Feature extraction(MFCC)**
- **Passing through the neural network (RNN + LSTM)**
- **Implementation of language model**
- **STEP 3: Storing the output in a text file**

```
def main():
    Voice_to_text()
    Text_Classification_and_Visualization()

def Voice_to_text():
    vAR_beam_width=1000
    vAR_lm_alpha=0.93
    vAR_lm_beta=1.18

    model=Model(vAR_Model_Path)
    model.enableExternalScorer(vAR_LM_Path)

    model.setScorerAlphaBeta(vAR_lm_alpha,vAR_lm_beta)
    model.setBeamWidth(vAR_beam_width)

# Conversion of audio data to 16khz
    !ffmpeg -i hospital.wav -vn -ar 16000 -ac 1 hospital1.wav

    def read_wav_file(filename):
        with wave.open(filename, 'rb') as vAR_temp:
            frames=vAR_temp.getnframes()
            buffer=vAR_temp.readframes(frames)
        return buffer, rate

    def transcribe(file):
        buffer,rate=read_wav_file(file)
        data16=np.frombuffer(buffer,dtype=np.int16)
        return model.stt(data16)

# Storing the output in a .txt file
    f= open(vAR_Text_Path,"w+")

    f.write(transcribe('hospital1.wav'))
    f.close()
    def Text_Classification_and_Visualization():
    with open(vAR_Text_Path,'r') as file:
        read_file = file.read()

```

Step 4: Working With Text Classification and Text Analysis

Text files are actually a series of words (ordered). To run machine learning algorithms, we need to convert the text files into numerical feature vectors. We will be using the bag of words model for our example. Briefly, we segment each text file into words (for English splitting by space), and count # of times each word occurs in each document, and finally assign each word an integer id. Each unique word in our dictionary will correspond to a feature (descriptive feature).

Removing stop words: (the, then...etc) from the data. You should do this only when stop words are not useful for the underlying problem. In most of the text classification problems, this is indeed not useful. Let's see if removing stop words increases accuracy.
In our code, Following are the steps of Text Classification:-

```
69
70
71      # Text analytics (summarized content)
72          tokenized_text=sent_tokenize(read_file)
73          tokenized_word=word_tokenize(read_file)
74
75          fdist = FreqDist(tokenized_word)
76      # removing all the stop words
77          vAR_stop_words=set(stopwords.words("english"))
78          filtered_sent=[]
79          for vAR_iter in tokenized_word:
80              if vAR_iter not in vAR_stop_words:
81                  filtered_sent.append(vAR_iter)
82          with open(vAR_Symptom_Path, "r") as vAR:
83              lines = vAR.readlines()
84          Outputlist = []
85      # matched symptoms from filtered tokenized words from text file
86          for vAR_val in filtered_sent:
87              with open(vAR_Symptom_Path,"r") as vAR:
88                  lines = vAR.readlines()
89              for line in lines:
90                  vAR_out = line.strip()
91                  if vAR_val == vAR_out:
92                      Outputlist.append(vAR_val)
93
```

- Importing text file
- Tokenization of Words
- Stop words removal
- Importing symptoms data file
- Matching symptoms from both texta file
- List the matched symptoms from an existing text file.
- Represent the occurrence of each word

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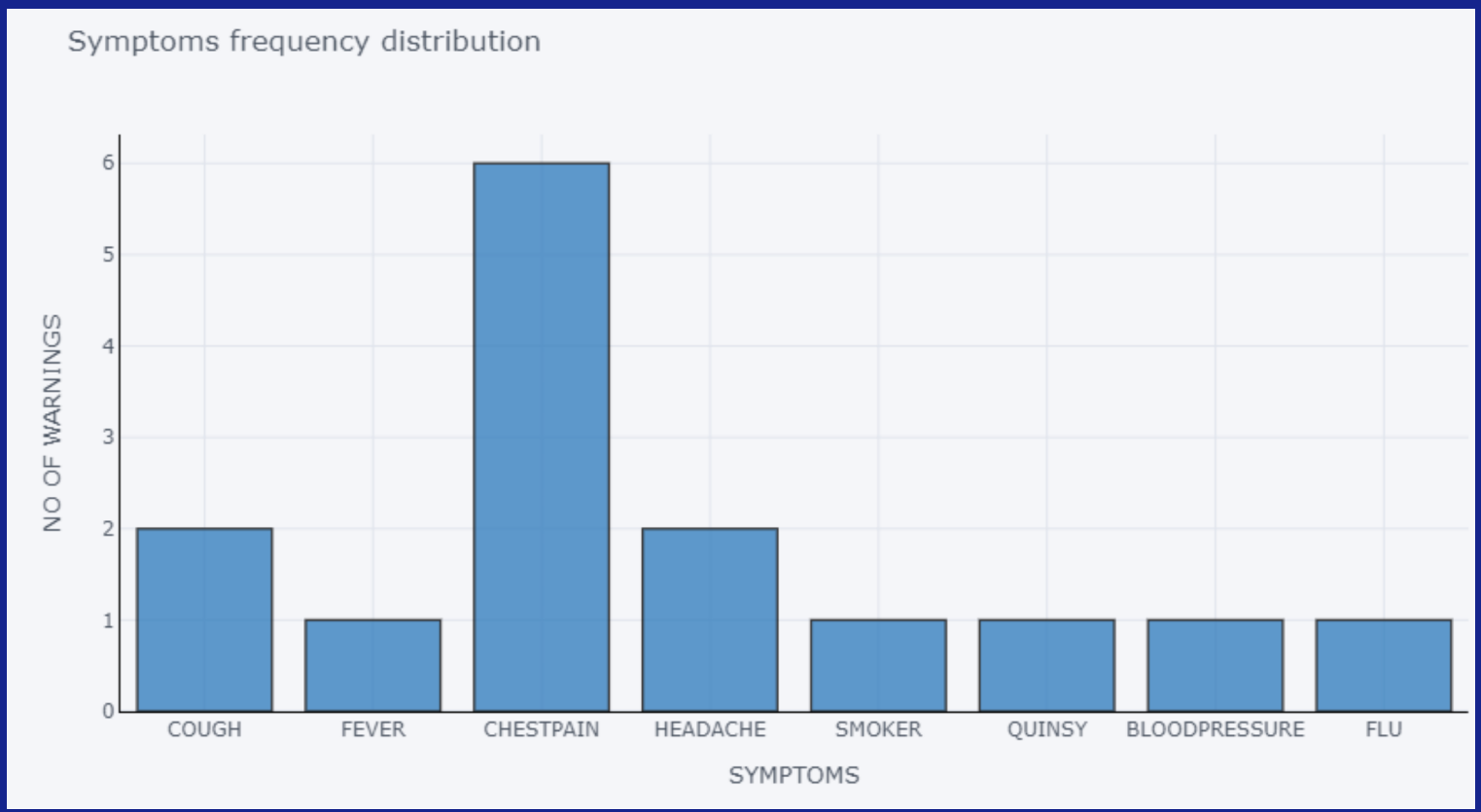
Step 5: Insights and Data Visualization

Cleaned and processed text data is rich and contains lots of insights. But for data scientists, text data is a bit more challenging to use to represent insights in charts and graphs because it's not numerical. Text visualization requires different skills, mainly, efficiently using screen real estate to visualize relationships between phenomena and highlight the main message. This may involve leaving some data out to allow the main insight or objective to be achieved.

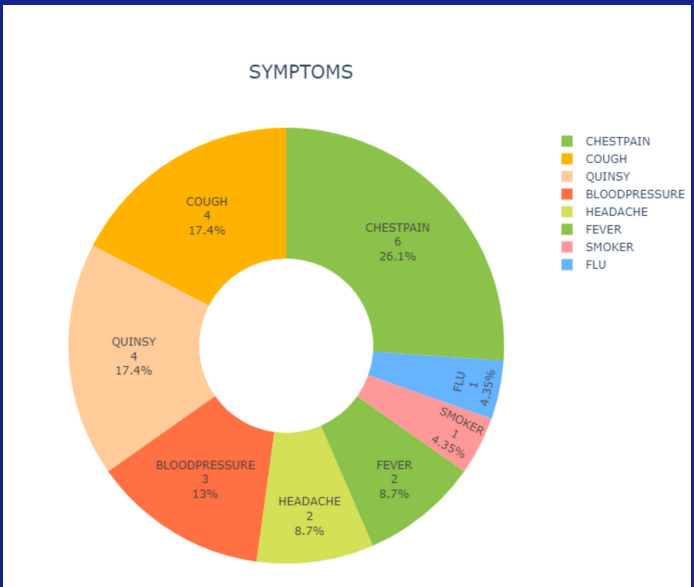
```
93
94      # Plotting a Line Chart
95          plt.plot(Outputlist)
96          plt.ylabel('Symptoms')
97          plt.xlabel('numbers')
98          plt.show()
99          symptoms = list(set(Outputlist))
100         print(symptoms)
101         vAR_df = DataFrame (Outputlist,columns=['Symptoms'])
102         vAR_table=vAR_df['Symptoms'].value_counts()
103
104     # visualization using Pie chart
105         vAR_table.plot.pie(y=vAR_df.index,shadow=False, explode=None,
106          startangle=90, autopct='%1.1f%%')
107         plt.axis('equal')
108         plt.tight_layout()
109         plt.show()
110         cf.go_offline()
111         cf.set_config_file(offline=False, world_readable=True)
112     # visualization using cufflinks and plotly libraries
113         vAR_df.iplot(kind='hist',bins=50,xTitle='symptoms',
114         linecolor='black',yTitle='frequency',
115         title='Symptoms frequency distribution')
116
117     if __name__ == "__main__":
118         main()
```

Voice to Text

at the hospital Patient and doctor mister white , the doctor is waiting for you. thank you. hello mr white. what have you come in for today? hello doctor.i m feeling ill, i have got quite a bad cough, but i dont seem to have a fever. i see . how long have you had these symptoms? just for a couple of days . first , i didn't take it seriously. but yesterday my situation got worse. i started to feel chestpain . are you having any other problems except coughing and chestpain? i feel myself very tired . and also i have terrible headache. do you smoke ? yes , i do. come in. sorry for interupting doctor. but , we really need you in the operation room. it is an emergency. doctor foster will examine your patient.mr white, as you have heard i need to attend the operation. my collegue will examine you right now. could you please sit on the examination table? hello , i am doctor paul foster. i will examine you . nurse, what are the symptoms? mister white suffers from coughing, chestpain and headache. the symptoms started a couple of days ago . and yesterday he felt worse. he is a smoker and he is 28 years old. please open your mouth mr white. he has quinsy . could you roll up your sleeve? i'd like to take your bloodpressure . 120 over 80. that's fine. please cough. mr white we need your chest x-ray. ok doctor . come in please .come in please. hello again mr white. here is my x-ray doctor.let me see. mr white, you suffer from flu . it may be because of the seasonal change. i am going to give you a prescription for some medicine. you should take 3 times a day after meals. also i am giving you vitamin pills to strengthen your immune system. moreover, you should stay at home and have a rest for 3 days. i strongly recomend you to give up smoking. thank you doctor. thank you for watching.

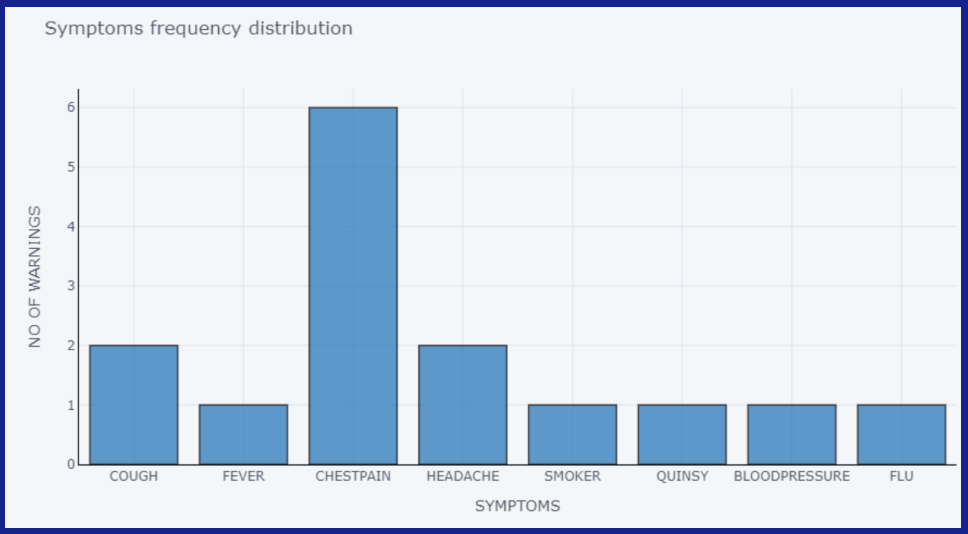


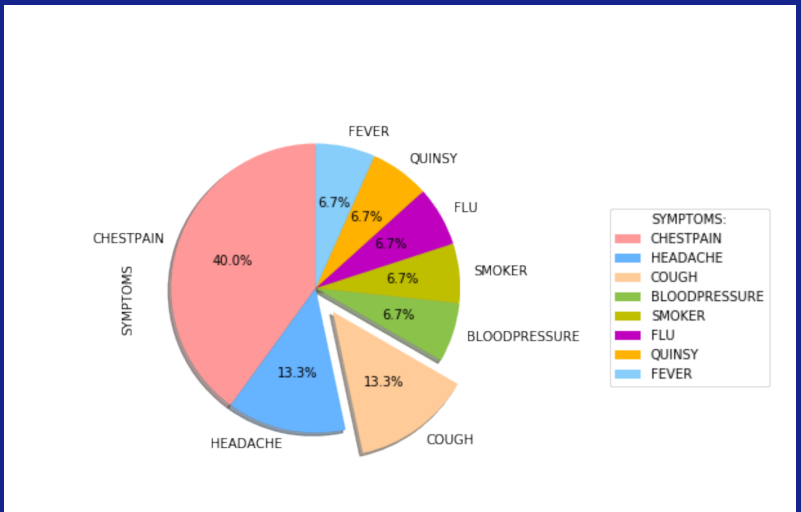
Patient Voice to Text to Insights



Most Spoken Words From the Conversation Between a Patient and Physician

Patient Symptoms and Warning Signs of Health Condition





Frequency of Patient Symptoms and Warning Signs of Health Condition

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Who We Are

The DeepSphere.AI team comprises MIT learning facilitators, University of California instructors, Harvard PhDs, Stanford alumni, industry leaders, and proven entrepreneurs. The group collectively brings business and technology together for in-depth, hands-on AI learning and a risk-free implementation and AI adoption.

Our Team

Massachusetts Institute of Technology

Stanford University

"Jothi...I am honored to learn from your comments and messages in the MIT Sloan&CSAIL course. I am deeply and impressed inspired by your ideas which make a great impact on my learning path... "
SinTing (Adele) Lui
MIT CSAIL AI Student

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Next Steps

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