

A Weekly Update on

DiabetIQ: An Intelligent Diabetes Management Application with LLM-Augmented Chatbot and ML-Based Early Risk Prediction

16 April, 2025

Group Information

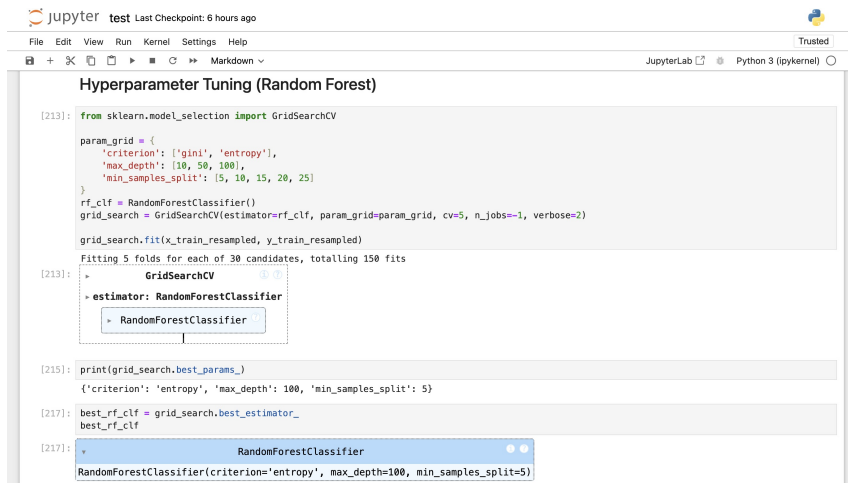
Group-01 CSE299 (Section-17)

1. Saif Mohammed - 2121913042
2. Nazibul Islam Nabil - 2222456642
3. Humayra Rahman Nipa - 2121128042
4. Umme Suraia Haque Setu - 2031278642

Weekly Update Brief

- ▶ **Backend Implementation:** Implemented Backend with Flask (Python Framework) MVVM architecture.
- ▶ **ML Model Train:** Applied Machine Learning Algorithms: Logistic Regression, SVM, Decision Tree, Random Forest, KNN with Hyperparameter Tuning (Grid Search Cross Validation).
- ▶ **LLM RAG Chatbot:** Processed BADAS Guideline 2019 PDF, implemented document chunking, embeddings, and retrieval for Q&A conversation.
- ▶ **Summary Documentation:** Completed a summary documentation on *Attention in Transformers: Concepts and Code in PyTorch*

Machine Learning (Model Train)



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Trusted

JupyterLab Python 3 (ipykernel)

Hyperparameter Tuning (Random Forest)

```
[213]: from sklearn.model_selection import GridSearchCV

param_grid = {
    'criterion': ['gini', 'entropy'],
    'max_depth': [10, 50, 100],
    'min_samples_split': [5, 10, 15, 20, 25]
}

rf_clf = RandomForestClassifier()
grid_search = GridSearchCV(estimator=rf_clf, param_grid=param_grid, cv=5, n_jobs=-1, verbose=2)

grid_search.fit(x_train_resampled, y_train_resampled)

Fitting 5 folds for each of 30 candidates, totalling 150 fits

[213]: > GridSearchCV
> estimator: RandomForestClassifier
> RandomForestClassifier

[215]: print(grid_search.best_params_)

{'criterion': 'entropy', 'max_depth': 100, 'min_samples_split': 5}

[217]: best_rf_clf = grid_search.best_estimator_
best_rf_clf

[217]: RandomForestClassifier
RandomForestClassifier(criterion='entropy', max_depth=100, min_samples_split=5)
```

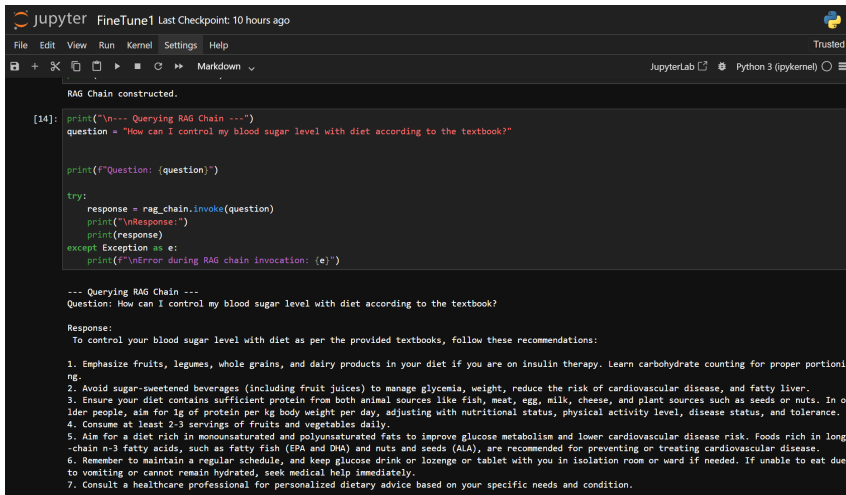
Figure: Hyperparameter Tuning (Random Forest)

Performance Metrics of ML Algorithms for Early Diabetic Prediction

Serial	Classifier	Precision	Recall	F1-Score	Accuracy	AUC
1	XGBoost	0.93	0.94	0.93	94%	0.64
2	Random Forest	0.94	0.93	0.94	93%	0.68
3	Gradient Boosting	0.94	0.92	0.93	92%	0.73
4	SVM	0.94	0.90	0.92	90%	0.78
5	Adaboost	0.94	0.88	0.91	88%	0.74
6	Naive Bayes	0.95	0.88	0.90	88%	0.81
7	Decision Tree	0.93	0.88	0.90	88%	0.71
8	Logistic Regression	0.95	0.87	0.90	87%	0.80
9	KNN	0.94	0.84	0.88	84%	0.73

Table: Sorted Performance Metrics of ML Algorithms for Early Diabetic Prediction

Fine Tune LLM RAG Q&A Chatbot



```
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JupyterLab Python 3 (pykernel)
```

```
RAG Chain constructed.

[14]: print("\n--- Querying RAG Chain ---")
question = "How can I control my blood sugar level with diet according to the textbook?"

print(f"Question: {question}")

try:
    response = rag_chain.invoke(question)
    print("\nResponse:")
    print(response)
except Exception as e:
    print(f"\nError during RAG chain invocation: {e}")

--- Querying RAG Chain ---
Question: How can I control my blood sugar level with diet according to the textbook?

Response:
To control your blood sugar level with diet as per the provided textbooks, follow these recommendations:

1. Emphasize fruits, legumes, whole grains, and dairy products in your diet if you are on insulin therapy. Learn carbohydrate counting for proper portioning.
2. Avoid sugar-sweetened beverages (including fruit juices) to manage glycemia, weight, reduce the risk of cardiovascular disease, and fatty liver.
3. Ensure your diet contains sufficient protein from both animal sources like fish, meat, egg, milk, cheese, and plant sources such as seeds or nuts. In older people, aim for 1g of protein per kg body weight per day, adjusting with nutritional status, physical activity level, disease status, and tolerance.
4. Consume at least 2-3 servings of fruits and vegetables daily.
5. Aim for a diet rich in monounsaturated and polyunsaturated fats to improve glucose metabolism and lower cardiovascular disease risk. Foods rich in long-chain n-3 fatty acids, such as fatty fish (EPA and DHA) and nuts and seeds (ALA), are recommended for preventing or treating cardiovascular disease.
6. Remember to maintain a regular schedule, and keep glucose drink or lozenge or tablet with you in isolation room or ward if needed. If unable to eat due to vomiting or cannot remain hydrated, seek medical help immediately.
7. Consult a healthcare professional for personalized dietary advice based on your specific needs and condition.
```

Figure: Fine Tune Chatbot

Backend Implementation: MVVM Architecture

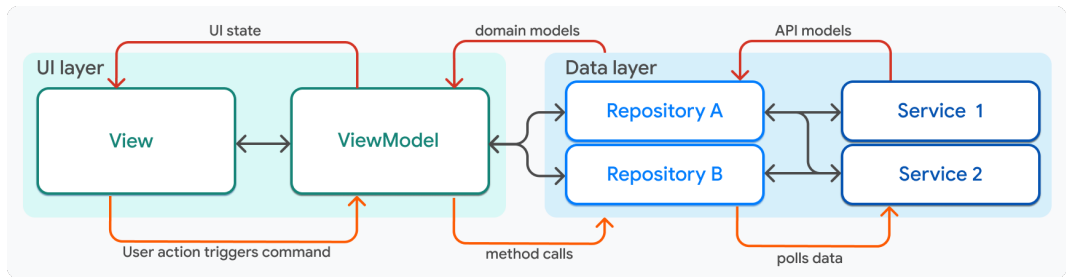


Figure: MVVM Architecture

Summary Documentation

Name: Humayra Rahman Nipa ;

Id : 2121128042

Understanding Retrieval-Augmented Generation

1. Introduction

Retrieval-Augmented Generation (RAG) is an advanced technique in the field of artificial intelligence (AI) that enhances the ability of language models to provide accurate and contextually relevant responses. RAG integrates external sources of knowledge by combining two key components:

Retrieval: The process of identifying and extracting relevant information from a large collection of documents.

Generation: Generation is the process of transforming retrieved information into fluent, and contextually appropriate responses, enhancing AI with real-time or external data.

2. How does RAG Work?

The RAG architecture operates through a two-stage pipeline, effectively merging retrieval and generation mechanisms:

Figure: Summary Documentation on RAG

Achievements

- ▶ Applied Machine Learning Algorithms for machine machine learning algorithms
- ▶ Fine-tuned basic retrieval and generation from the textbook.
- ▶ Implemented backend using MVVM Architecture (Flask)
- ▶ Summarized documentation on RAG.

Technology Stack

- ▶ **Programming Language:** Python
- ▶ **Framework:** LangChain
- ▶ **Libraries:** NumPy, Pandas, Matplotlib, Seaborn, Scikit-learn
- ▶ **Embedding Model:** HuggingFaceEmbeddings: *intfloat/e5-small-v2*
- ▶ **Vector Database:** chromadb
- ▶ **LLM:** Ollama LLM: *mistral*
- ▶ **Document Processing:** PyPDF

Work Distribution (This Week)

- ▶ **Saif Mohammed - 2121913042**

- ▶ ML Algorithms Application
- ▶ ML Algorithms Evaluation

- ▶ **Nazibul Islam Nabil - 2222456642**

- ▶ LLM Q&A Chatbot Prototype





- ▶ **Humayra Rahman Nipa - 2121128042**

- ▶ Summary Documentation on Transformers

- ▶ **Umme Suraia Haque Setu - 2031278642**

- ▶ Summary Documentation on Transformers

References

-  A. Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems*, 3rd ed. Sebastopol, CA, USA: O'Reilly Media, 2023.
-  LangChain Engineer, “LLM Part: Learn RAG From Scratch – Python AI Tutorial,” YouTube. [Online]. Available: <https://www.youtube.com/>. [Accessed: Feb. 19, 2025].
-  P. Lewis, E. Denoyer, and S. Riedel, “Retrieval-Augmented Generation for Knowledge-Intensive NLP Tasks,” *arXiv preprint arXiv:2005.11401*, May 2020. [Online]. Available: <https://arxiv.org/abs/2005.11401>.
-  DeepLearning.AI, *Attention in Transformers: Concepts and Code in PyTorch*. [Online]. Available: <https://www.deeplearning.ai/short-courses/attention-in-transformers-concepts-and-code-in-pytorch/>. [Accessed: Mar. 11, 2025.]