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SPRING AI

GENERATIVE ARTIFICIAL INTELLIGENCE CON JAVA

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RETRIEVAL AUGMENTED GENERATION

PARTE 1 - APPROCCIO TEXT TO VECTOR STORE

➔ Chatbot Ollama-CV e Gemini-Venis

⚠ Approccio *naive* (informazione testuale estratta tramite GENAI-assisted web scraping/summarization)

- 1 Iscrizione al portale HuggingFace e creazione access token
- 2 Verifica e modifica variabili di ambiente
- 3 Creazione configurazione ambiente Docker Qdrant
- 4 Modifica dipendenze di progetto
- 5 Modifica configurazione e profilo applicativo
- 6 Creazione *prompt templates* per strategia RAG
- 7 Configurazione vector store per Ollama e Gemini embeddings
- 8 Creazione component per popolamento vector store (dati Venis e CV)
- 9 Creazione interfaccia e implementazione del servizio
- 10 Modifica controllore MVC
- 11 Test delle funzionalità con Postman/Insomnia

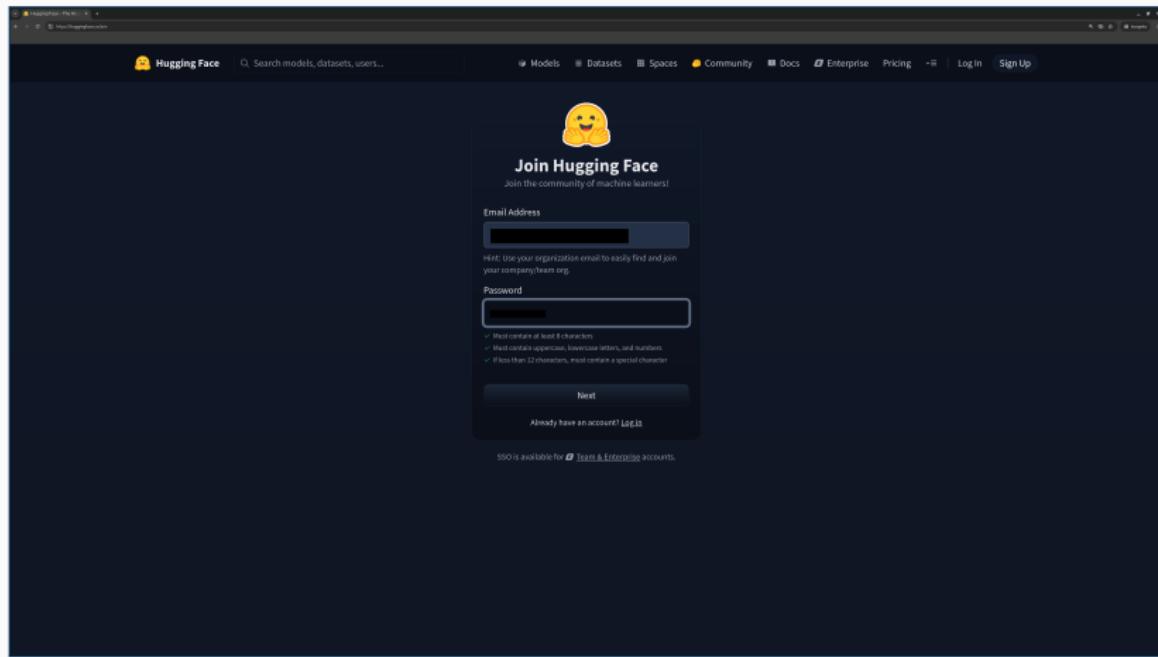
AMBIENTE DI SVILUPPO

CREAZIONE ACCOUNT HUGGINGFACE

- 1 Accedere al portale <https://huggingface.co/> e cliccare il pulsante Sign up

The screenshot shows the Hugging Face homepage. At the top right, there is a red-bordered "Sign Up" button. The main content area features a large emoji of a smiling face with hands raised. Below it, the text "The AI community building the future." is displayed. A sidebar on the left lists various AI categories such as NLP, Computer Vision, and Audio. The right side shows a list of trending models, including "meta-llama/Llama-2-7B" and "stabilityai/stable-diffusion-xl-base-0.9". At the bottom, there is a "Trending on 🤖 this week" section.

2 Creare una nuova utenza



AMBIENTE DI SVILUPPO

CREAZIONE ACCOUNT HUGGINGFACE

3 Accedere al portale e selezionare Access Tokens nel menu in alto a destra

The screenshot shows the Hugging Face platform interface. On the left, there's a sidebar with options like 'Profile', 'Inbox (0)', 'Settings', 'Billing', and 'Get PRO'. Below that are sections for 'Organizations' and 'Resources'. The main area shows a 'Following' list with items from 'essential' (They might open source something soon), 'yogito' (Pioneering in AI video generation technology), and 'Qwen' (Developing advanced large language and vision models). On the right, there's a sidebar with trending projects like 'deepseek-x1/10e', 'MinIMaxAI/MinI', and 'tencent/HunyuB'. At the very bottom, there's a preview of a project called 'Wav2.24B Fast' which generates a video from an image with a text prompt. The top right corner features a user profile for 'Simone.Scannapieco' and a navigation bar with links for 'Models', 'Datasets', 'Spaces', 'Community', 'Docs', 'Enterprise', and 'Pricing'. A prominent blue button labeled 'Follow' is visible next to the user profile. The 'Access Tokens' option is highlighted with a red box in the top right corner of the page content area.

AMBIENTE DI SVILUPPO

CREAZIONE ACCOUNT HUGGINGFACE

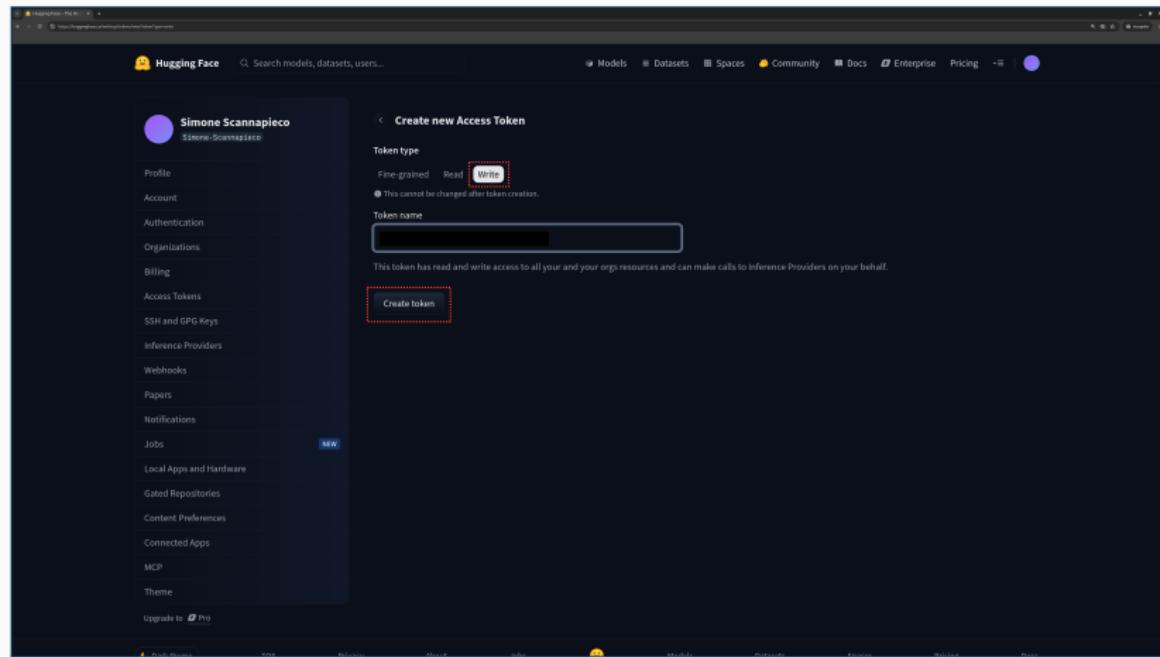
- 4 Premere sul pulsante Create new token

The screenshot shows the Hugging Face Hub interface. On the left, there's a sidebar with various account management options like Profile, Account, Authentication, Organizations, Billing, and several token-related sections: Access Tokens, SSH and GPG Keys, Inference Providers, Webhooks, Papers, Notifications, Jobs, Local Apps and Hardware, Gated Repositories, Content Preferences, Connected Apps, MCP, and Theme. A prominent 'Upgrade to Pro' button is at the bottom of this sidebar. The main content area is titled 'Access Tokens' and contains a sub-section 'User Access Tokens'. It features a table with columns: Name, Value, Last Refreshed Date, Last Used Date, and Permissions. The table currently has four rows, each with a 'Value' column containing a placeholder '00000000-0000-0000-0000-000000000000' and a 'Permissions' column showing 'WRITE' with a dropdown arrow. A red dashed box highlights the 'Create new token' button located at the top right of the table area. At the very bottom of the page, there's a footer bar with links for Help, Support, API, and more.

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CREAZIONE ACCOUNT HUGGINGFACE

- 5 Selezionare token di tipo Write, denominare il token e premere Create token



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CREAZIONE ACCOUNT HUGGINGFACE

6 Cercare il modello di *embedding*, leggendone la card

The screenshot shows the Hugging Face platform interface. At the top, there is a search bar with the placeholder "Simone Scannapieco". Below the search bar, a dropdown menu shows "Models" selected, with the search result "Simone-Scannapieco/sentence-bert-base-italian-v2" listed. To the right of the search results, there are tabs for "Models", "Datasets", "Spaces", "Community", "Docs", "Enterprise", "Pricing", "Log In", and "Sign Up".

The main content area displays a list of models. One model is highlighted: "meta-llama/Llama-2-7B" by "T0 Generation". Other visible models include "stable-diffusion/stable-diffusion-xl-base-0.9", "openchat/openchat", "llyasviel/Gretelinet-v1.1", "carlsberg/zenzoonic_v2_2L", "meta-llama/Llama-2-13b", "t1ll1er/T0plus-4B-15Text", "MiroslavM/VisatCoke-15B-V2.0", "CompVis/latent-diffusion-v1-4", "stabilityai/stable-diffusion-2-inference", and "Salesforce/qwen-7b-disk-instruct".

A large central banner features the text "The AI community building the future." with a smiling emoji above it. Below the banner, there are buttons for "Explore AI Apps" and "Browse 1M+ models".

At the bottom of the page, there is a "Trending on 🤖 this week" section.

AMBIENTE DI SVILUPPO

CREAZIONE ACCOUNT HUGGINGFACE

6 Cercare il modello di *embedding*, leggendone la card

The screenshot shows the Hugging Face Model Card interface for the model `sentence-bert-base-italian-xxl-uncased-F32-GGUF`. The card includes the following details:

- Model Card**: Shows the model's name, last updated (16 days ago), and its use of the GGUF binary format.
- Hardware compatibility**: Supports 32-bit hardware.
- Inference Providers**: Lists supported providers like Sentence Similarity.
- Base model**: The model is based on the `sickipedia/sentence-bert-base-italian-xxl-uncased` model.
- Dataset used to train**: The dataset used for training is `PhilipMay/stsb_wmt11_it`.

File launch.json

```
{  
    // Use IntelliSense to learn about possible attributes.  
    // Hover to view descriptions of existing attributes.  
    // For more information, visit: https://go.microsoft.com/fwlink/?linkid=830387  
    "version": "0.2.0",  
    "configurations": [  
        {  
            "type": "java",  
            "name": "Launch Current File",  
            "request": "launch",  
            "mainClass": "${file}"  
        },  
        {  
            "type": "java",  
            "name": "DemoApplication",  
            "request": "launch",  
            "mainClass": "it.venis.ai.spring.demo.DemoApplication",  
            "projectName": "demo",  
            "env": {  
                "GOOGLE_AI_API_KEY": "...",  
                "HUGGING_FACE_HUB_TOKEN": "..."  
            }  
        }  

```

File settings.json

```
{  
    "java.compile.nullAnalysis.mode": "disabled",  
    "java.configuration.updateBuildConfiguration": "interactive",  
    "java.test.config": {  
        "env": {  
            "GOOGLE_AI_API_KEY": "...",  
            "HUGGING_FACE_HUB_TOKEN": "..."  
        }  
    }  
}
```

File docker-compose.yml

```
services:  
  ...  
  spring-ai-vector-store:  
    image: qdrant/qdrant:${QDRANT_VERSION:-latest}  
    hostname: spring-ai-vector-store  
    container_name: spring_ai_vector_store  
    ports:  
      - ${QDRANT_HTTP_PORT:-6333}:6333  
      - ${QDRANT_GRPC_PORT:-6334}:6334  
    volumes:  
      - spring_ai_vector_store:/qdrant/storage  
    restart: unless-stopped  
  
volumes:  
  ...  
  spring_ai_vector_store:  
    name: spring_ai_vector_store
```

File spring-ai.env

```
...  
# qdrant configuration  
QDRANT_VERSION=v1.13.0  
QDRANT_HTTP_PORT=6333  
QDRANT_GRPC_PORT=6334  
  
# default: latest  
# default: 6333  
# default: 6334
```

Dipendenze di sistema aggiuntive

```
...
<dependency>
    <groupId>org.springframework.ai</groupId>
    <artifactId>spring-ai-rag</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.ai</groupId>
    <artifactId>spring-ai-advisors-vector-store</artifactId>
</dependency>
<dependency>
    <groupId>org.springframework.ai</groupId>
    <artifactId>spring-ai-starter-vector-store-qdrant</artifactId>
</dependency>
...
...
```

Configurazione applicativo

```
spring:
  ...
  profiles:
    active: rag-text-to-vector-store
  autoconfigure:
    exclude:
      - org.springframework.ai.vectorstore.qdrant.autoconfigure.QdrantVectorStoreAutoConfiguration
      # We must disable Vector Store auto-configuration because of two different EmbeddingModel beans
      # (OpenAI-Gemini and Ollama). The goal is to have two different vector collections, one for each
      # family of LLM.
  ai:
    ollama:
      ...
      embedding:
        model: hf.co/Simone-Scannapieco/sentence-bert-base-italian-xxl-uncased-F32-GGUF
    openai:
      ...
      embedding:
        options:
          model: gemini-embedding-001
  vectorstore:
    qdrant:
      initialize-schema: true
      host: 172.17.0.1
      port: 6334
  ...
```

File application-rag-text-to-vector-store.yml

```
demo:  
  rag:  
    prompt:  
      system:  
        ita: classpath:templates/get-rag-data-system-ita-prompt.st  
        eng: classpath:templates/get-rag-data-system-eng-prompt.st  
    user:  
      ita:  
      eng:  
vectorstore:  
  qdrant:  
    collection-name:  
      ollama: vector_store_ttvs_ollama  
      gemini: vector_store_ttvs_gemini
```

File erase_llm_volumes.sh

```
#!/bin/bash

volume_name=spring_ai_llm

docker volume rm $volume_name
```

File erase_vector_store_volumes.sh

```
#!/bin/bash

volume_name=spring_ai_vector_store

docker volume rm $volume_name
```

File templates/get-rag-data-system-ita-prompt.st

Sei un assistente AI in grado di rispondere alle domande dell'utente solo in base al contesto fornito dalla sezione DOCUMENTI.

Se la risposta non è presente nella sezione DOCUMENTI, informa l'utente di non sapere la risposta.

DOCUMENTI: <documenti>

File templates/get-rag-data-system-eng-prompt.st

You are an helpful assistant, answering questions based on the given context in the DOCUMENTS section and no prior knowledge.

If the answer is not in the DOCUMENTS section, then reply that you cannot answer to the question.

DOCUMENTS: <documenti>

Configurazione Vector Store - I

```
package it.venis.ai.spring.demo.config;

...

@Configuration
public class RAGConfig {

    @Value("${spring.ai.vectorstore.qdrant.host:localhost}")
    private String qdrantHost;
    @Value("${spring.ai.vectorstore.qdrant.port:6334}")
    private Integer qdrantPort;
    @Value("${spring.ai.vectorstore.qdrant.use-tls:false}")
    private Boolean useTls;

    @Bean
    public QdrantClient qdrantClient() {
        QdrantGrpcClient.Builder grpcClientBuilder = QdrantGrpcClient.newBuilder(
            qdrantHost, qdrantPort, useTls);
        return new QdrantClient(grpcClientBuilder.build());
    }

    @Value("${demo.rag.vectorstore.qdrant.collection-name.gemini:vector_store_gemini}")
    private String qdrantCollectionNameGemini;
    @Value("${demo.rag.vectorstore.qdrant.collection-name.ollama:vector_store_ollama}")
    private String qdrantCollectionNameOllama;
    @Value("${spring.ai.vectorstore.qdrant.initialize-schema:false}")
    private Boolean qdrantInitializeSchema;

    ...
}
```

Configurazione Vector Store - II

```
...
@Bean
public VectorStore geminiVectorStore(QdrantClient qdrantClient, OpenAiEmbeddingModel geminiEmbeddingModel) {
    return QdrantVectorStore.builder(qdrantClient, geminiEmbeddingModel)
        .collectionName(qdrantCollectionNameGemini)
        .initializeSchema(qdrantInitializeSchema)
        .build();
}

@Bean
public VectorStore ollamaVectorStore(QdrantClient qdrantClient, OllamaEmbeddingModel ollamaEmbeddingModel) {
    return QdrantVectorStore.builder(qdrantClient, ollamaEmbeddingModel)
        .collectionName(qdrantCollectionNameOllama)
        .initializeSchema(qdrantInitializeSchema)
        .build();
}
```

Componente popolamento Qdrant - I

```
package it.venis.ai.spring.demo.rag;

...
@Component
@Profile("rag-text-to-vector-store")
public class TextDataLoader {

    private final VectorStore geminiVectorStore;
    private final VectorStore ollamaVectorStore;

    public TextDataLoader(@Qualifier("geminiVectorStore") VectorStore geminiVectorStore,
        @Qualifier("ollamaVectorStore") VectorStore ollamaVectorStore) {
        this.geminiVectorStore = geminiVectorStore;
        this.ollamaVectorStore = ollamaVectorStore;
    }

    @PostConstruct
    public void loadVenisInfoIntoVectorStore() {
        List<String> venisInfo = List.of(...);
        SearchRequest searchRequest = SearchRequest.builder()
            .query("Check")
            .similarityThresholdAll()
            .build();
        List<Document> similarDocs = geminiVectorStore.similaritySearch(searchRequest);
        if (similarDocs.size() == 0) {
            List<Document> documents =
                venisInfo.stream().map(Document::new).collect(Collectors.toList());
            this.geminiVectorStore.add(documents);
        }
    }
}
```

Componente popolamento Qdrant - II

```
...
@PostConstruct
public void loadSSCVInfoIntoVectorStore() {
    List<String> ssCVInfo = List.of(...);
    SearchRequest searchRequest = SearchRequest.builder()
        .query("Check")
        .similarityThresholdAll()
        .build();
    List<Document> similarDocs = ollamaVectorStore.similaritySearch(searchRequest);
    if (similarDocs.size() == 0) {
        List<Document> documents = ssCVInfo.stream().map(Document::new).collect(Collectors.toList());
        this.ollamaVectorStore.add(documents);
    }
}
```

Interfaccia servizio

```
package it.venis.ai.spring.demo.services;

import it.venis.ai.spring.demo.model.Answer;
import it.venis.ai.spring.demo.model.QuestionRequest;

public interface RAGService {

    public Answer getGeminiRAGAnswer(QuestionRequest request);

    public Answer getOllamaRAGAnswer(QuestionRequest request);

}
```

Implementazione servizio - I

```
package it.venis.ai.spring.demo.services;  
  
...  
  
@Service  
@Configuration  
public class RAGServiceImpl implements RAGService {  
  
    private final ChatClient geminiChatClient;  
    private final ChatClient ollamaChatClient;  
    private final ChatClient ollamaMemoryChatClient;  
    private VectorStore geminiVectorStore;  
    private VectorStore ollamaVectorStore;  
  
    public RAGServiceImpl(  
        @Qualifier("geminiChatClient") ChatClient geminiChatClient,  
        @Qualifier("ollamaChatClient") ChatClient ollamaChatClient,  
        @Qualifier("ollamaMemoryChatClient") ChatClient ollamaMemoryChatClient,  
        @Qualifier("geminiVectorStore") VectorStore geminiVectorStore,  
        @Qualifier("ollamaVectorStore") VectorStore ollamaVectorStore) {  
  
        this.geminiChatClient = geminiChatClient;  
        this.ollamaChatClient = ollamaChatClient;  
        this.ollamaMemoryChatClient = ollamaMemoryChatClient;  
        this.geminiVectorStore = geminiVectorStore;  
        this.ollamaVectorStore = ollamaVectorStore;  
  
    }  
  
    ...
```

Implementazione servizio - II

```
...
@Value("${demo.rag.prompt.system.eng}")
private Resource ragDataSystemEngPrompt;

@Override
public Answer getGeminiRAGAnswer(QuestionRequest request) {

    SearchRequest searchRequest = SearchRequest.builder()
        .query(request.body().question())
        .topK(4)
        .similarityThreshold(.2)
        .build();

    List<Document> similarDocs = geminiVectorStore.similaritySearch(searchRequest);

    String similarDocsString = similarDocs.stream()
        .map(Document::getText)
        .collect(Collectors.joining(System.lineSeparator()));

    return new Answer(this.geminiChatClient.prompt()
        // .advisors(advisorSpec -> advisorSpec.param(ChatMemory.CONVERSATION_ID,
        // // request.username()))
        .system(s -> s.text(this.ragDataSystemEngPrompt)
            .params(Map.of("documenti", similarDocsString)))
        .user(request.body().question())
        .templateRenderer(StTemplateRenderer.builder().startDelimiterToken('<')
            .endDelimiterToken('>')
            .build())
        .call()
        .content());
}

...

```

Implementazione servizio - III

```
...
@Value("${demo.rag.prompt.system.ita}")
private Resource ragDataSystemItaPrompt;

@Override
public Answer getOllamaRAGAnswer(QuestionRequest request) {

    SearchRequest searchRequest = SearchRequest.builder()
        .query(request.body().question())
        .topK(4)
        .similarityThreshold(.3)
        .build();

    List<Document> similarDocs = ollamaVectorStore.similaritySearch(searchRequest);

    String similarDocsString = similarDocs.stream()
        .map(Document::getText)
        .collect(Collectors.joining(System.lineSeparator()));

    return new Answer(this.ollamaMemoryChatClient.prompt()
        .advisors(advisorSpec -> advisorSpec.param(ChatMemory.CONVERSATION_ID, request.username()))
        .system(s -> s.text(this.ragDataSystemItaPrompt)
            .params(Map.of("documenti", similarDocsString)))
        .user(request.body().question())
        .templateRenderer(StTemplateRenderer.builder().startDelimiterToken('<')
            .endDelimiterToken('>')
            .build())
        .call()
        .content());
}

}
```

Implementazione controllore REST

```
package it.venis.ai.spring.demo.controllers;  
  
...  
  
@RestController  
public class QuestionController {  
  
    private final QuestionService service;  
    private final RAGService ragService;  
  
    public QuestionController(QuestionService service, RAGService ragService) {  
        this.service = service;  
        this.ragService = ragService;  
    }  
  
    ...  
  
    @PostMapping("/gemini/ask/rag")  
    public Answer getGeminiRAGAnswer(@RequestBody QuestionRequest request) {  
        return this.ragService.getGeminiRAGAnswer(request);  
    }  
  
    @PostMapping("/ollama/ask/rag")  
    public Answer getOllamaRAGAnswer(@RequestBody QuestionRequest request) {  
        return this.ragService.getOllamaRAGAnswer(request);  
    }  
}
```

⚠ Verificare la dashboard Qdrant (<http://172.17.0.1:6333/dashboard>)

The screenshot shows the Qdrant dashboard interface. On the left, there is a sidebar with various icons: a magnifying glass, a camera, a document, a lightbulb, and a link. The main area is titled "Collections". It features a search bar labeled "Search Collection". Below the search bar is a table with the following columns: Name, Status, Points (Approx), Segments, Shards, Vectors Configuration (Name, Size, Distance), and Actions. Two collections are listed:

Name	Status	Points (Approx)	Segments	Shards	Vectors Configuration (Name, Size, Distance)	Actions
vector_store_ttv_gemini	green	18	8	1	default 3072 Cosine	⋮
vector_store_ttv_ollama	green	17	8	1	default 768 Cosine	⋮

At the bottom left of the dashboard, it says "v1.13.0".



<https://github.com/simonescannapieco/spring-ai-advanced-dgroove-venis-code.git>

Branch: 7-spring-ai-gemini-ollama-rag-text-to-vector-store