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SPRING AI

GENERATIVE ARTIFICIAL INTELLIGENCE CON JAVA

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Corso avanzato per Venis S.p.A, Venezia, Italia

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RETRIEVAL AUGMENTED GENERATION

PARTE 1

➔ 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

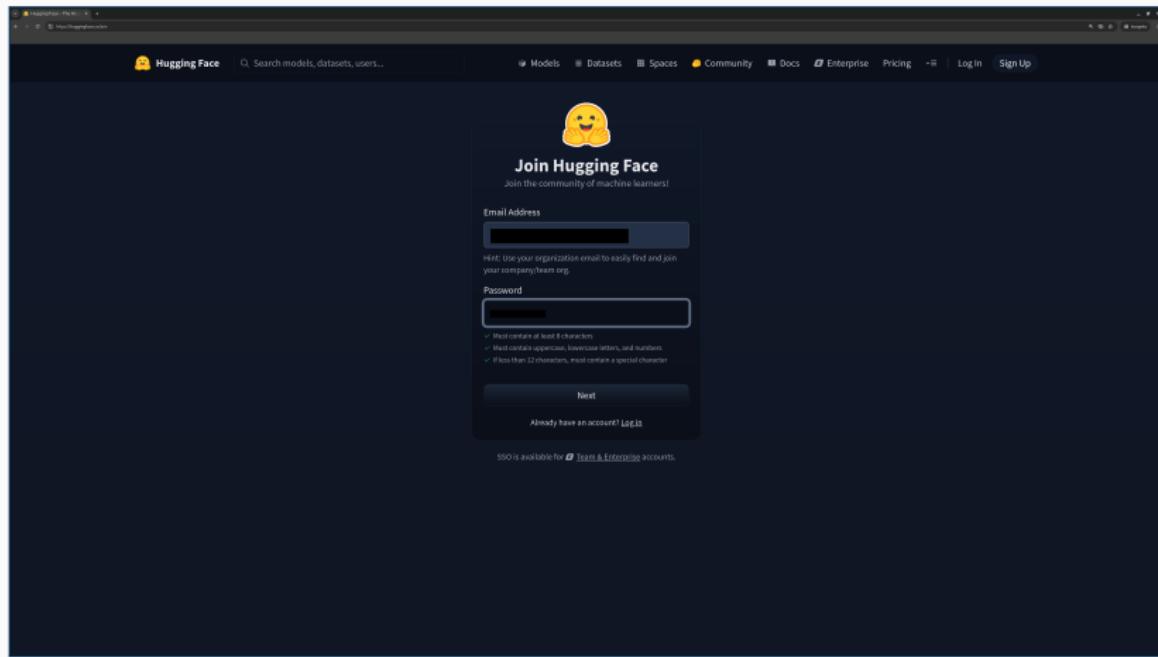
AMBIENTE DI SVILUPPO

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-2-70B" 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 portal interface. On the left, there's a sidebar with options like 'Profile', 'Inbox (0)', 'Settings', 'Billing', 'Create New', 'Getting Started', 'Documentation', 'Forum', 'Tasks', 'Learn', and a 'Dark theme' toggle. The main area has tabs for 'Models', 'Datasets', 'Spaces', 'Papers', 'Collections', 'Community', 'Posts', 'Updates', 'Libes', and 'Articles'. Below these tabs, there's a 'Following' section with a count of 0, and a list of profiles: 'essential' (They might open source something soon), 'yogito' (Pioneering in AI video generation technology), and 'Qwen' (Developing advanced large language and vision models). To the right, there's a 'Profile' section for 'Simone.Scannapieco' and a 'Trending' section with various AI projects. A prominent purple box highlights the 'Access Tokens' option under the 'Settings' menu in the top right corner. At the bottom, there are sections for 'DeepSeek OCR Demo', 'DeepStyle v3', and 'Wav2.2 Animato'.

AMBIENTE DI SVILUPPO

CREAZIONE ACCOUNT HUGGINGFACE

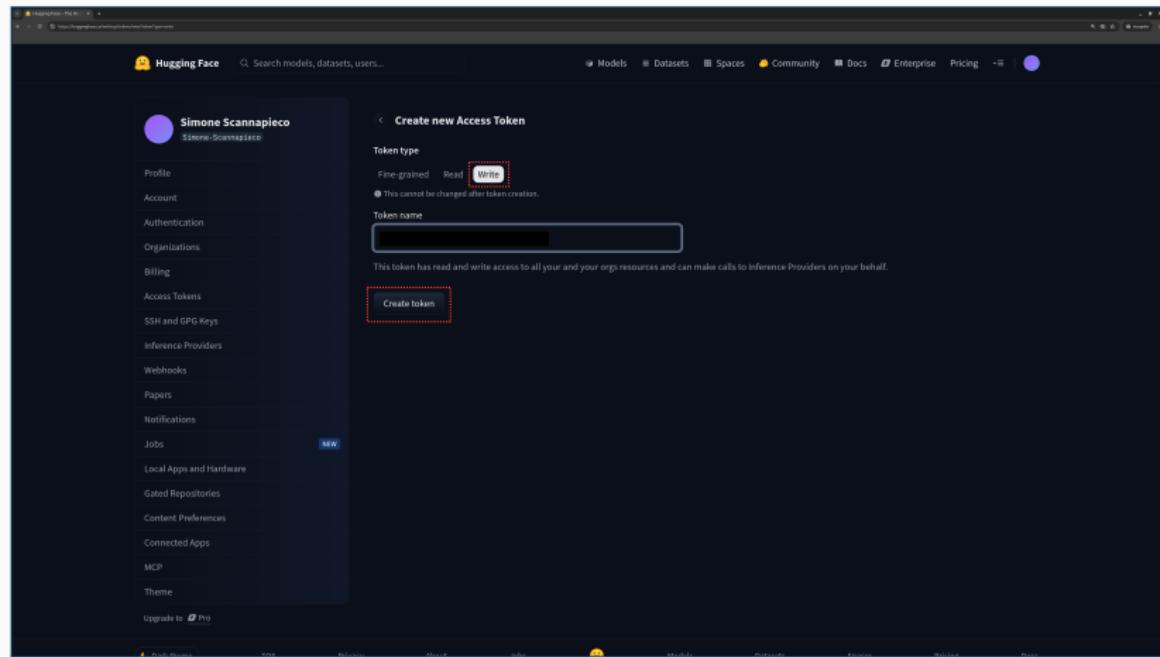
- 4 Premere sul pulsante Create new token

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' or 'READ'. 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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- 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, the results for "Simone Scannapieco" are displayed. The first result is "Simone-Scannapieco/sentence-bert-base-italian-v2", which is highlighted in blue. To the right of the search results, there is a sidebar with various categories such as Models, Datasets, Spaces, Community, Docs, Enterprise, Pricing, Log In, and Sign Up. The "Models" section is currently selected. On the left side of the main content area, there is a large yellow emoji of a smiling face. Below the emoji, the text "The AI community building the future." is displayed in a large, bold font. At the bottom of the main content area, there are two buttons: "Explore AI Apps" and "Browse 1M+ models". On the right side of the screen, there is a list of trending models. Some of the models listed include "meta-llama/Llama-2-70B", "stable-diffusion/stable-diffusion-xl-base-0.9", "openchat/openchat", "llyasviel/Gretelinet-v1.1", "carlsbader/zeroshotcoco_v2_2L", "meta-llama/Llama-2-13b", "t1muz/Fine-tuned-4B-512tokens", "MirroredVisionCoCoc-1B-V2.0", "CompVis/latent-diffusion-v1-4", "stabilityai/stable-diffusion-2.1", and "Salesforce/qwen-7b-disk-12bit". Each model entry includes a thumbnail image, the model name, a brief description, and some statistics like "Test Generation" and "Updated 4 days ago".

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 license (MIT).
- Community:** Includes links for Sentence Similarity, sentence-transformers, GGFU, Transform, PhilipMay/stsb_muli_mt, Italian, sentence-transformer, feature-extraction, and License: MIT.
- Model card:** Provides a detailed description of the model as a `sentence-transformers` model mapping sentences and paragraphs to a 768-dimensional dense vector space for tasks like clustering or semantic search. It notes dependencies on `dbmdz/bert-base-italian-xxl-uncased` and `nickrocks/bert-base-italian-xxl-uncased`.
- Hardware compatibility:** Lists supported architectures: 32-bit and F32 (441.85).
- Inference Providers:** Shows support for Sentence Similarity.
- Model tree:** Lists the base model as `nickrocks/sentence-bert-base-italian-xxl-uncased` and a quantized version.
- Dataset used to train:** PhilipMay/stsb_muli_mt.

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 data:

| 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