OpenSPG

Create a New Project

1. Create a new project configuration inside the folder (OpenSPG/KAG/kag/examples)

Main elements are as follows and they will be discussed in the following sections:

- Project configuration
- Project builder
- Project solver

yaml

```yaml
#-----------project configuration start----------------#
openie_llm:
  api_key: your-key
  base_url: https://api.deepseek.com
  model: deepseek-chat
  type: maas

chat_llm: &chat_llm
  api_key: your-key
  base_url: https://api.deepseek.com
  model: deepseek-chat
  type: maas

vectorize_model: &vectorize_model
  api_key: your-key
  base_url: https://api.siliconflow.cn/v1/
```

When creating this configuration important things to pay attention:

1.1. API keys for vectorization and LLM models

yaml

```yaml
openie_llm:
  api_key: your-key
  base_url: https://api.deepseek.com
  model: deepseek-chat
  type: maas

chat_llm: &chat_llm
```

```yaml
chat_llm: &chat_llm
  api_key: your-key
  base_url: https://api.deepseek.com
  model: deepseek-chat
  type: maas

vectorize_model: &vectorize_model
  api_key: your-key
  base_url: https://api.siliconflow.cn/v1/
  model: BAAI/bge-m3
```

1.2. Project name

```yaml
namespace: ExampleNetwork
```

1.3. Project Builder will describe the data pipeline and the data format (csv in this case)

```yaml
#------------project builder start----------------#
kag_builder_pipeline:
  chain:
    type: structured_builder_chain # kag.builder.default_chain.DefaultStructuredBuilderChain
    mapping:
      type: spg_mapping # kag.builder.componnet.mapping.SPGTypeMapping
    writer:
      type: kg_writer # kag.builder.component.writer.kg_writer.KGWriter
  num_threads_per_chain: 1
  num_chains: 16
  scanner:
    type: csv_scanner #json_scanner # kag.builder.component.scanner.csv_scanner
#------------project builder end----------------#
```

1.4 Project Solver will decsribe the pipeline for reasoning and querying

```yaml
#------------kag-solver configuration start----------------#
search_api: &search_api
  type: openspg_search_api #kag.solver.tools.search_api.impl.openspg_search_api.OpenSPGSearchAPI

graph_api: &graph_api
  type: openspg_graph_api #kag.solver.tools.graph_api.impl.openspg_graph_api.OpenSPGGraphApi

chain_vectorizer:
  type: batch
  vectorize_model: *vectorize_model
```

```
exact_kg_retriever: &exact_kg_retriever
  type: default_exact_kg_retriever # kag.solver.retriever.impl.default_exact_kg_retriever.DefaultExactKgRetriever
  el_num: 1
  llm_client: *chat_llm
  search_api: *search_api
```

2. **Create a new project**

```shell
knext project create --config_path ./kag_config_network.yaml
```

After this script you will have your folder with your chosen project name and modules inside as builder, reasoner, schema, solver as well as configuration file.

Create a Schema

```shell
cd network/schema
```

```scheme
namespace network

TaxonomyInterface(TaxonomyInterface): ConceptType
    hypernymPredicate: isA

SAP(SAP): EntityType
    properties:
        idSAPEntity(idSAPEntity): Text
        hasNativeName(hasNativeName): Text
        hasIPAddrv4(hasIPAddrv4): Text
        hasIPAddrv6(hasIPAddrv6): Text
        IND#belongTo(belongTo): TaxonomyInterface

InterfaceEntity(InterfaceEntity): EntityType
    properties:
        idInterfaceEntity(idInterfaceEntity): Text
```

When creating a schema important the basic elements/things to pay attention:

- Defining nodes: Concept type, Entity Type and Event Type
- Defining properties : Properties can be of basic, standard types and relationships
  - Basic Type：Text、Integer、Float
  - Standard Type：STD.ChinaMobile、STD.Email、STD.IdCardNo、STD.MacAddress、STD.Date、STD.ChinaTelCode、STD.Timestamp
  - **Properties** can exist on both nodes and relationships, where:
    - **Node properties** describe the characteristics of an entity (e.g., `age` for `Person`).
    - **Relationship properties** describe specific attributes of the connection between two entities (e.g., the amount of a transaction, the date of a transaction, etc.).
  - The property id, name, and description are built-in and do not need to be explicitly declared
  - The English name of the property must start with a lowercase letter and can only contain letters and numbers (no hyphens etc)
  - Constraints can be defined for properties and rules:
    - Properties: notNull, MultiValue
  - Rules
- Event types can point to any type, entity types cannot point to event types, and concept types can only point to other concept types, while the reverse is prohibited.
- Concept types can only have the parent class "Thing" and cannot inherit other types. This is because concept types inherently have a hierarchical relation, implying inheritance semantics. If concept types were to inherit, it would result in conflicting semantics.
- Shema should be as close as possible to the data otherwise there should be some mapping between non-matching attribute name/schema element (SPGTypeMapping parses the attribute name from the CSV file and map it to the properties defined in the EntityType.
- If the relation is defined as relation and not as property then there should be a specific table for it. Otherwise it should be defined in the property. Risk mining example: The example doesn't work because there is not a table in the dataset pointing at the relation. Either the it should be defined in the property and riectly add it to the table or it should be defined in the relation and create a new table.
- Sometimes leaving leadTo in the properties can cause an error of duplicate key entry. (In the example it is on the relations.

scss Full Screen

```scss
RouteWithdrawEvent(RouteWithdrawEvent): EventType
    properties:
        subject(subject): NetworkElement
        index(index): Index
        trend(trend): Trend
        time(time): STD.Date
        neID(neID): Text
        routeDistinguisher(routeDistinguisher): Text
        peerAddress(peerAddress): Text
        isAdjRIBin(isAdjRIBin): Text
        isAdjRIBout(isAdjRIBout): Text
```

```
        IND#belongTo(belongTo): TaxonomyControlPlane
    relations:
        CAU#leadTo(leadTo): DroppedTrafficEvent
```

Details can be found in the following links:

openspg.yuque.com

openspg.yuque.com

openspg.yuque.com (Example schema customisation)

The relationships can be described in 2 ways: Phsically in the schema and using DSL rules. "The relationships expressed using DSL rules in the SPG schema are generated through real-time computation during N-degree inference, which effectively meets this requirement."

Knowledge Graph Construction

KGBuilder Pipeline:
openspg.yuque.com

- Structured Mapping: The original data and the schema-defined fields are not completely consistent, so a data field mapping process needs to be defined.
- Entity Linking: In relationship building, entity linking is a very important construction method. This example demonstrates a simple case of implementing entity linking capability for companies.
- RiskMining application it takes around 15 minutes to build the data (40KB) with vectorizer

Inference

graph inference-based question answering can be done in 2 ways(openspg.yuque.com):

- **Inference with Existing Data Modeling:** This type of inference is for structured data that has a clear data schema. Challenges are:
    - Data Scale Limitation: Large models cannot directly handle massive amounts of structured data.
    - Insufficient Knowledge Dependency: Large models lack sufficient knowledge about the underlying data.
- **Inference without Data Modeling:** This type of inference is for unstructured data that lacks a clear data schema.
    - In such scenarios, the system cannot rely on a predefined schema to optimize the planner (Planner) and instead uses a weak schema constraint mechanism to express any type of data through entity types (Entity).

The Schema Rules

This is the data for RouteWithdrawEvent:

```sql
id,name,subject,index,trend,time
1,RouteWithdrawEvent1,CSF0000001579,route,withdraw,4.4.2025
2,RouteWithdrawEvent2,CSF0000000004,route,withdraw,5.4.2025
3,RouteWithdrawEvent3,CSF0000000004,route,drop,6.4.2025
```

When I added the concept rules for a belongTo relationship for index=route and trend=withdraw I see the following data from Neo4J

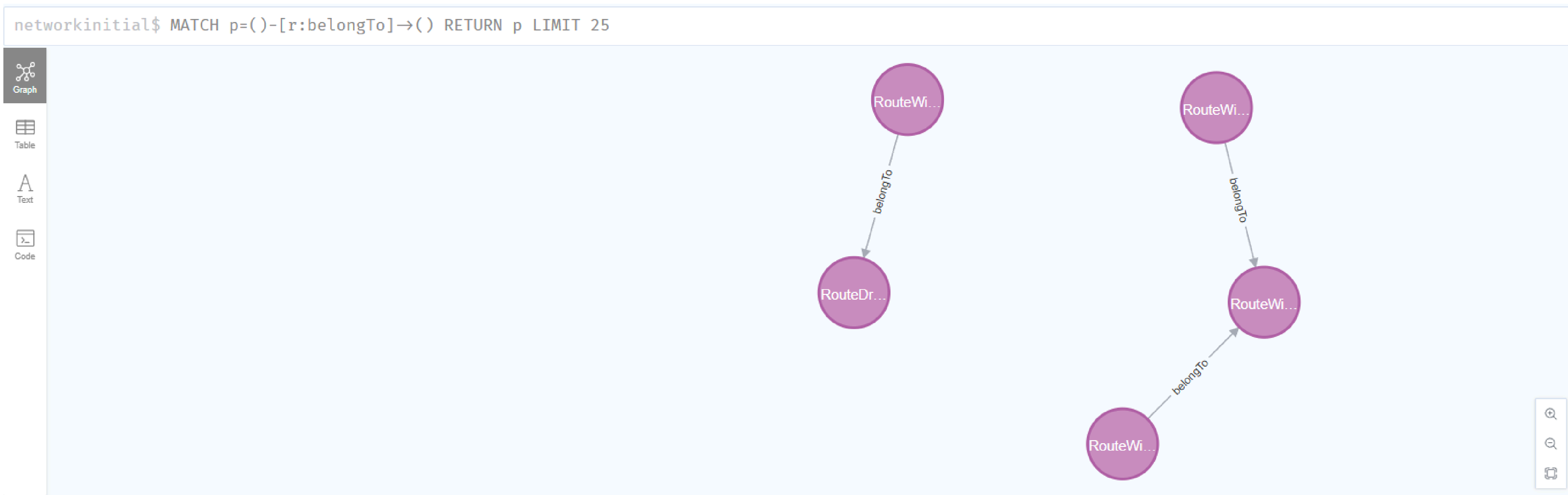
```javascript
`TaxonomyControlPlane`/`RouteWithdraw`:
    rule: [[
        Define (e:RouteWithdrawEvent)-[p:belongTo]->(o:`TaxonomyControlPlane`/`RouteWithdraw`) {
            Structure {
            }
            Constraint {
                R1: e.index == 'route'
                R2: e.trend == 'withdraw'
            }
        }
    ]]


```

When I added the concept rules for a belongTo relationship for RouteDrop I see the following data from Neo4J

```javascript
`TaxonomyControlPlane`/`RouteWithdraw`:
    rule: [[
        Define (e:RouteWithdrawEvent)-[p:belongTo]->(o:`TaxonomyControlPlane`/`RouteWithdraw`) {
            Structure {
            }
            Constraint {
                R1: e.index == 'route'
                R2: e.trend == 'withdraw'
            }
        }
    ]]

`TaxonomyControlPlane`/`RouteDrop`:
    rule: [[
        Define (e:RouteWithdrawEvent)-[p:belongTo]->(o:`TaxonomyControlPlane`/`RouteDrop`) {
            Structure {
```



LeadTo Relationship

This is supposed to be a logical rule which should be created on the fly. The idea is that one event should lead to another event and for that case based on the given constraints a new node and a property should be created.

```groovy
`TaxonomyControlPlane`/`RouteWithdraw`:TaxonomyForwardingPlane/`DroppedTraffic`
    rule: [[
        Define (s:`TaxonomyControlPlane`/`RouteWithdraw`)-[p:leadTo]->(o:`TaxonomyForwardingPlane`/`DroppedTraffic`) {
            Structure {
                (s)-[:subject]->(c:NetworkElement)
            }
            Constraint {
            }
            Action {
                downEvent = createNodeInstance(
                    type=DroppedTrafficEvent,
                    value = {
                        subject=c.id
                        name=eventName
                        trend="drop"
                        index="traffic"
```

Since the logcal rules do not (always) work I decided to create the table phsically so that leadTo relation would be created in the phsical table.

MySQL and Neo4j Database Imports

The schema is stored in the MySQL database and the instance data is stored in the Neo4j database. When I make any changes to the data or schema or the data, before reuploading them I delete everything so that there would be no problem between different rule/schema versions.

MySQL

Script for entering the docker mysql environment

```sql
docker exec -it release-openspg-mysql mysql -uroot -p
```

Default password:openspg

After entering the password you can see the tables created for openspg database:

```sql
show databases;
```

```
USE openspg;
show tables;
| Tables_in_openspg                 |
+-----------------------------------+
| kg_biz_domain                     |
| kg_builder_job                    |
| kg_config                         |
| kg_data_source                    |
| kg_ontology_entity                |
| kg_ontology_entity_parent         |
| kg_ontology_entity_property_range |
| kg_ontology_ext                   |
| kg_ontology_property_constraint   |
| kg_ontology_release               |
| kg_ontology_semantic              |
```

I am deleting the rules created to be sure that no two rules that I create would cause any problem.

```sql
select * from kg_ontology_semantic; --> This table show the rules created for the schema elements (just showing which elements)
delete from kg_ontology_semantic;
select * from kg_semantic_rule; --> This table show the rules executed for the schema elements (full rule as in the concept.rule)
delete from kg_semantic_rule;
select * from kg_ontology_property_constraint;
delete from kg_ontology_property_constraint;
select * from kg_ontology_entity_parent;
delete from kg_ontology_entity_parent;
select * from kg_ontology_entity;
delete from kg_ontology_entity;
```

Neo4j

Other thing to delete is the Neo4j database that you're working on

```sql
DROP DATABASE network;
```

Finally it is necessary to delete the folder where the metadata is stored.

```plaintext
/home/iomuser1/github/openspg/KAG/kag/examples/network/builder/extract-runner-ckpt
```

OWL-OpenSPG Schema Comparison

HYP: Hypernym relation

OpenSPG Relation Type	OWL Equivalent	Explanation
isA Is a type of...	**rdfs:subClassOf**	Describes subclass relationships (e.g., "Dog is a type of Mammal").
locateAt Is located at...	**Object Property** (`hasLocation`)	Defines relationships between entities (e.g., "Office is located at New York").
mannerOf A is a specific implementation or way of B. Similar to "isA," but used for verbs. For example, "auction" → "sale"	**Object Property** (possibly with `rdfs:subClassOf` or `rdf:Property`)	Describes specific methods or implementations (e.g., "Auction is a specific form of Sale").

SYNANT: Synonymy/Antonymy relation

Synonymy and **Antonymy** typically aren't directly supported in OWL but can be expressed through **labels** or **comments** that describe relationships between terms. RDF and OWL focus more on the **semantic meaning** of concepts, rather than direct synonym/antonym distinctions.

OpenSPG Relationship Type (Descriptions from OpenSPG)	Possible OWL Equivalent / Concept	Explanation
synonym Expresses synonyms.	**rdfs:label / equivalentClass**	Use **`rdfs:label`** or **`rdfs:comment`** to associate labels or synonyms. Alternatively, **`equivalentClass`** can be used to declare two classes as equivalent.
antonym Expresses antonyms.	**rdfs:comment / negative relations via axioms**	**Antonyms** can be indicated with annotations or by defining **inverse relationships** or negative axioms.

symbolOf A symbolically represents B. For example, "red" → "passion".	**ObjectProperty** or **AnnotationProperty**	A symbol (like "red" for "passion") might be represented using an **ObjectProperty** or **AnnotationProperty** in OWL to link concepts symbolically.
distinctFrom A and B are different members of a set, and something that belongs to A cannot belong to B. For example, "August" → "September".	**DisjointClasses**	In OWL, two classes can be defined as **disjoint** using `rdfs:disjointWith` or **`owl:disjointWith`**, meaning they cannot have any instance in common.
definedAs A and B have significant overlap in meaning, but B is a more explanatory version of A. For example, "peace" → "absence of war".	**EquivalentClass / rdfs:comment**	A more explanatory or detailed definition can be represented using **`rdfs:comment`** or by specifying an **`EquivalentClass`** axiom.
locatedNear A and B are usually found near each other. For example, "chair" → "table".	**ObjectProperty** or **proximity-based reasoning**	OWL does not have a direct way to specify proximity, but **object properties** can be used to link concepts, and reasoning can be used to infer "closeness" based on relationships.
similarTo A and B are similar. For example, "blender" → "food processor".	**EquivalentClass / ObjectProperty**	Similar concepts can be modeled using `EquivalentClass`, or using `ObjectProperties` if the similarity reflects a **relationship** between entities.
etymologicallyRelatedTo A and B have a common origin. For example, "folkmusiikki" → "folk music".	**AnnotationProperty**	**Etymology** can be represented as an **annotation property** or an **ObjectProperty** linking related terms based on linguistic origin.

CAU: Causal relation

Causal relationships are usually expressed through **ObjectProperties**. OWL can define these using properties like `causes` and `leadsTo`. Reasoning can infer causal relationships.

OpenSPG Relationship Type (Descriptions from OpenSPG)	Possible OWL Equivalent / Concept	Explanation
leadTo Expresses the logical rule through which an event is generated, such as an instance of event A generating an instance of event B under specified conditions. This predicate is recognized by the system as an intention for instance generation, used for implementing the instance propagation of events.	**ObjectProperty** (causal)	A **cause-effect** relationship (like "hunger leads to the need to eat") is expressed using **ObjectProperties** and can be inferred through reasoning.
causes Expresses a constant causal relation without any conditional constraints.	**ObjectProperty / Class-level axioms**	Similar to `leadTo`, **causes** can be modeled using an **ObjectProperty** that connects an event to its effect.
obstructedBy A is a goal that can potentially be hindered by B, where B acts as an obstacle to hinder the realization of A. For example, "sleep" → "noise".	**Negative ObjectProperties**	Causal obstructions can be modeled through **inverse relationships** or by introducing **negative object properties** (e.g., `obstructs`).
causesDesire A triggers a desire or need for B in a person, where the state or event of A stimulates a desire or need for B. For example, "hunger" → "go to the store".	**ObjectProperty** (desire-related)	This could be modeled using **ObjectProperties** to connect events or states with desires or needs (e.g., "hunger causes the desire for food").
createdBy B is a process or motive that creates A. For example, "cake" → "baking".	**ObjectProperty** (creator)	`createdBy` can be represented as an **ObjectProperty**, linking an event to the process or action that created it.

SEQ: Sequential relation

Sequential relationships (like "happened before") are modeled using **transitive object properties** in OWL.

OpenSPG Relationship Type (Descriptions from OpenSPG)	Possible OWL Equivalent / Concept	Explanation
happenedBefore A occurs before B.	**Transitive ObjectProperty**	Sequential dependencies are often modeled using **transitive object properties** (e.g., `happenedBefore`).
hasSubevent A and B are events, where B is a sub-event that occurs as part of A. For example, "eating" → "chewing".	**SubClassOf** / **ObjectProperty**	Sub-events can be modeled using `hasSubevent` as an **ObjectProperty**, or events can be subclassed as part of a larger event using `rdfs:subClassOf`.
hasFirstSubevent A is an event that begins with sub-event B. For example, "sleeping" → "closing eyes".	**SubClassOf** / **ObjectProperty**	Similar to **hasSubevent**, but specifically marking the **first** subevent in a sequence.
hasLastSubevent A is an event that ends with sub-event B. For example, "cooking" → "cleaning the kitchen".	**SubClassOf** / **ObjectProperty**	Similar to **hasSubevent**, but specifying the **last** subevent.
hasPrerequisite In order for A to occur, B needs to occur; B is a prerequisite for A. For example, "dreaming" → "sleeping".	**ObjectProperty** (precondition)	Prerequisites are modeled as **ObjectProperties** where an event depends on the occurrence of another event.

IND: Induction relation

`belongTo` in OpenSPG is similar to `rdf:type` in OWL, where entities are classified under broader categories.

OpenSPG Relationship Type (Descriptions from OpenSPG)	Possible OWL Equivalent / Concept	Explanation

belongTo This relation is commonly used in SPG to describe the classification relation from entity types to concept types. For example, "company event" → "company event category".	**rdf:type / rdfs:subClassOf**	This is used for categorizing entities into classes. OWL uses `rdf:type` to indicate class membership.

INC: Inclusion relation

Part-whole relationships are modeled using `isPartOf` (e.g., a "wing" is part of a "bird"). **OWL** supports this through **ObjectProperties**.

OpenSPG Relationship Type (Descriptions from OpenSPG)	Possible OWL Equivalent / Concept	Explanation
isPartOf A is a part of B.	**ObjectProperty**	This is equivalent to `isPartOf` in OWL, represented as an **ObjectProperty** (e.g., "wing is part of bird").
hasA B belongs to A as an inherent part or due to societal constructs. HasA is often the reverse relation of PartOf. For example, "bird" → "wing".	**ObjectProperty**	This is often the reverse of **isPartOf**, so `hasA` is typically modeled as an **ObjectProperty**.
madeOf A is made up of B. For example, "bottle" → "plastic".	**ObjectProperty / DataProperty**	`madeOf` is represented as an **ObjectProperty**, typically linking an object to its material or component.
derivedFrom A is derived from or originated from B, used to express composite concepts.	**ObjectProperty**	`derivedFrom` expresses a **part-whole** or **origin relationship** and is represented as an **ObjectProperty**.

hasContext A is a word used in the context of B, where B can be a subject area, technical field, or regional dialect. For example, "astern" → "ship".	**AnnotationProperty**	**Contextual relationships** (e.g., "astern" related to ships) are often captured using **AnnotationProperties** in OWL.

USE: Usage relation

Usage relations like `usedFor` and `capableOf` can be modeled using **ObjectProperties** in OWL.

OpenSPG Relationship Type (Descriptions from OpenSPG)	Possible OWL Equivalent / Concept	Explanation
usedFor A is used for B, where the purpose of A is B. For example, "bridge" → "crossing over water".	**ObjectProperty**	This is equivalent to an **ObjectProperty** linking entities to their intended use (e.g., a "knife" used for "cutting").
capableOf A is capable of doing B. For example, "knife" → "cutting".	**Functional ObjectProperty**	Represents a **capability**, usually modeled as an **ObjectProperty** (e.g., "knife" capable of "cutting").
receivesAction B is an action that can be performed on A. For example, "button" → "press".	**ObjectProperty**	This can be modeled as an **ObjectProperty** linking entities with actions they can receive (e.g., "button" → "press").
motivatedByGoal Someone does A because they desire outcome B; A is a step towards achieving goal B. For example, "competition" → "winning".	**ObjectProperty**	This is similar to expressing goal-directed actions, typically using an **ObjectProperty** in OWL.

Logs

docker logs -f release-openspg-server

docker logs -f release-openspg-mysql

docker logs -f release-openspg-neo4j

docker logs -f release-openspg-minio

What is not/working between previous and current versions?

OpenSPG 0.5	OpenSPG 0.0.3	
Possible to create Index in the schema	Index doesn't work	
There are scanners for data import (e.g. jsonscanner, csvscanner)	No scanners	
Only supports for Neo4j	Supports TUgraph and Neo4j	
Project can be deleted curl http://127.0.0.1:8887/project/api/delete?projectId=1	No possibility to delete project	