

Софийски университет “Св. Климент Охридски”

Факултет по математика и информатика

Проект

по

Бази от знания

на тема

Работа с база от знания за храни (проект тип А)

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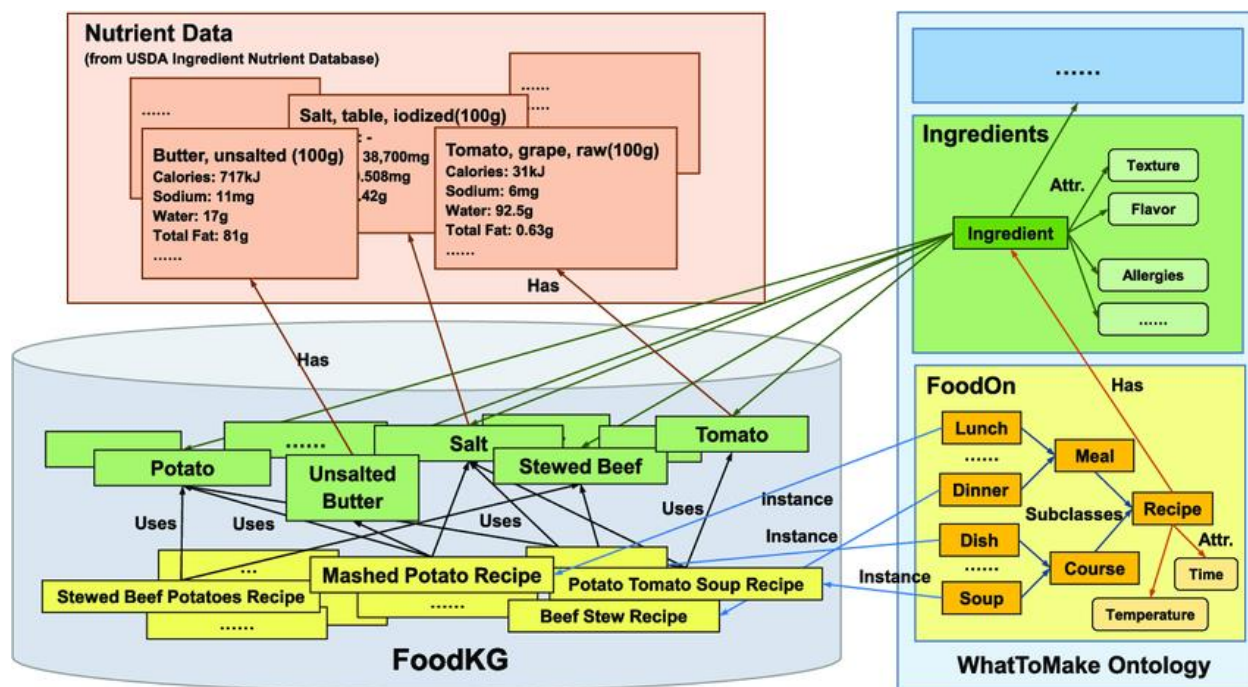
12.06.2023 г.

Описание на данните, използвани в проекта

FoodKG е граф от знания, съдържащ рецепти, съставки и хранителни вещества, който обхваща над милион рецепти и 67 милиона тройки. За изграждането му са използвани подмножества на обекти от онтологията FoodOn, като е обогатена информацията за избраните обекти.

Подробно описание за това как е създадена базата от знания има в [\[1\]](#), а документацията е налична в [\[2\]](#).

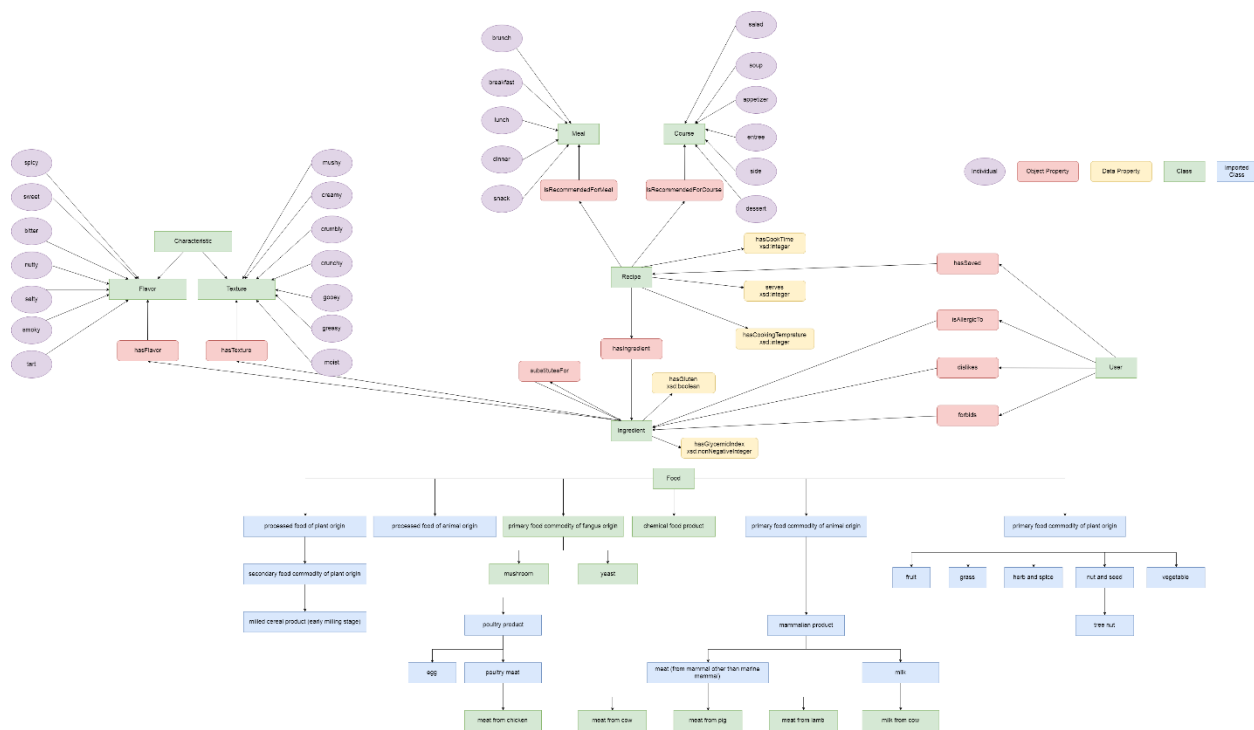
Основните обекти в FoodKG са част от онтологията WhatToMake, която е използвана за целите на проекта.



Фигура 1 Структура на FoodKG

Онтологията WhatToMake е съставена от три части: Food, FoodOn и Ingredient. Food съдържа всички базови класове, които са създадени за онтологията. FoodOn съдържа всички импортирани класове от FoodOn (тази част не е използвана за заявките в проекта). Ingredient съдържа всички индивиди, които представляват различни рецепти и съставки. Документацията и .rdf файловете, описващи частите на онтологията, могат да бъдат намерени на следните линкове:

Food	Документация	Онтология
FoodOn	Документация	Онтология
Ingredient	Документация	Онтология



Фигура 2 Визуализация на основните обекти в онтологията WhatToMake

Описание на принципите и методите за взимане на решения и правила за извод на GraphDB

GraphDB използва прав извод на правилата, за да извършва разсъждения [3]. Той следва стратегия, известна като пълна материализация, при която правилата за извод се прилагат многократно към експлицитно заявените факти, докато не могат да бъдат изведени други имплицитни факти. Този подход гарантира, че изведеното затваряне на базата знания е изчислено и достъпно за оценка или изпълнение на заявки към базата.

GraphDB предоставя възможност за включване и изключване на разсъжденията при изпълнение на заявки. Ако разсъждението е изключено, резултатът от заявката се базира само на знания и данни, които са експлицитно включени в онтологията.

В Приложение А са представени 3 [примерни заявки, които демонстрират начина на взимане на решения от базата знания](#).

Първата от тях е за извличане на съставките, които са заместители на други съставки (използвайки симетричната релация **wtm:substitutesFor**).

Когато разсъждението е изключено, има 12 резултата, защото в онтологията връзката **wtm:substitutesFor** между съставките не е дефинирана експлицитно и в двете посоки.

Когато разсъждението е включено, има 16 резултата от изпълнението на заявката.

Втората от тях е за извличане на храните които могат да бъдат ядени преди вечеря (използвайки транзитивната релация **wtm:isEatenBefore**).

Когато разсъждението е изключено, има 10 резултата, защото в онтологията връзката **wtm:isEatenBefore** може да бъде транзитивна. Например *ind:BananaBread* е храна, за която е дефинирано *wtm:isRecommendedForMeal wtm:Breakfast*, а за *wtm:Breakfast* е дефинирано, че *wtm:isEatenBefore wtm:Lunch*, както и *wtm:Lunch wtm:isEatenBefore wtm:Dinner*, но няма експлицитна връзка *wtm:Breakfast wtm:isEatenBefore wtm:Dinner*, поради което *ind:BananaBread* не се включва в резултатите.

Когато разсъждението е включено, има 16 резултата от изпълнението на заявката. В тези резултати се включва и *ind:BananaBread*.

Третата от тях е за извличане на храните които имат сол в тях (използвайки обратната на *wtm:hasIngredient* релация **wtm:isIngredientIn**).

Когато разсъждението е изключено, няма резултати, понеже в онтологията връзката между храните и съставките е дефинирана със свойството *wtm:hasIngredient*, което е обратно на **wtm:isIngredientIn**.

Когато разсъждението е включено, има 16 резултата от изпълнението на заявката.

Проблеми и предизвикателства при разработката

За целите на проекта са използвани .rdf файловете на Food и Ingredient частите от WhatToMake. В последствие се оказва, че няма достатъчно сложни релации в онтологията, поради което тя беше разширена със следните релации:

Domain	Property	Range	Characterisitics
Ingredient	isIngredientIn	Recipe	inverse property (of hasIngredient)
Meal	isEatenBefore	Meal	Transitive property, inverse property (of isEatenAfter)
Meal	isEatenAfter	Meal	Transitive property, inverse property (of isEatenBefore)

За целта е използван **owlready2** [4]. Кодът е наличен в *update_ontology.ipynb* файла в документацията на проекта.

Първоначалните .rdf файлове са налични в папката *food-repository/init*, а файловете след добавяне на новите релации – в папката *food-repository/updated*.

Бъдещо развитие

Проектът може да бъде разширен, като се разработи приложение, което да връща на потребителите резултатите от заявките. Също може да бъде добавена възможност потребителите сами да дефинират заявки към базата от знания. Не на последно място, базата от знания може да бъде разширена с още индивиди както и връзки между тях.

Приложение А: SPARQL заявките и резултатите от изпълнението им в GraphDB

Заявките са приложени във файла **queries.txt**.

- **Заявка 1:** Извличане на всички храни, които съдържат банани, но не съдържат орехи

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX wtm: <http://purl.org/heals/food/>
PREFIX ind: <http://purl.org/heals/ingredient/>
SELECT DISTINCT ?recipe
WHERE {
  {
    ?recipe wtm:hasIngredient ind:Banana .
  }
  MINUS
  {
    ?recipe wtm:hasIngredient ind:Walnut .
  }
}
```

Резултат от изпълнението:

SPARQL Query & Update ⓘ

Editor only Editor and results Results only

Sample × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed ×

```
1 # Get foods that have banana and don't have walnut in them
2 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
3 PREFIX wtm: <http://purl.org/heals/food/>
4 PREFIX ind: <http://purl.org/heals/ingredient/>
5 SELECT DISTINCT ?recipe
6 WHERE {
7   {
8     ?recipe wtm:hasIngredient ind:Banana .
9   }
10  MINUS
11  {
12    ?recipe wtm:hasIngredient ind:Walnut .
13  }
14 }
```

Run keyboard shortcuts

Table Raw Response Pivot Table Google Chart Download as

Filter query results Showing results from 1 to 2 of 2. Query took 0.1s, today at 22:18.

	recipe
1	http://purl.org/heals/ingredient/BananaBlueberryAlmondFlourMuffin
2	http://purl.org/heals/ingredient/WholeGrainBananaPancake

- **Заявка 2:** Сортиране на храните по брой съставки

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX wtm: <http://purl.org/heals/food/>
SELECT ?recipe (COUNT(DISTINCT ?ingredient) as ?num_ingredients)
WHERE {
  ?recipe wtm:hasIngredient ?ingredient .
}
GROUP BY ?recipe
ORDER BY DESC(?num_ingredients)
```

Резултат от изпълнението:

SPARQL Query & Update ⓘ

Editor only Editor and results Results only ⓘ

Sample × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × ⓘ

```
1 # Get foods with most ingredients
2 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
3 PREFIX wtm: <http://purl.org/heals/food/>
4 SELECT ?recipe (COUNT(DISTINCT ?ingredient) as ?num_ingredients)
5 WHERE {
6   ?recipe wtm:hasIngredient ?ingredient .
7 }
8 GROUP BY ?recipe
9 ORDER BY DESC(?num_ingredients)
```

Run keyboard shortcuts

Table Raw Response Pivot Table Google Chart Download as

Filter query results Showing results from 1 to 22 of 22. Query took 0.1s, moments ago.

	recipe	num_ingredients
1	http://purl.org/heals/ingredient/PotRoastWithVegetables	*14**xsd:integer
2	http://purl.org/heals/ingredient/BeefStew	*12**xsd:integer
3	http://purl.org/heals/ingredient/GlutenFreeCoconutCake	*11**xsd:integer
4	http://purl.org/heals/ingredient/BeefNilaga	*10**xsd:integer
5	http://purl.org/heals/ingredient/BraisedBalsamicChicken	*10**xsd:integer
6	http://purl.org/heals/ingredient/ChickenSalad	*10**xsd:integer
7	http://purl.org/heals/ingredient/AlmondBiscotti	*9**xsd:integer

- **Заявка 3:** Извличане на храните, които потребителят „user15“ не харесва

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX wtm: <http://purl.org/heals/food/>
SELECT ?recipeLabel ?ingredientLabel
WHERE {
    ?recipe wtm:hasIngredient ?ingredient .
    {
        ?user rdf:type wtm:User .
        ?user rdfs:label "user 15" .
        ?user wtm:dislikes ?ingredient .
    }

    ?ingredient rdfs:label ?ingredientLabel .
    ?recipe rdfs:label ?recipeLabel .
}
```

Резултат от изпълнението:

SPARQL Query & Update ⓘ

Editor only Editor and results Results only ⓘ

Sample × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed ×

```
1 # Get foods that "user15" dislikes
2 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
3 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
4 PREFIX wtm: <http://purl.org/heals/food/>
5 SELECT ?recipeLabel ?ingredientLabel
6 WHERE {
7     ?recipe wtm:hasIngredient ?ingredient .
8     {
9         ?user rdf:type wtm:User .
10        ?user rdfs:label "user 15" .
11        ?user wtm:dislikes ?ingredient .
12    }
13
14    ?ingredient rdfs:label ?ingredientLabel
```

Run keyboard shortcuts

Table Raw Response Pivot Table Google Chart Download as

Filter query results Showing results from 1 to 5 of 5. Query took 0.1s, moments ago.

	recipeLabel	ingredientLabel
1	"almond biscotti"	"almond"
2	"flourless coconut and almond cake"	"almond"
3	"beef nilaga"	"celery"
4	"beef stew"	"celery"
5	"chicken salad"	"celery"

- **Заявка 4:** Категоризиране на храните спрямо времето им за приготвяне („Slow“ до 30 мин. вкл., „Medium“ между 30 и 60 мин. вкл. и „Fast“ над 60 мин.)

```
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX wtm: <http://purl.org/heals/food/>
SELECT ?recipeLabel ?cooking_time_category
WHERE {
    ?recipe wtm:hasCookTime ?cooking_time .
    BIND(IF(?cooking_time <= 30, "Fast",
            IF(?cooking_time > 60, "Slow", "Average"))) AS
?cooking_time_category) .

    ?recipe rdfs:label ?recipeLabel .
}
```

Резултат от изпълнението:

SPARQL Query & Update ⓘ

Editor only Editor and results Results only ⓘ

Sample × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed ×

```

1 # Categorize cooking time
2 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
3 PREFIX wtm: <http://purl.org/heals/food/>
4 SELECT ?recipeLabel ?cooking_time_category
5 WHERE {
6     ?recipe wtm:hasCookTime ?cooking_time .
7     BIND(IF(?cooking_time <= 30, "Fast",
8             IF(?cooking_time > 60, "Slow", "Average"))) AS ?cooking_time_category) .
9
10    ?recipe rdfs:label ?recipeLabel .
11 }
```

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Run

keyboard shortcuts

Table Raw Response Pivot Table Google Chart

Download as

Filter query results Showing results from 1 to 22 of 22. Query took 0.1s, moments ago.

	recipeLabel	cooking_time_category
1	'almond biscotti'	'Slow'
2	'baked chicken tender'	'Average'
3	'banana blueberry almond flour muffin'	'Average'
4	'banana bread'	'Slow'
5	'beef nilaga'	'Slow'
6	'beef stew'	'Slow'
7	'braised balsamic chicken'	'Average'

- **Заявка 5:** Извличане на съставките, които хрупкава текстура, като се включват и съставките без зададена структура в базата

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX wtm: <http://purl.org/heals/food/>
PREFIX ind: <http://purl.org/heals/ingredient/>
SELECT ?ingredient ?texture {
  ?ingredient rdf:type wtm:Ingredient .
  OPTIONAL {
    ?ingredient wtm:hasTexture ?texture .
    FILTER(?texture = ind:Crunchy) .
  }
}
```

Резултат от изпълнението:

SPARQL Query & Update ⓘ

Editor only Editor and results Results only ⓘ

Sample × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed ×

```
1 # Get ingredients that have crunchy texture or the texture is not specified
2 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
3 PREFIX wtm: <http://purl.org/heals/food/>
4 PREFIX ind: <http://purl.org/heals/ingredient/>
5 SELECT ?ingredient ?texture {
6   ?ingredient rdf:type wtm:Ingredient .
7   OPTIONAL {
8     ?ingredient wtm:hasTexture ?texture .
9     FILTER(?texture = ind:Crunchy) .
10  }
11 }
```

Run keyboard shortcuts

Table Raw Response Pivot Table Google Chart Download as

Filter query results Showing results from 1 to 75 of 75. Query took 0.1s, moments ago.

	ingredient	texture
1	http://purl.org/heals/ingredient/AllPurposeFlour	
2	http://purl.org/heals/ingredient/Almond	http://purl.org/heals/ingredient/Crunchy
3	http://purl.org/heals/ingredient/Pecan	http://purl.org/heals/ingredient/Crunchy
4	http://purl.org/heals/ingredient/PumpkinSeed	
5	http://purl.org/heals/ingredient/Walnut	http://purl.org/heals/ingredient/Crunchy
6	http://purl.org/heals/ingredient/BakingPowder	
7	http://purl.org/heals/ingredient/Butter	

- **Заявка 6:** Извличане на храните, които се препоръчват или за междинно ядене, или са гарнитура, или са и двете

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX wtm: <http://purl.org/heals/food/>
SELECT ?recipe {
  {
    ?recipe wtm:isRecommendedForMeal wtm:Snack.
  }
  UNION
  {
    ?recipe wtm:isRecommendedForCourse wtm:Side.
  }
}
```

Резултат от изпълнението:

SPARQL Query & Update ⓘ

Editor only Editor and results Results only ⓘ

Sample × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed ×

```
1 # Get foods that are snacks, side courses or both
2 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
3 PREFIX wtm: <http://purl.org/heals/food/>
4 SELECT ?recipe {
5   {
6     ?recipe wtm:isRecommendedForMeal wtm:Snack.
7   }
8   UNION
9   {
10    ?recipe wtm:isRecommendedForCourse wtm:Side.
11  }
12 }
```

Run keyboard shortcuts

Table Raw Response Pivot Table Google Chart Download as

Filter query results Showing results from 1 to 9 of 9. Query took 0.1s, moments ago.

	recipe
1	http://purl.org/heals/ingredient/AlmondBiscotti
2	http://purl.org/heals/ingredient/BananaBlueberryAlmondFlourMuffin
3	http://purl.org/heals/ingredient/BananaBread
4	http://purl.org/heals/ingredient/Brownies
5	http://purl.org/heals/ingredient/GlutenFreeCoconutCake
6	http://purl.org/heals/ingredient/KamutMuffin
7	http://purl.org/heals/ingredient/BananaBread

- **Заявка 7:** Категоризиране на храните спрямо гликемичния им индекс („Low“ до 55 вкл., „Medium“ между 55 и 70 и „High“ над 70 вкл.)

```
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX wtm: <http://purl.org/heals/food/>
SELECT ?ingredientLabel ?glycemic_index_category
WHERE {
    ?ingredient wtm:hasGlycemicIndex ?glycemic_index .
    BIND(IF(?glycemic_index <= 55, "Low",
            IF(?glycemic_index >= 70, "High", "Medium"))) AS
?glycemic_index_category) .

    ?ingredient rdfs:label ?ingredientLabel .
}
```

Резултат от изпълнението:

SPARQL Query & Update ⓘ

Editor only Editor and results Results only ⓘ

Sample × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed × Unnamed ×

```
1 # Categorize glycemic index
2 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
3 PREFIX wtm: <http://purl.org/heals/food/>
4 SELECT ?ingredientLabel ?glycemic_index_category
5 WHERE {
6     ?ingredient wtm:hasGlycemicIndex ?glycemic_index .
7     BIND(IF(?glycemic_index <= 55, "Low",
8             IF(?glycemic_index >= 70, "High", "Medium"))) AS ?glycemic_index_category) .
9
10    ?ingredient rdfs:label ?ingredientLabel .
11 }
```

Run keyboard shortcuts

Table Raw Response Pivot Table Google Chart Download as

Filter query results Showing results from 1 to 76 of 76. Query took 0.1s, moments ago.

	ingredientLabel	glycemic_index_category
1	"all purpose flour"	"High"
2	"almond"	"Low"
3	"pecan"	"Low"
4	"pumpkin seed"	"Low"
5	"walnut"	"Low"
6	"baking powder"	"Low"
7	"butter"	"Low"

- **Заявка 8:** Извличане на храните, които имат повече от 4 порции

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX wtm: <http://purl.org/heals/food/>
SELECT DISTINCT ?recipe ?serves
WHERE {
    ?recipe wtm:serves ?serves .
    FILTER(?serves > 4).
}
```

Резултат от изпълнението:

SPARQL Query & Update

Editor only Editor and results Results only

Sample

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```

1 # Get foods that have more than 4 serves
2 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
3 PREFIX wtm: <http://purl.org/heals/food/>
4 SELECT DISTINCT ?recipe ?serves
5 WHERE {
6   ?recipe wtm:serves ?serves .
7   FILTER(?serves > 4).
8 }

```

Save

Share

Link

Export

Run

keyboard shortcuts

Table

Raw Response

Pivot Table

Google Chart

Download as

Filter query results

Showing results from 1 to 15 of 15. Query took 0.1s, moments ago.

	recipe	↑	serves	↓
1	http://purl.org/heals/ingredient/AlmondBiscotti	15	↑xsd:integer	
2	http://purl.org/heals/ingredient/BananaBread	10	↑xsd:integer	
3	http://purl.org/heals/ingredient/BeefNiaga	5	↑xsd:integer	
4	http://purl.org/heals/ingredient/BeefStew	10	↑xsd:integer	
5	http://purl.org/heals/ingredient/BraisedBalsamicChicken	6	↑xsd:integer	
6	http://purl.org/heals/ingredient/Brownies	16	↑xsd:integer	
7	http://purl.org/heals/ingredient/ChickenSalad	12	↑xsd:integer	

- Заявка 9:** Извличане на средното време за приготвяне на храните, групирани по типа ястие. Резултатът е закръглен до втората цифра след десетичната запетая.

```

PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX wtm: <http://purl.org/heals/food/>
SELECT ?type_code (ROUND(AVG(?cook_time)*100)/100 as ?avg_cook_time) WHERE {
  VALUES (?type ?type_code) {
    (wtm:Salad "SALAD")
    (wtm:Soup "SOUP")
    (wtm:Appetizer "APPETIZER")
    (wtm:Entree "ENTREE")
    (wtm:Side "SIDE")
    (wtm:Dessert "DESSERT")
  }
  ?recipe rdf:type wtm:Recipe .
  ?recipe wtm:hasCookTime ?cook_time .
  ?recipe wtm:isRecommendedForCourse ?type .
}
GROUP BY ?type_code
ORDER BY ?avg_cook_time

```

Резултат от изпълнението:

SPARQL Query & Update

Editor only Editor and results Results only

Sample

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+

```

1 # Get average cook time (rounded to the second digit after decimal point) of foods grouped by course type
2 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
3 PREFIX wtm: <http://pur1.org/heals/food/>
4 SELECT ?type_code (ROUND(AVG(?cook_time)*100)/100 as ?avg_cook_time) WHERE {
5     VALUES (?type ?type_code) {
6         (wtm:Salad "SALAD")
7         (wtm:Soup "SOUP")
8         (wtm:Appetizer "APPETIZER")
9         (wtm:Entree "ENTREE")
10        (wtm:Side "SIDE")
11        (wtm:Dessert "DESSERT")
12    }
13    ?recipe rdf:type wtm:Recipe .
14    ?recipe wtm:hasCookTime ?cook_time

```

Run

keyboard shortcuts

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Filter query results

Showing results from 1 to 4 of 4. Query took 0.1s, moments ago.

	type_code		avg_cook_time	
1	'SIDE'		'33.33' ^{xsd:decimal}	
2	'ENTREE'		'57.5' ^{xsd:decimal}	
3	'DESSERT'		'65.83' ^{xsd:decimal}	
4	'APPETIZER'		'117.5' ^{xsd:decimal}	

- **Заявка 10:** Извличане на храните, които се препоръчват и за междинно ядене, и за закуска, и за десерт

```
PREFIX wtm: <http://purl.org/heals/food/>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT ?recipeLabel WHERE {
    {
        ?recipe wtm:isRecommendedForMeal wtm:Snack
    }
    .
    {
        ?recipe wtm:isRecommendedForMeal wtm:Breakfast
    }
    ?recipe wtm:isRecommendedForCourse ?course .

    FILTER(?course = wtm:Dessert)

    ?recipe rdfs:label ?recipeLabel .
}
```

Резултат от изпълнението:

SPARQL Query & Update ⓘ

Editor only Editor and results Results only ⓘ

```
1 # Get all foods that are recommended or snack and breakfast and or dessert
2 PREFIX wtm: <http://purl.org/heals/food/>
3 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
4 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
5 SELECT ?recipeLabel WHERE {
6   {
7     ?recipe wtm:isRecommendedForMeal wtm:Snack
8   }
9   .
10  {
11    ?recipe wtm:isRecommendedForMeal wtm:Breakfast
12  }
13  ?recipe wtm:isRecommendedForCourse ?course .
14 }
```

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Filter query results Showing results from 1 to 4 of 4. Query took 0.1s, moments ago.

	recipeLabel
1	'banana blueberry almond flour muffin'
2	'banana bread'
3	'gluten free coconut cake'
4	'kamut muffin'

- **Заявка 11:** Извличане на храните, които имат пиле в тях и всичките им съставки имат нисък гликемичен индекс (≤ 55)

```
PREFIX wtm: <http://purl.org/heals/food/>
PREFIX ind: <http://purl.org/heals/ingredient/>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT ?recipeLabel (MAX(?glycemic_index) as ?max_glycemic_index) WHERE {
  ?recipe wtm:hasIngredient ind:Chicken .
  ?recipe wtm:hasIngredient ?ingredient .
  ?ingredient wtm:hasGlycemicIndex ?glycemic_index .

  ?recipe rdfs:label ?recipeLabel .
}
GROUP BY ?recipeLabel
HAVING (?max_glycemic_index <= 55)
```

Резултат от изпълнението:

SPARQL Query & Update ⓘ

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```
1 # Get all foods that have chicken in them and all ingredients have low glycemc index
2 PREFIX wtm: <http://purL.org/heals/food/>
3 PREFIX ind: <http://purL.org/heals/ingredient/>
4 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
5 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
6 SELECT ?recipeLabel (MAX(?glycemc_index) as ?max_glycemc_index) WHERE {
7     ?recipe wtm:hasIngredient ind:Chicken .
8     ?recipe wtm:hasIngredient ?ingredient .
9     ?ingredient wtm:hasGlycemcIndex ?glycemc_index .
10
11     ?recipe rdfs:label ?recipeLabel .
12 }
13 GROUP BY ?recipeLabel
14 HAVING (?max_glycemc_index <= 55)
```

Run keyboard shortcuts

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Filter query results Showing results from 1 to 3 of 3. Query took 0.1s, moments ago.

	recipeLabel	max_glycemc_index
1	"baked chicken tender"	"55" ^{^^xsd:nonNegativeInteger}
2	"braised balsamic chicken"	"30" ^{^^xsd:nonNegativeInteger}
3	"grilled chicken kabob"	"20" ^{^^xsd:nonNegativeInteger}

Заявки, които демонстрират начина на взимане на решения от базата знания:

- **Заявка 12:** Извличане на съставките, които са заместители на други съставки (използвайки симетричната релация **wtm:substitutesFor**)

```
PREFIX wtm: <http://purl.org/heals/food/>
SELECT ?ingredient ?ingr_1 where {
    ?ingr_1 wtm:substitutesFor ?ingredient .
}
```

Резултат от изпълнението (с включен извод):

SPARQL Query & Update

Sample

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+

```

1 # Symmetric property
2 PREFIX wtm: <http://purl.org/heals/food/>
3 SELECT ?ingredient ?ingr_1 where {
4     ?ingr_1 wtm:substitutesFor ?ingredient .
5 }
6

```

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Showing results from 1 to 16 of 16. Query took 0.1s, moments ago.

	ingredient	ingr_1
1	http://purl.org/heals/ingredient/GlutenFreeFlour	http://purl.org/heals/ingredient/AllPurposeFlour
2	http://purl.org/heals/ingredient/KamutFlour	http://purl.org/heals/ingredient/AllPurposeFlour
3	http://purl.org/heals/ingredient/WholeWheatFlour	http://purl.org/heals/ingredient/AllPurposeFlour
4	http://purl.org/heals/ingredient/Pecan	http://purl.org/heals/ingredient/Almond
5	http://purl.org/heals/ingredient/PumpkinSeed	http://purl.org/heals/ingredient/Almond
6	http://purl.org/heals/ingredient/Walnut	http://purl.org/heals/ingredient/Almond
7	http://purl.org/heals/ingredient/Almond	http://purl.org/heals/ingredient/Pecan

Резултат от изпълнението (с изключен извод):

SPARQL Query & Update

Editor only Editor and results Results only

Sample

Unnamed

Unnamed

Unnamed

Unnamed

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+

```

1 # Symmetric property
2 PREFIX wta: <http://purl.org/heals/food/>
3 SELECT ?ingredient ?ingr_1 where {
4     ?ingr_1 wta:substitutesFor ?ingredient .
5 }
6

```

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Filter query results

Showing results from 1 to 12 of 12. Query took 0.1s, moments ago.

	ingredient	ingr_1
1	http://purl.org/heals/ingredient/Pecan	http://purl.org/heals/ingredient/Almond
2	http://purl.org/heals/ingredient/PumpkinSeed	http://purl.org/heals/ingredient/Almond
3	http://purl.org/heals/ingredient/Walnut	http://purl.org/heals/ingredient/Almond
4	http://purl.org/heals/ingredient/Almond	http://purl.org/heals/ingredient/Pecan
5	http://purl.org/heals/ingredient/Walnut	http://purl.org/heals/ingredient/Pecan
6	http://purl.org/heals/ingredient/Walnut	http://purl.org/heals/ingredient/PumpkinSeed
7	http://purl.org/heals/ingredient/Almond	http://purl.org/heals/ingredient/Walnut

- **Заявка 13:** Извличане на храните които могат да бъдат ядени преди вечеря (използвайки транзитивната релация **wtm:isEatenBefore**)

```
PREFIX wtm: <http://purl.org/heals/food/>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
SELECT ?recipe ?meal WHERE {
    ?recipe wtm:isRecommendedForMeal ?meal .
    ?meal wtm:isEatenBefore wtm:Dinner .
}
```


Резултат от изпълнението (с включен извод):

SPARQL Query & Update

Editor only

Editor and results

Results only

Sample

Unnamed

Unnamed

Unnamed

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+

```

1 # Get foods that can be eaten before dinner
2 PREFIX wtm: <http://purl.org/heals/food/>
3 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
4 SELECT ?recipe ?meal WHERE {
5     ?recipe wtm:isRecommendedForMeal ?meal .
6     ?meal wtm:isEatenBefore wtm:Dinner .
7 }

```

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Filter query results

Showing results from 1 to 19 of 19. Query took 0.1s, moments ago.

	recipe	meal
1	http://purl.org/heals/ingredient/BananaBlueberryAlmondFlourMuffin	food Breakfast
2	http://purl.org/heals/ingredient/BananaBread	food Breakfast
3	http://purl.org/heals/ingredient/CornedBeefHash	food Breakfast
4	http://purl.org/heals/ingredient/GlutenFreeCoconutCake	food Breakfast
5	http://purl.org/heals/ingredient/GoldenKamutBread	food Breakfast
6	http://purl.org/heals/ingredient/KamutMuffin	food Breakfast
7	http://purl.org/heals/ingredient/KamutPancake	food Breakfast

Резултат от изпълнението (с изключен извод):

SPARQL Query & Update

Editor only

Editor and results

Results only

Sample

Unnamed

Unnamed

Unnamed

Unnamed

Unnamed

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+

```

1 # Get foods that can be eaten before dinner
2 PREFIX wtm: <http://purl.org/heals/food/>
3 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
4 SELECT ?recipe ?meal WHERE {
5     ?recipe wtm:isRecommendedForMeal ?meal .
6     ?meal wtm:isEatenBefore wtm:Dinner .
7 }

```

Save

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Link

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Table

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Filter query results

Showing results from 1 to 10 of 10. Query took 0.1s, moments ago.

	recipe	meal
1	http://purl.org/heals/ingredient/BakedChickenTender	food Lunch
2	http://purl.org/heals/ingredient/BeefNilaga	food Lunch
3	http://purl.org/heals/ingredient/BeefStew	food Lunch
4	http://purl.org/heals/ingredient/BraisedBalsamicChicken	food Lunch
5	http://purl.org/heals/ingredient/ChickenSalad	food Lunch
6	http://purl.org/heals/ingredient/GrilledChickenKabob	food Lunch
7	http://purl.org/heals/ingredient/PotRoastWithVegetables	food Lunch

- **Заявка 14:** Извличане на храните които имат сол в тях (използвайки обратната на *wtm:hasIngredient* релация **wtm:isIngredientIn**)

```
PREFIX wtm: <http://purl.org/heals/food/>
PREFIX ind: <http://purl.org/heals/ingredient/>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
SELECT ?recipeLabel WHERE {
    ind:Salt wtm:isIngredientIn ?recipe .
    ?recipe rdfs:label ?recipeLabel .
}
```

Резултат от изпълнението (с включен извод):

SPARQL Query & Update

Editor only

Editor and results

Results only

Sample

Unnamed

Unnamed

Unnamed

Unnamed

Unnamed

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```

1 # Get all foods that have salt in them
2 PREFIX wtm: <http://purl.org/heaals/food/>
3 PREFIX ind: <http://purl.org/heaals/ingredient/>
4 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
5 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
6 SELECT ?recipeLabel WHERE {
7     ind:Salt wtm:isIngredientIn ?recipe .
8     ?recipe rdfs:label ?recipeLabel .
9 }

```

Save

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Link

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Table

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Filter query results

Showing results from 1 to 16 of 16. Query took 0.1s, moments ago.

	recipeLabel
1	"almond biscotti"
2	"baked chicken tender"
3	"banana bread"
4	"braised balsamic chicken"
5	"brownies"
6	"chicken salad"
7	"gluten free coconut cake"

Резултат от изпълнението (с изключен извод):

SPARQL Query & Update ⓘ

Editor only Editor and results Results only ⓘ

```
1 # Get all foods that have salt in them
2 PREFIX wts: <http://purl.org/heals/food/>
3 PREFIX ind: <http://purl.org/heals/ingredient/>
4 PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
5 PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
6 SELECT ?recipeLabel WHERE {
7   ind:salt wts:isIngredientIn ?recipe .
8   ?recipe rdfs:label ?recipeLabel .
9 }
```

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Filter query results No results. Query took 0.1s, moments ago.

recipeLabel
No data available in table

Библиография

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[2] Официална документация на FoodKG, (<https://foodkg.github.io>)

[3] Официална документация на GraphDB, (<http://graphdb.ontotext.com/documentation/standard/reasoning.html>)

[4] Официална документация на owlready2, (<https://owlready2.readthedocs.io/en/v0.36/intro.html>)