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APPENDIX

A. SPARQL Queries

SPARQL Query for **CQ1: Which aspects of sustainability are related to food consumption?**

1	PREFIX shfo: <http://SustainHealthyFoodOntology#>
2	SELECT DISTINCT ?sustainabilityAspect
3	WHERE {
4	?food ?sustainabilityAspect ?value .
5	FILTER (
6	STRSTARTS(STR(?sustainabilityAspect), STR(shfo:)) &&
7	(
8	CONTAINS(LCASE(STR(?sustainabilityAspect)), "co2")
9	CONTAINS(LCASE(STR(?sustainabilityAspect)), "land")
10	CONTAINS(LCASE(STR(?sustainabilityAspect)), "water")
11	CONTAINS(LCASE(STR(?sustainabilityAspect)), "eutrophication")
12	CONTAINS(LCASE(STR(?sustainabilityAspect)), "emission")
13)
14)

Table	Response	Visualization	4 results in 0.715 seconds
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sustainabilityAspect
filter
shfo:AmountOfWater
shfo:AmountOfCO2emissions
shfo:AmountOfEutrophication
shfo:AmountOfLandUse

CQ2: What is the environmental (eco) score of a specific food? (includes also and CQ3)

Specific food: food_banana

1	✓	PREFIX shfo: <http://SustainHealthyFoodOntology#>	
2		PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>	
3		SELECT ?property	
4		(xsd:decimal(?value) AS ?Value)	
5	✓	WHERE {	
6		shfo:Food_banana ?property ?value .	
7		FILTER (
8		?property IN (
9		shfo:AmountOfCO2emissions,	
10		shfo:AmountOfEutrophication,	
11		shfo:AmountOfLandUse,	
12		shfo:AmountOfWater	
13)	
14)	✓

Table	Response	Visualization	3 results in 0.079 seconds
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property	Value
filter	filter
shfo:AmountOfCO2emissions	0.086
shfo:AmountOfEutrophication	0.329
shfo:AmountOfLandUse	0.193

CQ4: Lowest Eutrophication Footprint

1	✓	PREFIX shfo: <http://SustainHealthyFoodOntology#>	
2		PREFIX owl: <http://www.w3.org/2002/07/owl#>	
3		PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>	
4		SELECT ?food	
5		(xsd:decimal(?eutrophication) AS ?Eutrophication)	
6	✓	WHERE {	
7		?food a owl:NamedIndividual ;	
8		shfo:AmountOfEutrophication ?eutrophication .	
9			
10		FILTER(xsd:decimal(?eutrophication) > 0.0)	
11		}	
12		ORDER BY ASC(?Eutrophication)	
13		LIMIT 20	
14			✓

Table	Response	Visualization	10 results in 0.071 seconds
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food	Eutrophication
filter	filter
shfo:Food_smoothie_fruit	0.243
shfo:Food_banana	0.329
shfo:Food_potatoes_raw	0.348
shfo:Food_oatmeal	1.123
shfo:Food_cane_sugar	1.692
shfo:Food_cheese_10_	9.837
shfo:Food_cheese_20_	9.837
shfo:Food_cheese_35_	9.837
shfo:Food_cheese_45_	9.837
shfo:Food_cheese_50_	9.837

CQ5 –

CQ6: What is the health (nutrient) score of a specific food? & CQ7: What is the micronutrient profile (key micronutrients) of the (consumed) food? & CQ8: What is the macronutrient profile (key macronutrients) of the (consumed) food?

1		PREFIX	shfo:	<http://SustainHealthyFoodOntology#>
2		PREFIX	xsd:	<http://www.w3.org/2001/XMLSchema#>
3		SELECT	?property	
4				(REPLACE(STR(xsd:decimal(?value)), "^(\\d+)\$", "\$1.0") AS ?formattedValue)
5		WHERE	{	
6			shfo:Food avocado	?property ?value .
7			FILTER	(
8			?property	IN
9				# Macronutrients
10			shfo:AmountOfProtein,	
11			shfo:AmountOfCarbs,	
12			shfo:AmountOfFat,	
13			shfo:AmountOfFiber,	
14			shfo:AmountOfSugar,	
15			shfo:hasAmountOfCalories,	
16				# Micronutrients
17			shfo:AmountOfCalcium,	
18			shfo:AmountOfIron,	
19			shfo:AmountOfMagnesium,	
20			shfo:AmountOfZinc,	
21			shfo:AmountOfVitaminA,	
22			shfo:AmountOfVitaminB6,	
23			shfo:AmountOfVitaminD,	
24			shfo:AmountOfVitaminE,	
25				# Nutrient Score
26			shfo:hasNutrientScore	
27)	

Table

Response

Visualization

▼

10 results in 0.203 seconds

property	formattedValue
filter	filter
shfo:AmountOfCalcium	15.0
shfo:AmountOfFiber	3.1
shfo:AmountOfIron	0.5
shfo:AmountOfMagnesium	26.0
shfo:AmountOfProtein	2.0
shfo:AmountOfVitaminB6	0.32
shfo:AmountOfVitaminE	2.7
shfo:AmountOfZinc	0.6
shfo:hasAmountOfCalories	186.0
shfo:hasNutrientScore	0.24

CQ9: Which foods are rich in protein but low in fat?

1	✓	PREFIX shfo: <http://SustainHealthyFoodOntology#>
2		PREFIX owl: <http://www.w3.org/2002/07/owl#>
3		PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
4		
5		SELECT ?food
6		(xsd:decimal(?protein) AS ?Protein)
7		(xsd:decimal(?fat) AS ?Fat)
8	✓	WHERE {
9		?food a owl:NamedIndividual ;
10		shfo:AmountOfProtein ?protein ;
11		shfo:AmountOfFat ?fat .
12		
13		FILTER(xsd:decimal(?protein) > 10.0 && xsd:decimal(?fat) < 5.0)
14		}

Table	Response	Visualization	▼	28 results in 0.038 seconds
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food	Protein	Fat
filter	filter	filter
shfo:Food_gelatin	88	0
shfo:Food_cod_dried_saltd	82	3
shfo:Food_shrimps_saltd_dried	63	2
shfo:Food_beef_saltd_dried_seasoned_pastirma_turkish	30	3
shfo:Food_beans_black_eyed_dried	23	2
shfo:Food_chervil_dried	23	4
shfo:Food_cod_boiled	23	1
shfo:Food_beef_smoke_dried	22	2
shfo:Food_hare_whole_raw	22	3
shfo:Food_parsley_dried	22	4
shfo:Food_peas_split_yellow_green_dried	22	2
shfo:Food_chicken_fillet_in_batter_raw	21	2
shfo:Food_peas_green_dried	21	2
shfo:Food_minced_meat_vegetarian_based_on_soya_unprepared	20	3
shfo:Food_plaice_boiled	19	2
shfo:Food_squid_raw	16	1
shfo:Food_pasta_wholemeal_raw	13	2

CQ10: What is a better (healthier) alternative for a specific food based on a health state?

Specific food: Food_cheese_gouda_48_av

1	<code>PREFIX shfo: <http://SustainHealthyFoodOntology#></code>
2	<code>PREFIX xsd: <http://www.w3.org/2001/XMLSchema#></code>
3	<code>PREFIX owl: <http://www.w3.org/2002/07/owl#></code>
4	
5	<code>SELECT ?food</code>
6	<code>(REPLACE(STR(xsd:decimal(?score)), "^((\\d+)?)", "\$1.0") AS ?formattedScore)</code>
7	<code>WHERE {</code>
8	<code># Get the reference score for feta</code>
9	<code>shfo:Food_cheese_gouda_48_av shfo:hasNutrientScore ?fetaScore .</code>
10	
11	<code># Get other food and their scores</code>
12	<code>?food a owl:NamedIndividual ;</code>
13	<code>shfo:hasNutrientScore ?score .</code>
14	
15	<code># Only return foods with a higher score than feta</code>
16	<code>FILTER(xsd:decimal(?score) > xsd:decimal(?fetaScore))</code>
17	<code>}</code>
18	<code>ORDER BY ASC(xsd:decimal(?score))</code>
19	

Table
Response
Visualization
406 results in 0.282 seconds

food	formattedScore
filter	filter
shfo:Food_cashew_nuts_unsalted	0.5
shfo:Food_hazelnuts_unsalted	0.5
shfo:Food_flour_spelt_wholemeal	0.5
shfo:Food_flour_wheat_wholemeal	0.5
shfo:Food_pasta_wholemeal_raw	0.5
shfo:Food_custard_soft__airy	0.51
shfo:Food_oatmeal	0.51
shfo:Food_pear_dried_soaked_in_water	0.51
shfo:Food_tomatoes_tinned	0.51
shfo:Food_cheese_spread_kids_eru	0.52
shfo:Food_cheese_w_cumin_48__average	0.52
shfo:Food_tomatoes_stewed_w_vegetable_oil	0.52
shfo:Food_bulgur_wheat_cooked	0.53
shfo:Food_custard_half_fat_all_flavours	0.53
shfo:Food_infant_food_fruit_12_months	0.53
shfo:Food_milk_based_drink_yakult_original	0.53

CQ11: What are the recommended daily intake levels for specific nutrients based on age, sex, and activity level?

For person_5446

1	✓	PREFIX shfo: <http://SustainHealthyFoodOntology#>
2		PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
3		SELECT ?property
4		(IF(isNumeric(?value), REPLACE(STR(xsd:decimal(?value)), "^(\\d+)\$", "\$1.0"),
5		STR(?value)) AS ?formattedValue)
6	✓	WHERE {
7		shfo:Person_5449 ?property ?value .
8		FILTER (
9		?property IN (
10		shfo:AmountOfCaloriesNeededPerDay,
11		shfo:AmountOfProteinNeededPerDay,
12		shfo:AmountOfFatNeededPerDay,
13		shfo:AmountOfCarbsNeededPerDay,
14		shfo:AmountOfFiberNeededPerDay,
15		shfo:AmountOfVitaminENeededPerDay,
16		shfo:AmountOfIronNeededPerDay,
17		shfo:AmountOfSodiumNeededPerDay,
18		shfo:AmountOfMagnesiumNeededPerDay,
19		shfo:AmountOfCalciumNeededPerDay
Table	Response	Visualization
10 results in 0.124 seconds		

property	formattedValue
filter	filter
shfo:AmountOfCalciumNeededPerDay	1000.0
shfo:AmountOfCaloriesNeededPerDay	2406.625
shfo:AmountOfCarbsNeededPerDay	270.7-391.1 g
shfo:AmountOfFatNeededPerDay	53.5-93.6 g
shfo:AmountOfFiberNeededPerDay	25 g
shfo:AmountOfIronNeededPerDay	18.0
shfo:AmountOfMagnesiumNeededPerDay	310.0
shfo:AmountOfProteinNeededPerDay	60.2-210.6 g
shfo:AmountOfSodiumNeededPerDay	2000.0
shfo:AmountOfVitaminENeededPerDay	15.0

CQ12: Which health states lead to dietary restrictions?

1

PREFIX shfo: <http://SustainHealthyFoodOntology#>

2

3

4

5

6

7

8

SELECT DISTINCT ?HealthState ?restrictedFood

WHERE {

?restrictedFood shfo:notRecommendedFor ?HealthState .

}

ORDER BY ?HealthState

Table

Response

Visualization

3,811 results in 0.129 seconds

EXPLORE

HealthState

restrictedFood

filter

filter

shfo:Anemia

shfo:Food_candybar_bounty

shfo:Anemia

shfo:Food_candybar_kitkat

shfo:Anemia

shfo:Food_candybar_lion

shfo:Anemia

shfo:Food_candybar_mars

shfo:Anemia

shfo:Food_candybar_milky_way

shfo:Anemia

shfo:Food_candybar_nuts

shfo:Anemia

shfo:Food_candybar_snickers

shfo:Anemia

shfo:Food_candybar_twix

shfo:Anemia

shfo:Food_cereal_bar_w_milk_kellogg_s

shfo:Anemia

shfo:Food_cheese_10_

shfo:Anemia

shfo:Food_cheese_20_

shfo:Anemia

shfo:Food_cheese_20_leidse_w_cumin_fries_clove

shfo:Anemia

shfo:Food_cheese_20_low_sodium

shfo:Anemia

shfo:Food_cheese_30_age_10_12_mths

shfo:Anemia

shfo:Food_cheese_30_age_4_7_mths

shfo:Anemia

shfo:Food_cheese_30_age_4_8_weeks

shfo:Anemia

shfo:Food_cheese_30_age_8_wk_4_mths

shfo:Anemia

shfo:Food_cheese_30_av

shfo:Anemia

shfo:Food_cheese_35_

shfo:Anemia

shfo:Food_cheese_40_leiden_w_cumin_fries_clove

Rows per page: 20

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Navigation icons

1	PREFIX shfo: <http://SustainHealthyFoodOntology#>
2	
3	SELECT DISTINCT ?food
4	WHERE {
5	?food shfo:notRecommendedFor shfo:LactoseRestrictedDiet .
6	}
7	ORDER BY ?food
8	

Table	Response	Visualization	398 results in 0.043 seconds
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food

filter

shfo:Food_after_eight_chocolate_mints
shfo:Food_almond_paste_filled_tarts_w_butter
shfo:Food_almond_paste_filled_tarts_wo_butter
shfo:Food_appel_pie_dutch_w_shortbread_w_butter
shfo:Food_apple_pie_dutch_w_shortbread_wo_butter
shfo:Food_apple_turnover_w_puff_pastry_w_butter
shfo:Food_apple_turnover_w_puff_pastry_wo_butter
shfo:Food_baked_chicory_w_cheese_and_ham
shfo:Food_bakery_mix_for_chocolate_cake
shfo:Food_biscuit
shfo:Food_biscuit_av
shfo:Food_biscuit_baby_toddler_boiletje
shfo:Food_biscuit_brown_digestive_w_chocolate
shfo:Food_biscuit_brown_wholemeal
shfo:Food_biscuit_cafe_noir
shfo:Food_biscuit_children_s_av
shfo:Food_biscuit_digestive
shfo:Food_biscuit_dutch_amaretti_bitterkoekjes
shfo:Food_biscuit_dutch_frou_frou
shfo:Food_biscuit_dutch_jodekoek

Rows per page: 20

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CQ14: What food can be consumed in a certain amount if a person has specific dietary restrictions or a health state?

CQ15: Which food groups is not suitable for individuals with specific dietary restrictions (e.g., vegan, lactose-intolerant)?

For vegans

1	PREFIX <u>shfo</u> : <http://SustainHealthyFoodOntology#>
2	
3	SELECT DISTINCT <u>?food</u>
4	WHERE {
5	<u>?food shfo:notRecommendedFor shfo:Vegan .</u>
6	}
7	ORDER BY <u>?food</u>
8	

Table	Response	Visualization	▼	6 results in 0.033 seconds
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food
filter

shfo:Dairy
shfo:Fish
shfo:Meat
shfo:MixedDishes
shfo:Pastry_and_Biscuits
shfo:SavouryDishes

B. Ontology Rules in Description Logic

DL Notation

$\exists \text{ hasHealthState.Pregnancy} \sqsubseteq \text{hasSex} = \text{"Female"}$

$\text{AlcoholicBeverages} \sqsubseteq \forall \text{ notRecommendedFor.Pregnancy}$

$\text{Dairy} \sqsubseteq \forall \text{ notRecommendedFor.}(\text{LactoseIntolerant} \sqcup \text{LactoseRestrictedDiet})$

$\text{Dairy} \sqcup \text{Meat} \sqcup \text{Fish} \sqcup \text{MixedDishes} \sqcup \text{Pastry_and_Biscuits} \sqcup \text{SavouryDishes} \sqsubseteq \forall \text{ notRecommendedFor.Vegan}$

$\text{Meat} \sqcup \text{Fish} \sqsubseteq \forall \text{ notRecommendedFor.Vegetarian}$

$\text{Meat} \sqsubseteq \forall \text{ notRecommendedFor.Pescatarian}$

$\text{PorkMeat} \sqsubseteq \forall \text{ notRecommendedFor.HalalDiet}$

$\text{HighFiberFood} \sqsubseteq \forall \text{ notRecommendedFor.DietaryFiberRestrictedDiet}$

$\text{HighFatFood} \sqsubseteq \forall \text{ notRecommendedFor.FatRestrictedDiet}$

DL Notation

HighSaltFood $\sqsubseteq \forall$ notRecommendedFor.SaltRestrictedDiet

HighIronFood $\sqsubseteq \forall$ recommendedFor.Anemia

HighSugarFood \sqcup HighCarbFood $\sqsubseteq \forall$ notRecommendedFor.Diabetes

Person \sqcap (hasAge $\geq 0 \sqcap$ hasAge ≤ 12) \rightarrow Child

Person \sqcap (hasAge $\geq 13 \sqcap$ hasAge ≤ 17) \rightarrow Teenager

Person \sqcap (hasAge $\geq 18 \sqcap$ hasAge ≤ 64) \rightarrow Adult

Person \sqcap (hasAge ≥ 65) \rightarrow SeniorAdult

Person \sqcap (hasBMI < 18.5) \rightarrow Underweight

Person \sqcap ($18.5 \leq$ hasBMI < 25) \rightarrow NormalWeight

Person \sqcap ($25 \leq$ hasBMI < 30) \rightarrow Overweight

Person \sqcap (hasBMI ≥ 30) \rightarrow Obesity

Peanut $\sqsubseteq \forall$ RestrictedFood.Peanut_Allergy

Milk $\sqsubseteq \forall$ RestrictedFood.Milk_Allergy

Egg $\sqsubseteq \forall$ RestrictedFood.Eggs_Allergy

Almond \sqcup Cashew \sqcup Walnut \sqcup Hazelnut \sqcup Nuts $\sqsubseteq \forall$ RestrictedFood.TreeNuts_Allergy

Soy $\sqsubseteq \forall$ RestrictedFood.Soy_Allergy

Wheat \sqcup Barley \sqcup Rye $\sqsubseteq \forall$ RestrictedFood.Wheat_Allergy

Fish \sqcup Salmon \sqcup Tuna \sqcup Cod $\sqsubseteq \forall$ RestrictedFood.Fish_Allergy

Shrimp \sqcup Crab \sqcup Lobster $\sqsubseteq \forall$ RestrictedFood.Shellfish_Allergy

Hypertension $\sqsubseteq \forall$ FoodInLimitedAmount. {Salt, ProcessedFood, CannedFood, SnackFood, FastFood, FriedFood, Butter, Margarine, Soda, Alcohol, Pickles}

Hypertension $\sqsubseteq \forall$ FoodToBeConsumedInHighAmount. {LowSodiumFood, FreshFood, NoSaltFood, OliveOil, Avocado, Nuts, WholeFruit, DarkChocolate, Water, HerbalTea, LeafyGreens, Beets, BellPeppers}

Diabetes $\sqsubseteq \forall$ FoodInLimitedAmount. {WhiteBread, WhiteRice, Pastries, SugaryCereal, Sugar, Sweet, Candy, Soda, Juice, Butter, Fried, FastFood, Chips, Cookies, Cake}

Diabetes $\sqsubseteq \forall$ FoodToBeConsumedInHighAmount. {WholeGrains, BrownRice, Quinoa, Oats, Berries, Apple, Pear, Citrus, GreekYogurt, LowFatDairy, OliveOil, Avocado, Nuts, Hummus, Seeds, DarkChocolate}