MSc in Artificial Intelligence - Batch 10
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Semantic Web & Ontological Engineering
Assignment

Introduction

- Doughnut Ontology

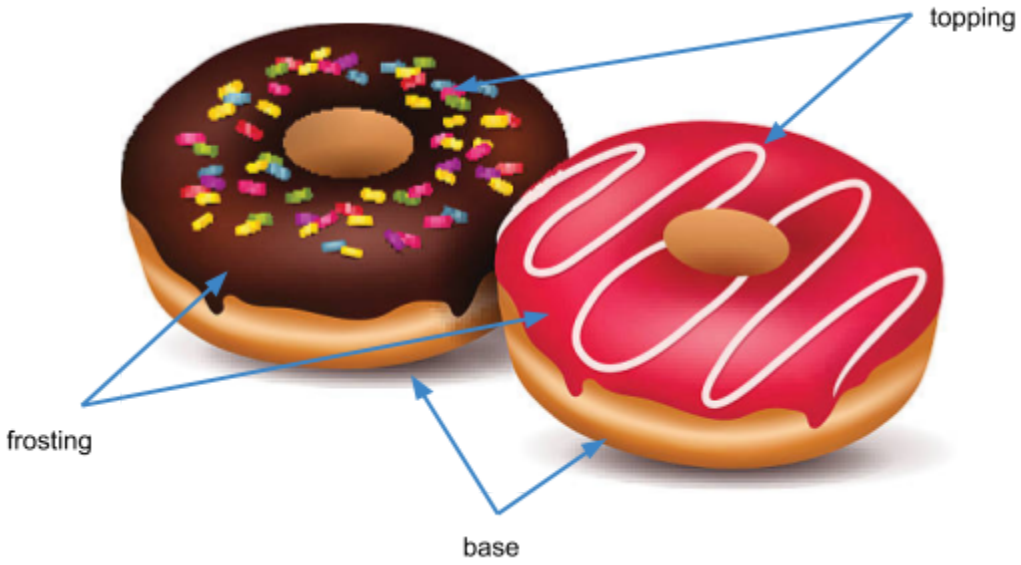
  Doughnut is a very popular dessert or a sweet. There are many flavours and variations of doughnuts available today. In this assignment I tried to create an ontology for various types of doughnuts available.

- Data taken from : online doughnut selling websites

- Implementation

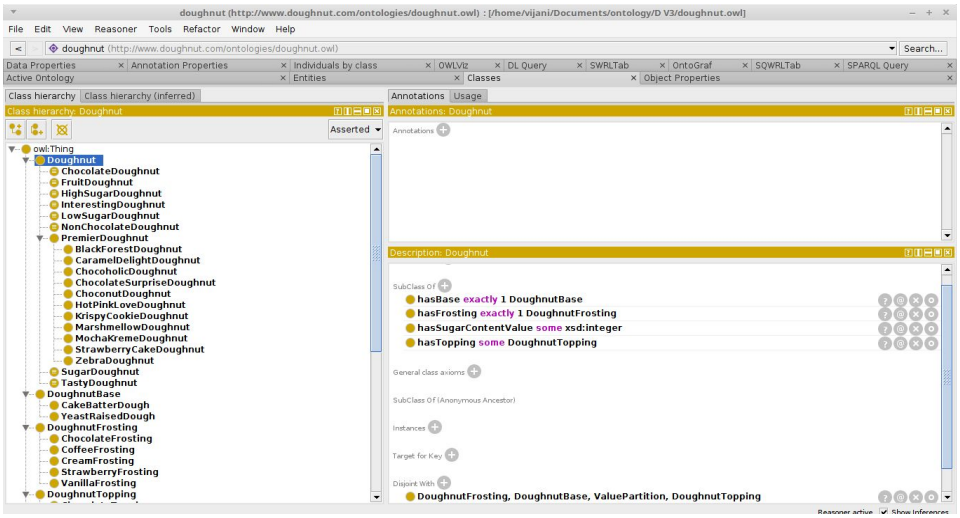
  Ontology was created using Protege as a 'OWL ontology'. Used SPARQL as the query language. Implemented a Java Web Project. Used Netbeans as IDE, Apache Tomcat, JSP Servlets as techniques, Apache Jena library to access OWL ontology.

- Doughnut base, frosting and topping:

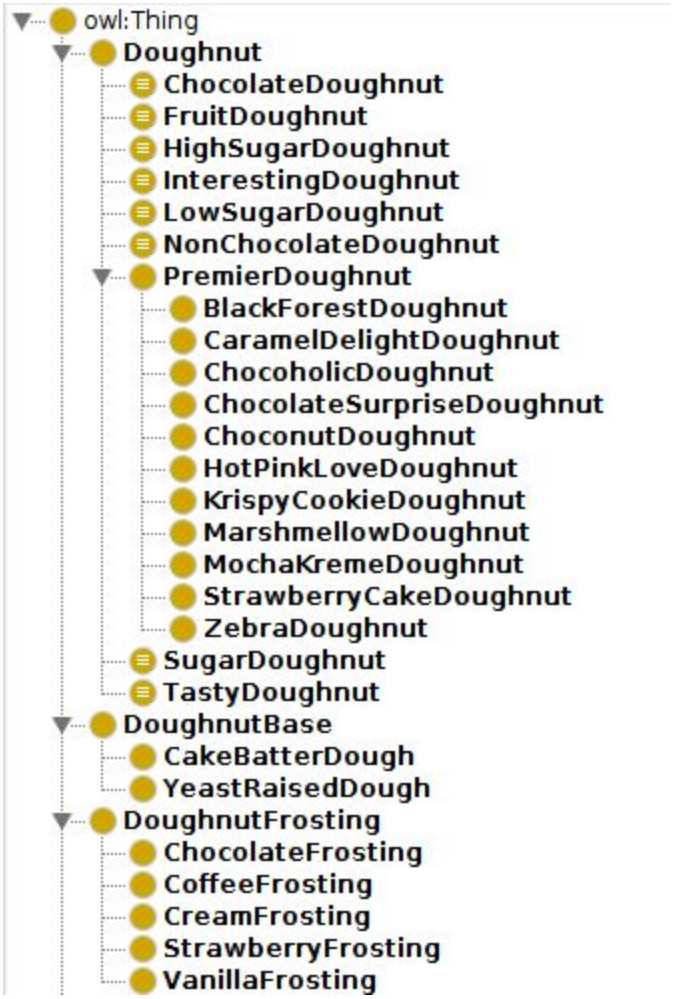


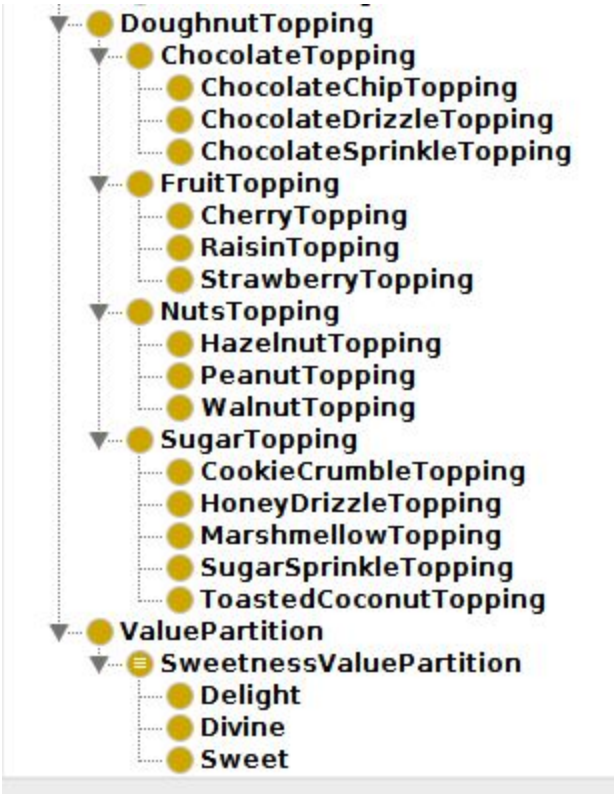
Building Ontology

- Pretege software



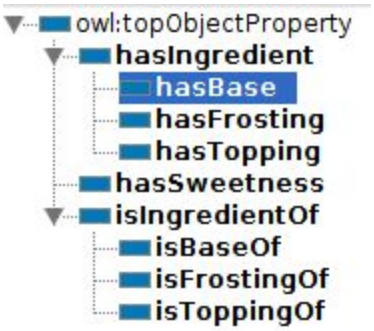
- Class Hierarchy





All primitive siblings are disjoint classes : an individual cannot be an instance of more than one of these classes.

- Object Properties



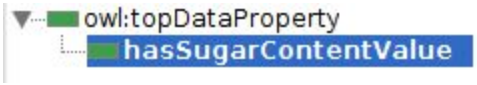
Note:

hasBase, hasFrosting are Functional properties : single valued properties.
hasIngredient is a Transitive property.
Property Domains and Ranges:

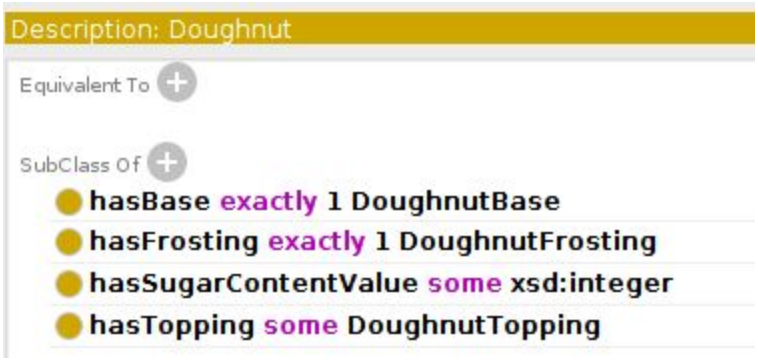
Property	**Domain**	**Range**	**Inverse of**
hasBase	Doughnut	DoughnutBase	isbaseOf
hasFrosting	Doughnut	DoughnutFrosting	isFrostingOf

hasTopping	Doughnut	DoughnutTopping	isToppingOf
isbaseOf	DoughnutBase	Doughnut	hasBase
isFrostingOf	DoughnutFrosting	Doughnut	hasFrosting
isToppingOf	DoughnutTopping	Doughnut	hasTopping

- Data Properties



  - Only 1 base per doughnut
  - Only 1 frosting per doughnut
  - Doughnut has Sugar content value in integer



- Property restrictions
  - Doughnut hasBase **exactly 1** DoughnutBase : hasValue restriction
  - Doughnut hasTopping **some** DoughnutTopping : Existential restriction
  - ZebraDougnut hasTopping **only** ChocolateDrizzleTopping : Universal restriction
  - InterestingDoughnut hasTopping **min 3** DoughnutTopping : Cardinality restriction

- Defined classes

  - Doughnuts with ChocolateFrosting and ChocolateTopping are ChocolateDoughnuts.
  - Opposite of ChocolateDoughnuts is NonChocolateDoughnuts.
  - Doughnuts with FruitTopping are FruitDoughnuts
  - Doughnuts with at least 3 toppings : InterestingDoughnuts
  - SugarLevel >= 350 : HighSugarDoughnut
  - SugarLevel < 350 : LowSugarDoughnut

Description: ChocolateDoughnut

Equivalent To

Doughnut
and ((hasFrosting some ChocolateFrosting)
and (hasTopping some ChocolateTopping))

Description: NonChocolateDoughnut

Equivalent To

Doughnut
and (not (ChocolateDoughnut))

Description: FruitDoughnut

Equivalent To

Doughnut
and (hasTopping some FruitTopping)

Description: InterestingDoughnut

Equivalent To

Doughnut
and (hasTopping min 3 DoughnutTopping)

Description: HighSugarDoughnut

Equivalent To

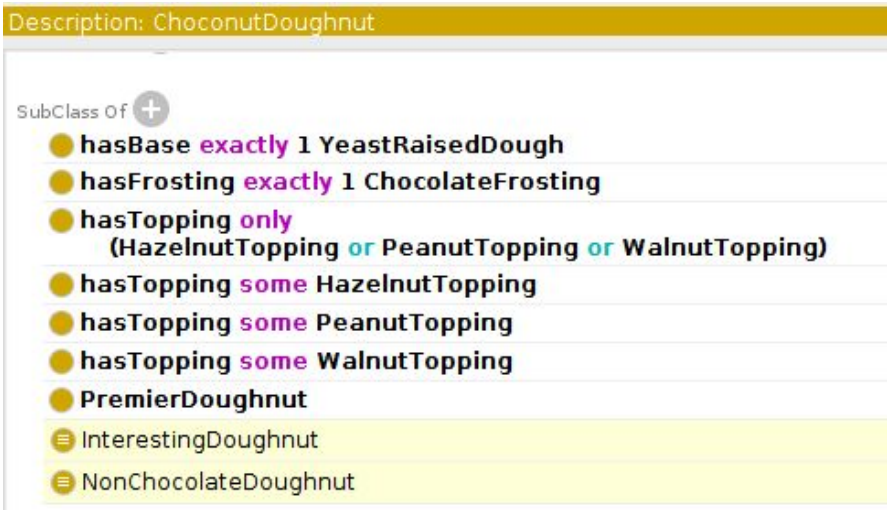
Doughnut
and (hasSugarContentValue some xsd:integer[>= 350])

Description: LowSugarDoughnut

Equivalent To

Doughnut
and (hasSugarContentValue some xsd:integer[< 350])

- Start Reasoner



- ValuePartitions

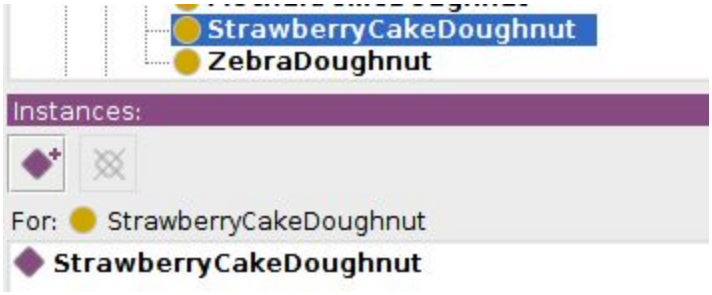
Sweetness :

Sweet < Delight < Divine

Added the sweetness value into Toppings. Example:

- Different Kinds of Doughnuts : Premier Doughnuts

- Individuals by class
  Ex:



SPARQL Queries

Doughnut with CakeBatterDough

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX doughnut: <http://www.doughnut.com/ontologies/doughnut.owl#>

SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:CakeBatterDough
}
```

Doughnut with CakeBatterDough & ChocolateFrosting

```
SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:CakeBatterDough.
        ?d      doughnut:hasFrosting    doughnut:ChocolateFrosting.
}
```

Doughnut with CakeBatterDough & CreamFrosting

```
SELECT DISTINCT  ?d
WHERE
{
```

```
        ?d      doughnut:hasBase        doughnut:CakeBatterDough.
        ?d      doughnut:hasFrosting    doughnut:CreamFrosting.
}
```

Doughnut with CakeBatterDough & VanillaFrosting

```
SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:CakeBatterDough.
        ?d      doughnut:hasFrosting    doughnut:VanillaFrosting.
}
```

Doughnut with CakeBatterDough & StrawberryFrosting

```
SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:CakeBatterDough.
        ?d      doughnut:hasFrosting    doughnut:StrawberryFrosting.
}
```

Doughnut with CakeBatterDough & CoffeeFrosting

```
SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:CakeBatterDough.
        ?d      doughnut:hasFrosting    doughnut:CoffeeFrosting.
}
```

Doughnut with YeastRaisedDough

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX doughnut: <http://www.doughnut.com/ontologies/doughnut.owl#>

SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:YeastRaisedDough.
}
```

Doughnut with YeastRaisedDough & ChocolateFrosting

```
SELECT DISTINCT  ?d
```

```
WHERE
{
        ?d      doughnut:hasBase        doughnut:YeastRaisedDough.
        ?d      doughnut:hasFrosting    doughnut:ChocolateFrosting.
}
```

Doughnut with CakeBatterDough & CreamFrosting

```
SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:YeastRaisedDough.
        ?d      doughnut:hasFrosting    doughnut:CreamFrosting.
}
```

Doughnut with CakeBatterDough & VanillaFrosting

```
SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:YeastRaisedDough.
        ?d      doughnut:hasFrosting    doughnut:VanillaFrosting.
}
```

Doughnut with CakeBatterDough & StrawberryFrosting

```
SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:YeastRaisedDough.
        ?d      doughnut:hasFrosting    doughnut:StrawberryFrosting.
}
```

Doughnut with CakeBatterDough & CoffeeFrosting

```
SELECT DISTINCT  ?d
WHERE
{
        ?d      doughnut:hasBase        doughnut:YeastRaisedDough.
        ?d      doughnut:hasFrosting    doughnut:StrawberryFrosting.
}
```

Retrieve all that has a topping.

```
SELECT DISTINCT         ?s
WHERE
{
        ?s      rdfs:subClassOf         ?restriction.
```

```
        ?restriction    owl:onProperty          doughnut:hasTopping.
}
```

Retrieve all topping categories

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX doughnut: <http://www.doughnut.com/ontologies/doughnut.owl#>

SELECT DISTINCT ?s
WHERE {
        ?s      rdfs:subClassOf         doughnut:DoughnutTopping .
}
```

To retrieve doughnuts with sugar content value of each

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX doughnut: <http://www.doughnut.com/ontologies/doughnut.owl#>

SELECT  ?x ?y
WHERE {
        ?x      doughnut:hasSugarContentValue       ?y.
}
```

To retrieve doughnut toppings with 'Divine' Sweetness value.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX doughnut: <http://www.doughnut.com/ontologies/doughnut.owl#>

SELECT DISTINCT     ?d
WHERE
{
        ?s              rdfs:subClassOf             ?restriction.
        ?restriction    owl:onProperty          doughnut:hasSweetness.
        ?restriction    owl:someValuesFrom          doughnut:Divine.
        ?d              doughnut:hasTopping     ?s.
}
LIMIT 4
```

To retrieve doughnut toppings with ‘Delight’ Sweetness value.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX doughnut: <http://www.doughnut.com/ontologies/doughnut.owl#>

SELECT DISTINCT     ?d
WHERE
{
        ?s              rdfs:subClassOf             ?restriction.
        ?restriction    owl:onProperty          doughnut:hasSweetness.
        ?restriction    owl:someValuesFrom          doughnut:Delight.
        ?d              doughnut:hasTopping     ?s.
}
ORDER BY (?s)
LIMIT 4
```

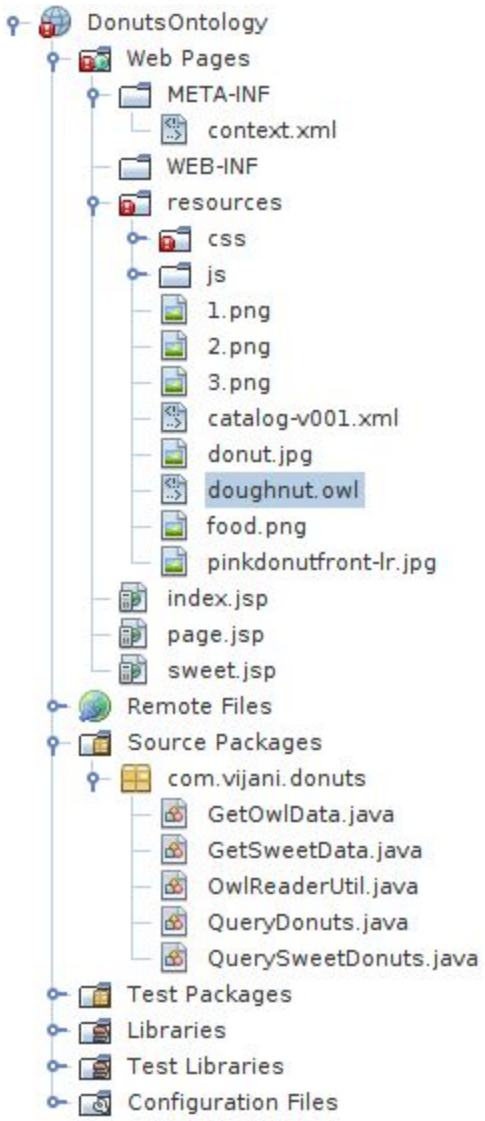
To retrieve doughnut toppings with 'Sweet' Sweetness value.

```
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX doughnut: <http://www.doughnut.com/ontologies/doughnut.owl#>

SELECT DISTINCT     ?d
WHERE
{
        ?s              rdfs:subClassOf             ?restriction.
        ?restriction    owl:onProperty          doughnut:hasSweetness.
        ?restriction    owl:someValuesFrom          doughnut:Sweet.
        ?d              doughnut:hasTopping     ?s.
}
LIMIT 3
```

Java Web Project

- Project Structure



- User Interfaces

Doughnut World

Standard Search

Custom Search

Doughnut Search

Doughnut Bases

YeastRaisedDough

Doughnut Frostings

ChocolateFrosting

Submit Query

Donut	Sugar Content
ChoconutDoughnut	152
ChocoholicDoughnut	312

Yummy Doughnut Search

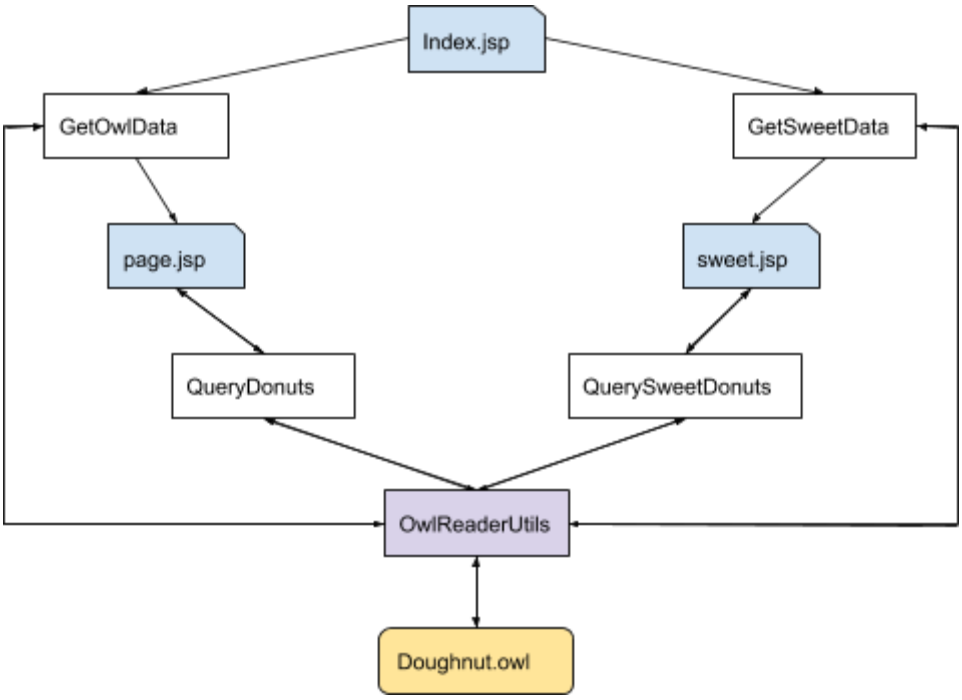
Sweetness

Divine

Submit Query

Donut
ZebraDoughnut
ChocolateSurpriseDoughnut
HotPinkLoveDoughnut
MochaKremeDoughnut

- Project overview diagram



========== End of the Assignment ==========