



Lab Modeling Exercise: Discussion

Protégé Short Course
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Scenario: Hosting Dinner

- Dinner party with guests Mary, Ashok, & Amara
 - Mary likes to have at least one main dish
 - Ashok eats only vegetarian food
- For Mary
 - At least one meat main dish
- For Ashok
 - A vegetarian soup or salad
 - At least one vegetarian main dish
 - A vegetarian dessert
- Dishes to be chosen from an Italian cookbook

Competency Questions

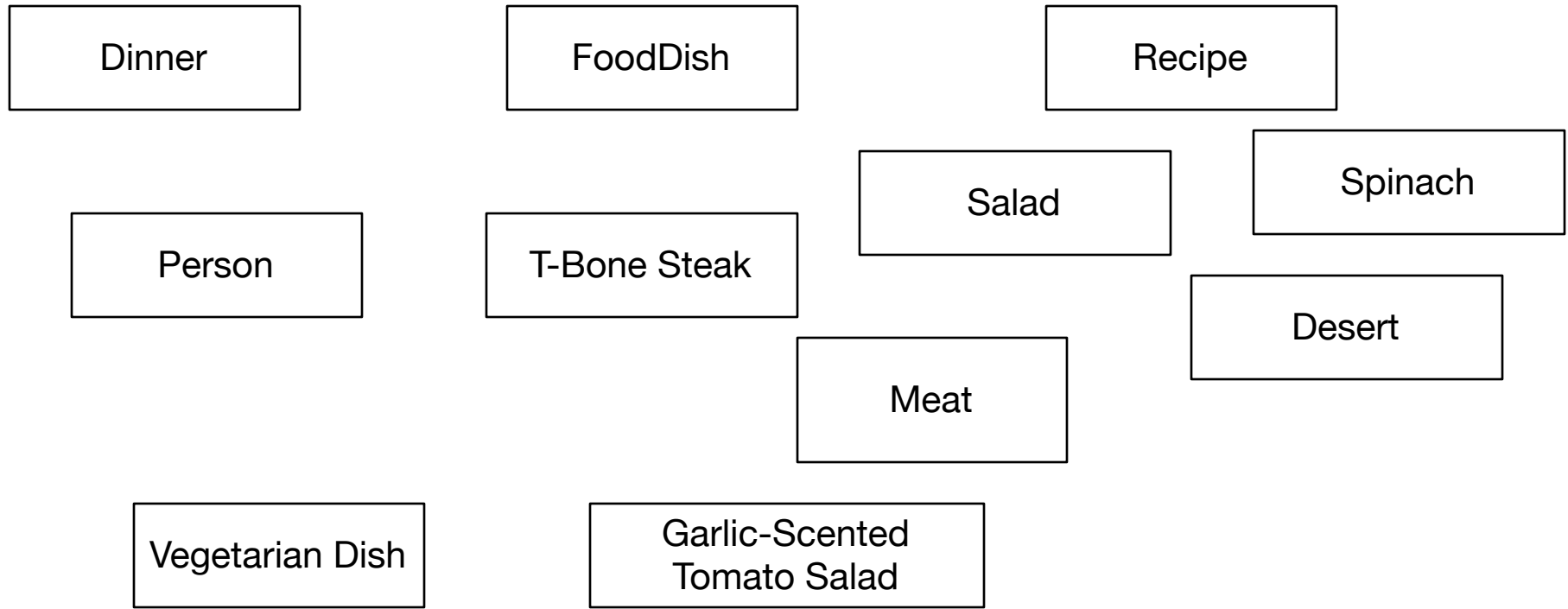
- Which dishes have meat as an ingredient?
- Which dishes are “meat dishes” and “vegetarian dishes”?
- What are some combinations of dishes
 - that are all vegetarian?
 - that have the combination of meat and vegetarian dishes for your party?

Bonus

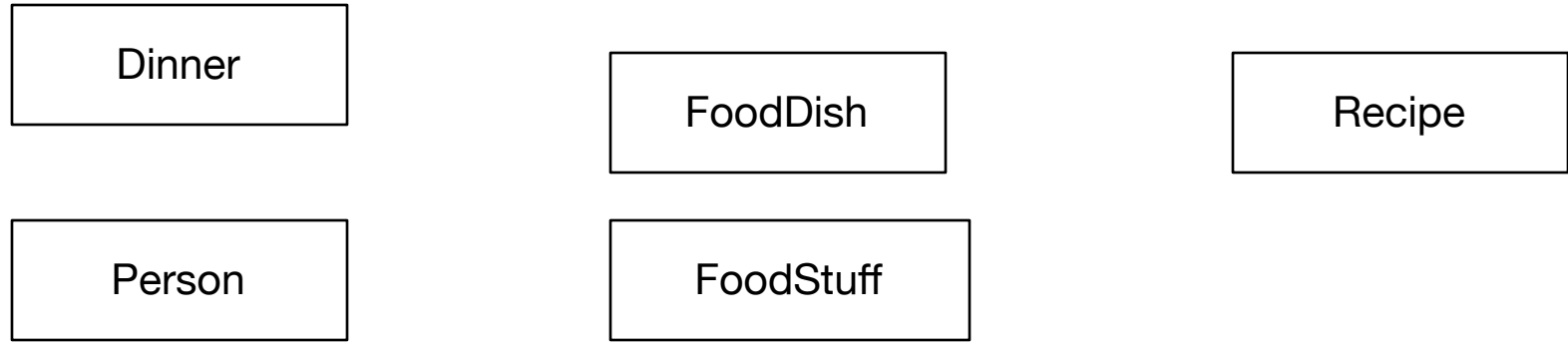
- Which recipe gives directions for a particular dish?
- Based on the recipes, what ingredients do you have to get for your dinner?

Conceptualize the Domain:

Mental Map of Terms in the Domain

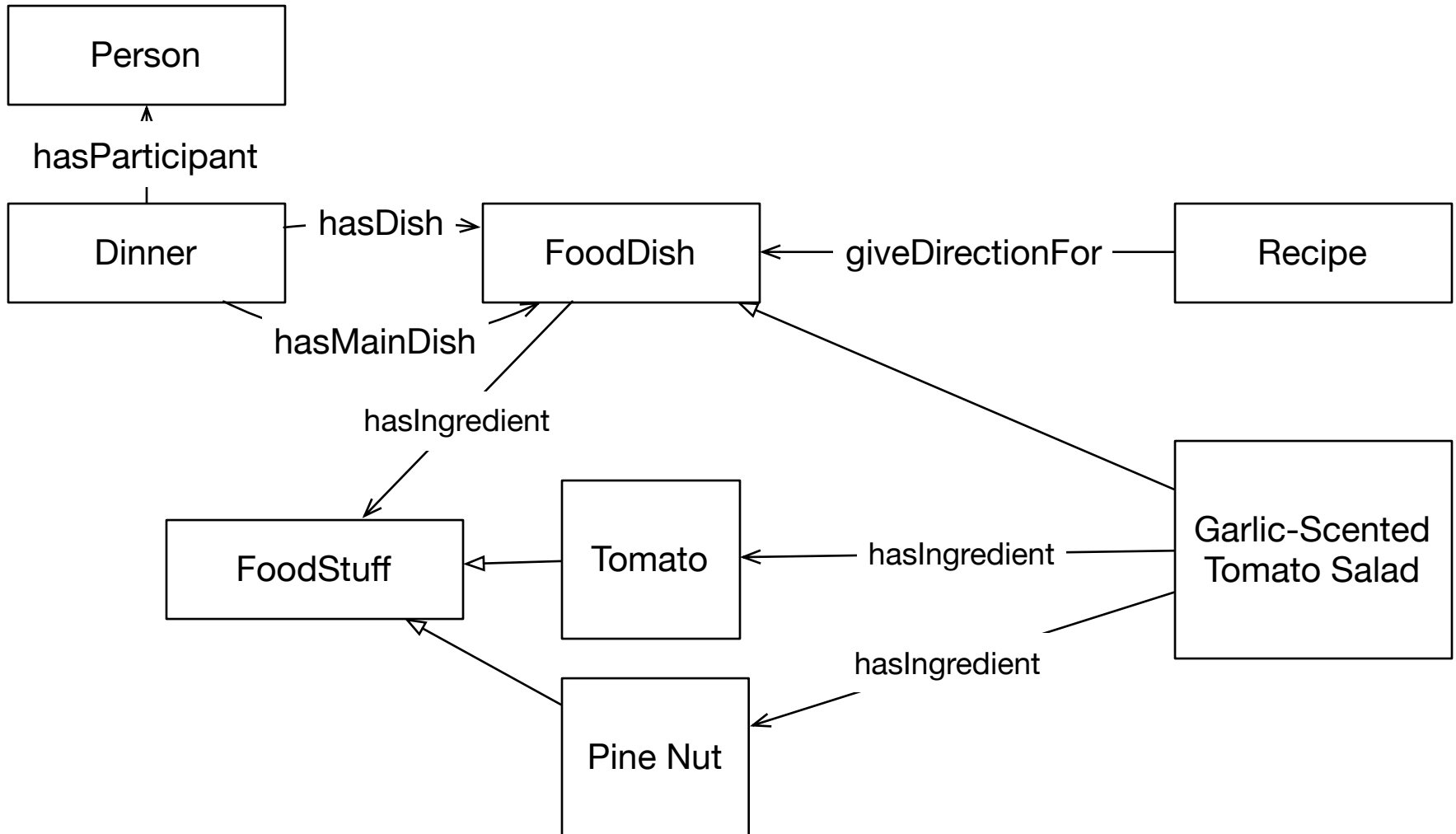


High-Level Concepts in the Domain



- What are examples of subclasses and individuals?
- What relationships should be modeled between these concepts?

One Possible Conceptualization



Organize FoodStuff into a Hierarchy:

Considerations

- Define superclass-subclass relationships that reflect is-a relationships
- Define vocabulary needed to answer competency questions
- Reuse existing definitions
- Siblings should be concepts that are similar in their levels of abstraction

A Possible Hierarchy



As defined in dinner-finished.owl in course materials

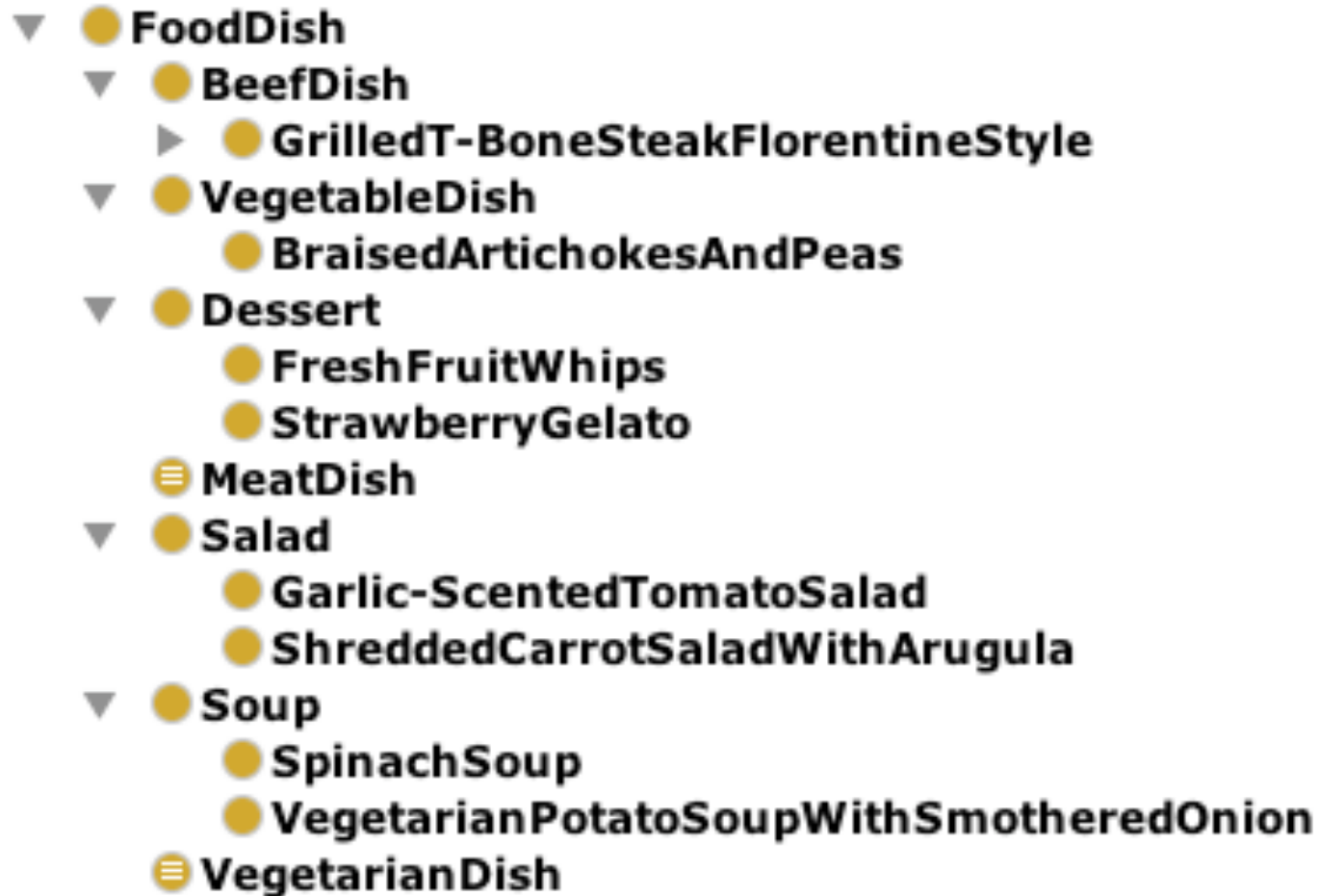
Modeling “FoodDish” and “Dinner”

- Are dishes such as “Braised Artichokes and Peas” classes or individuals?
- Class
 - Collection of individuals
 - Can be specialized
- The dinner I am hosting this Saturday versus the collection of possible dinners someone might give

Modeling Subclasses of “FoodDish”

- Subclasses based on source material
 - Salad, Soup, Beef Dish etc.
- Subclasses based on competency questions
 - Meat Dish
 - Vegetarian Dish
- Defined classes based on
 - Consensus on subject matter (e.g., source material)
 - Classification requirement

One Possible “FoodDish” Hierarchy



MainDish as a class?

What (Sub)Properties Are Needed?

- Familiar properties
 - Food dish *hasIngredient* some FoodStuff
 - Food dish *contains* some FoodStuff
- New object properties
 - Dinner *hasDish* some FoodDish
 - Dinner *hasMainDish* some FoodDish
 - Dinner *hasParticipant* some Person

Modeling “Dinner” and “FoodDish”

Description: Dinner

Equivalent To 

SubClass Of 

- **hasDish** **some** FoodDish
- **hasParticipant** **some** Person

Description: FoodDish

Equivalent To 

SubClass Of 

- **hasIngredient** **some** FoodStuff

Description: SpinachSoup


Equivalent To 


SubClass Of 

- **hasIngredient** **some** Butter
- **hasIngredient** **some** MeatBroth
- **hasIngredient** **some** Milk
- **hasIngredient** **some** Nutmeg
- **hasIngredient** **some** Onion
- **hasIngredient** **some** ParmigianoReggianoCheese
- **hasIngredient** **some** Salt
- **hasIngredient** **some** Spinach
- **Soup**

Defining and Querying for “MeatDish”

Description: MeatDish

Equivalent To 

-  **FoodDish**
and (contain **some** Meat)




DL query:

Query (class expression)

MeatDish

Query results

Subclasses (3)

-  **GrilledT-BoneSteakFlorentineStyle**
-  owl:Nothing
-  **SpinachSoup**

Why is Spinach Soup a “MeatDish”

Description: MeatDish

Equivalent To +

- FoodDish
and (contain some Meat)

Description: MeatBroth

Equivalent To +

SubClass Of +

- hasIngredient some Meat
- SoupStock

Description: SpinachSoup

Equivalent To +

SubClass Of +

- hasIngredient some Butter and hasIngredient some Milk and hasIngredient some Nutmeg and hasIngredient some Onion and hasIngredient some ParmigianoReggianoCheese and hasIngredient some Salt and hasIngredient some Spinach
- hasIngredient some MeatBroth
- Soup

☰ MeatDish

Defining Vegetarian Dish

- A vegetarian dish does not *contain* Meat

Description: VegetarianDish

Equivalent To



● **FoodDish**

and (not (contain some Meat))

Is This Dish Vegetarian?

Description: BraisedArtichokesAndPeas


Equivalent To +


SubClass Of +

- hasIngredient some Artichoke
- hasIngredient some BlackPepper
- hasIngredient some ExtraVirginOliveOil
- hasIngredient some Garlic
- hasIngredient some Lemon
- hasIngredient some Onion
- hasIngredient some Parsley
- hasIngredient some Pea
- hasIngredient some Salt
- VegetableDish

Open-World Assumption

Description: BraisedArtichokesAndPeas

Equivalent To 

SubClass Of 

- hasIngredient **some** Artichoke
- hasIngredient **some** BlackPepper
- hasIngredient **some** ExtraVirginOliveOil
- hasIngredient **some** Garlic
- hasIngredient **some** Lemon
- hasIngredient **some** Onion
- hasIngredient **some** Parsley
- hasIngredient **some** Pea
- hasIngredient **some** Salt
- VegetableDish

The dish may contain additional (unmentioned) ingredients!

Add Closure Axiom

Description: BraisedArtichokesAndPeas



SubClass Of +

contains **only** (Artichoke or BlackPepper or ExtraVirginOliveOil or Garlic or Lemon or Onion or Parsley or Pea or Salt)



- hasIngredient **some** Artichoke
- hasIngredient **some** BlackPepper
- hasIngredient **some** ExtraVirginOliveOil
- hasIngredient **some** Garlic
- hasIngredient **some** Lemon
- hasIngredient **some** Onion
- hasIngredient **some** Parsley
- hasIngredient **some** Pea
- hasIngredient **some** Salt
- VegetableDish

Description: Meat

SubClass Of +

FoodStuff

General class axioms +

SubClass Of (Anonymous Ancestor)

Instances +

Target for Key +

Disjoint With +

Condiment, SoupStock, PlantFood, CrushedIce, DairyProduct, AlcoholicDrink, VegetableOil

Alternative Approach

Description: BraisedArtichokesAndPeas

Equivalent To +

SubClass Of +

- hasIngredient some Artichoke
- hasIngredient some BlackPepper
- hasIngredient some ExtraVirginOliveOil
- hasIngredient some Garlic
- hasIngredient some Lemon
- hasIngredient some Onion
- hasIngredient some Parsley
- hasIngredient some Pea
- hasIngredient some Salt
- not (contains some Meat)
- VegetableDish

Find Combination of Dishes Suitable for My Dinner

- For Mary
 - At least one meat main dish
- For Ashok
 - A vegetarian soup or salad
 - At least one vegetarian main dish
 - A vegetarian dessert
- What is one minimal list of dishes that would be suitable for both?

General Definition of a Dinner Suitable for My Party:

A vegetarian soup or salad

At least one vegetarian main dish

A vegetarian dessert

At least one meat main dish

SubClass Of (Anonymous Ancestor)

● hasDish **some** FoodDish

● Dinner **and** (hasDish **some**
(Dessert **and** VegetarianDish)) **and** (hasDish **some**
((Salad **and** VegetarianDish) **or** (Soup **and** VegetarianDish))) **and**
(hasMainDish **some** VegetarianDish)

● Dinner **and** (hasMainDish **some** MeatDish)

A Dinner Suitable for My Party: Specific Choices

A vegetarian soup or salad

At least one vegetarian main dish

A vegetarian dessert

At least one meat main dish

Description: DinnerWithParticularDishesForVegetarianAndMeatEater_2

Equivalent To +

SubClass Of +

- Dinner
- hasDish some StrawberryGelato
- hasMainDish some Garlic-ScentedTomatoSalad
- hasMainDish some GrilledT-BoneSteakFlorentineStyle
- ☰ DinnerSuitableForVegetarianAndMeatEater

Is this what you expect?

Modeling “Recipe”

From the book *Essentials of Classic Italian Cooking* by Marcella Hazan

Garlic-Scented Tomato Salad

For 4 or 6 servings

4 to 5 garlic cloves

Salt

Pine nuts

Choice quality red wine vinegar

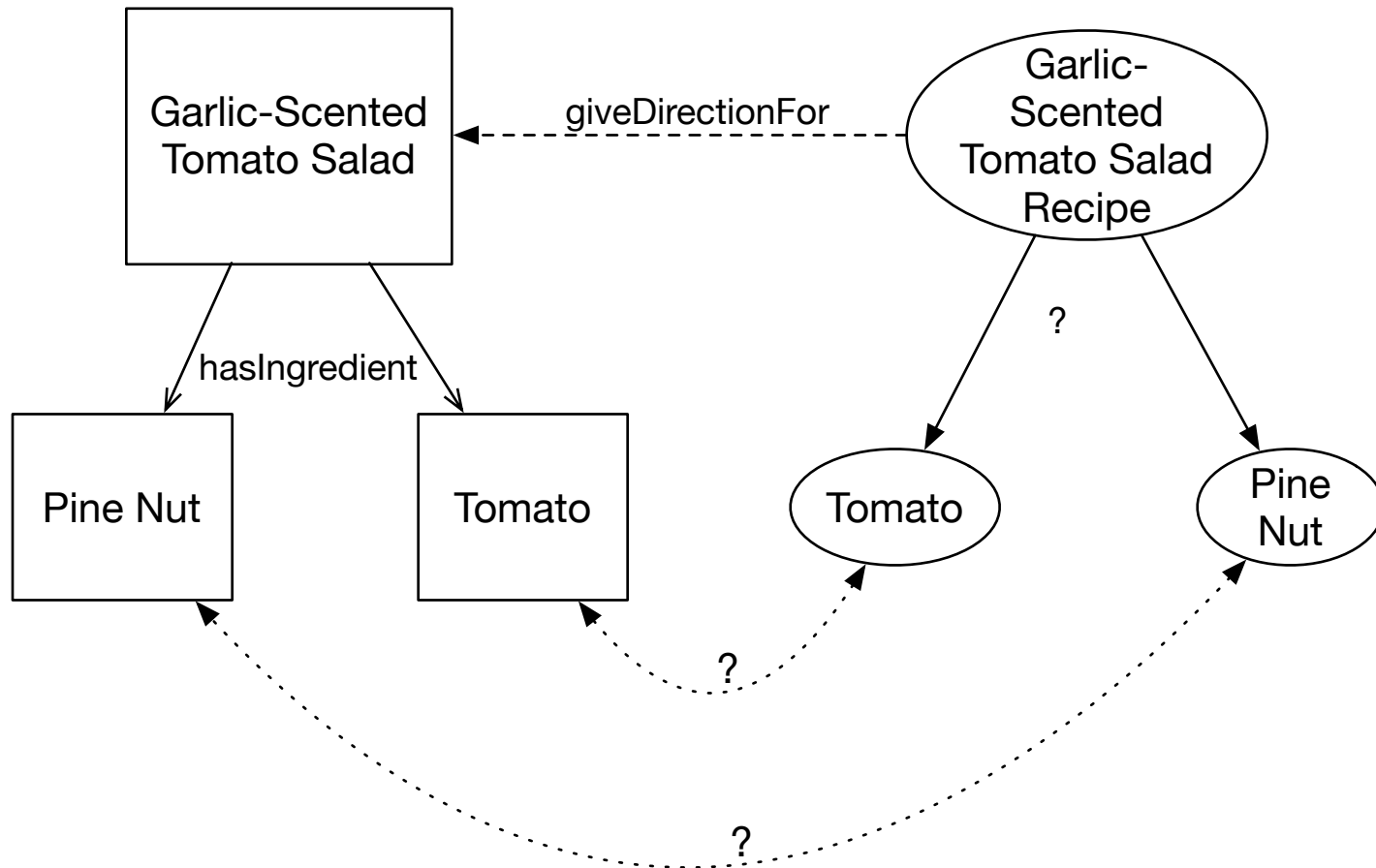
2 pounds fresh, ripe, firm, round or plum
tomatoes

1 dozen fresh basil leaves

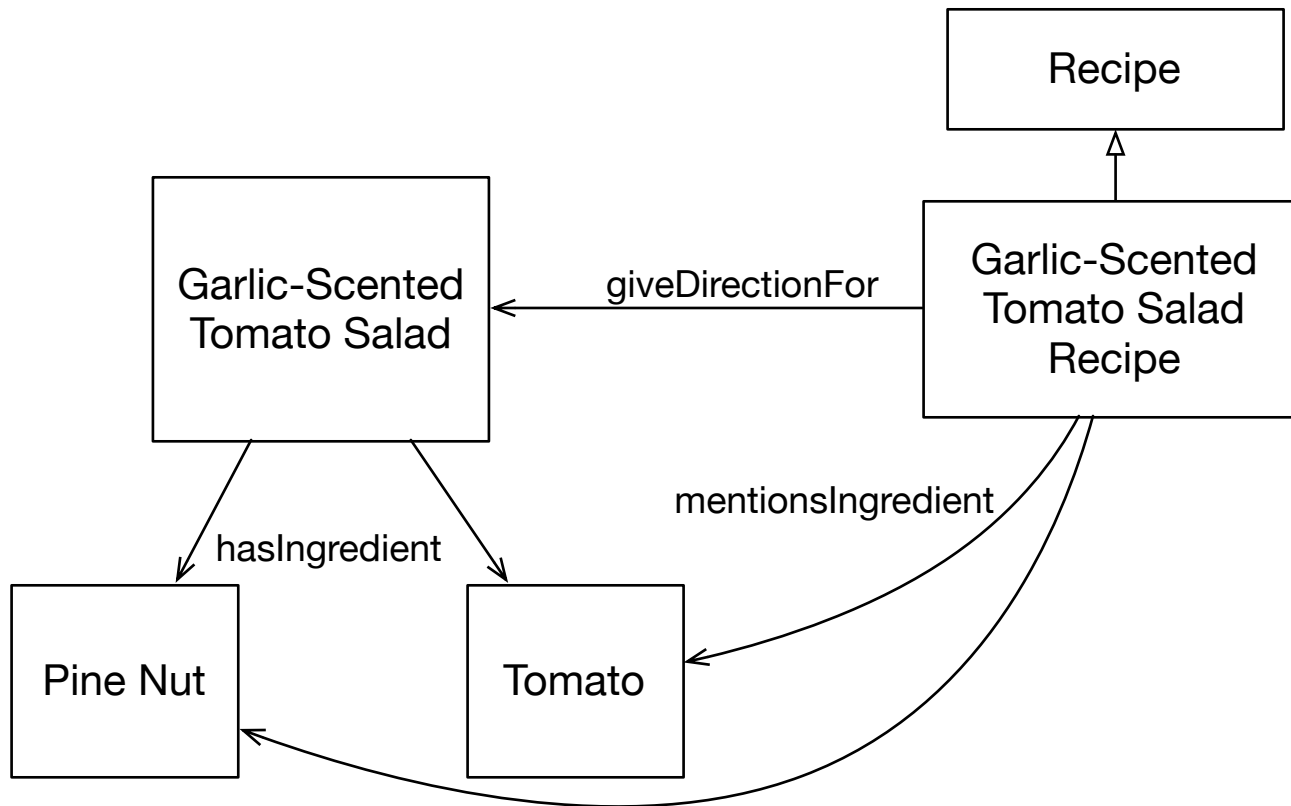
Extra virgin olive oil

What are classes and what are individuals?

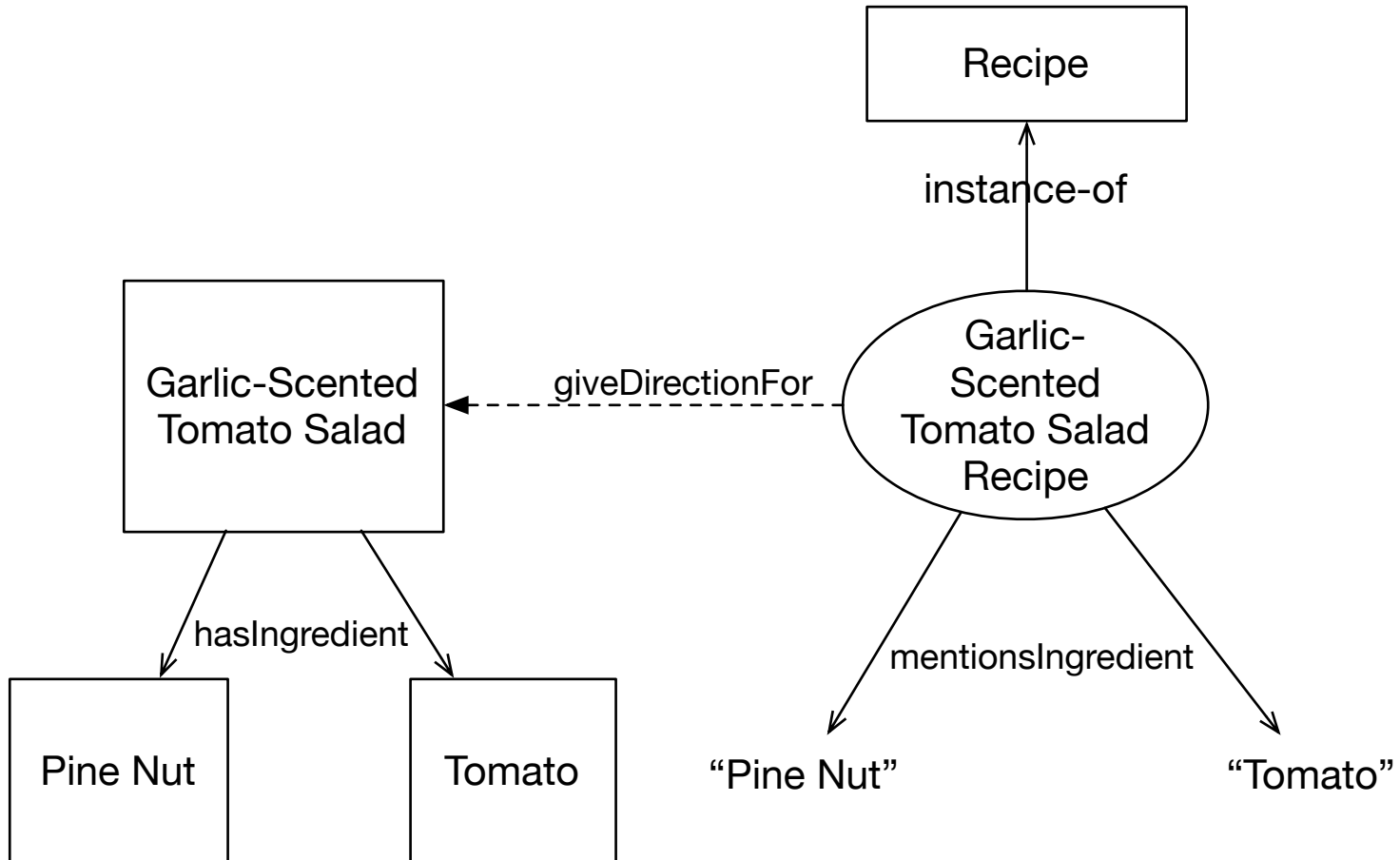
What are the Relationships Between Terms in a Recipe and Ingredients in a Dish?



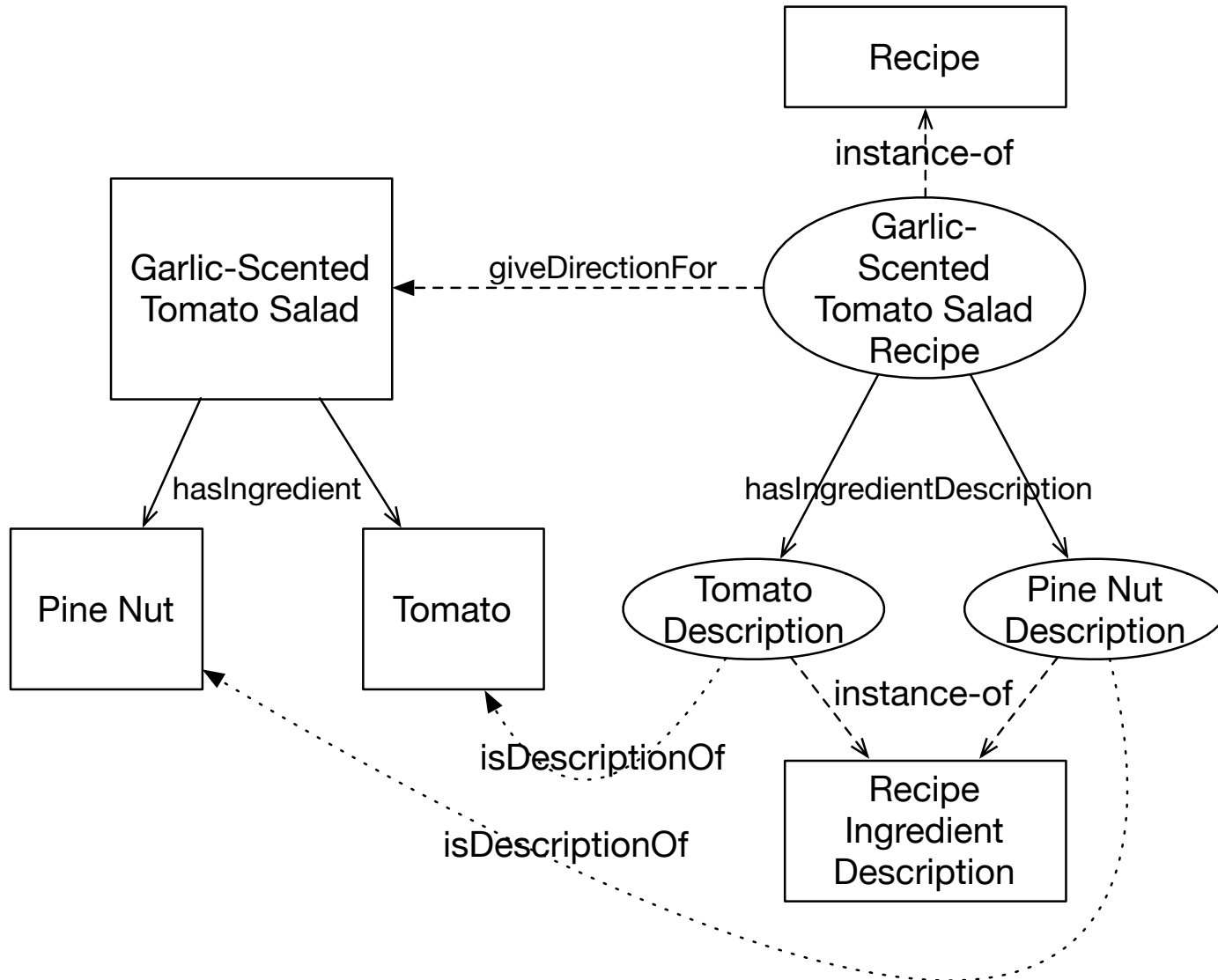
“Recipe” Modeling Choice 1



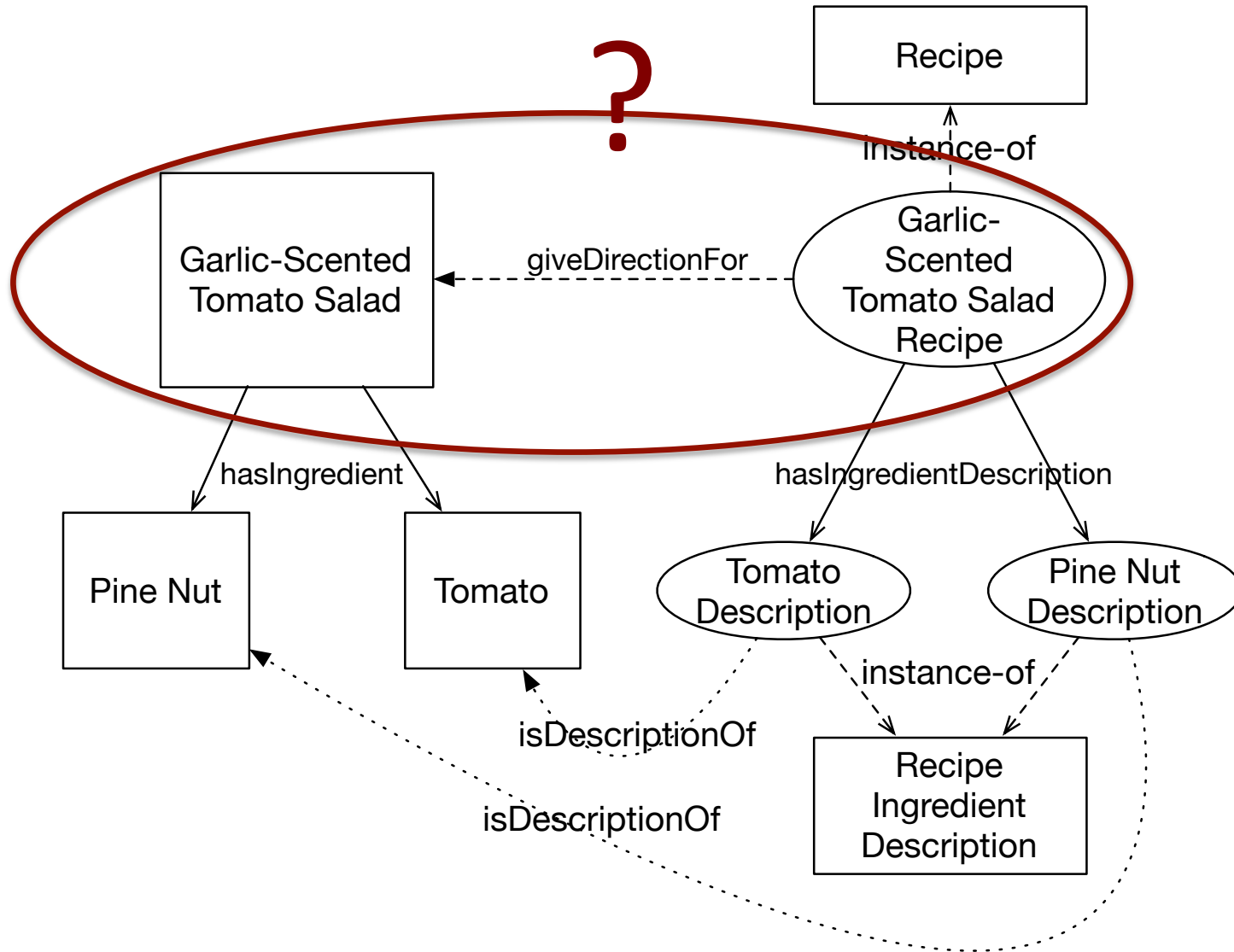
“Recipe” Modeling Choice 2



“Recipe” Modeling Choice 3



Implementing “Recipe”



Garlic-Scented Tomato Salad Recipe

Description: Garlic-ScentedTomatoSaladRe

Types +

- givesDirectionFor some Garlic-ScentedTomatoSalad ? @ X O
- Recipe ? @ X O

Same Individual As +

Different Individuals +

Property assertions: Garlic-ScentedTomatoSaladR

Object property assertions +

- hasIngredientDescription RedWineVinegarDescription ? @ X O
- hasIngredientDescription BasilLeafDescription ? @ X O
- hasIngredientDescription GarlicDescription ? @ X O
- hasIngredientDescription ExtraVirginOilDescription ? @ X O
- hasIngredientDescription TomatoDescription ? @ X O
- hasIngredientDescription SaltDescription ? @ X O
- hasIngredientDescription PineNutDescription ? @ X O

Query for Recipe that Gives Direction for a Garlic-Scented Tomato Salad

DL query:

Query (class expression)

Recipe **and** givesDirectionFor **some** Garlic-ScentedTomatoSalad

Query results

Instances (1)

◆ **Garlic-ScentedTomatoSaladRecipe**

Query for Ingredients Descriptions of a Recipe

Use SPARQL

Property assertions: Garlic-ScentedTomatoSaladRecipe

Object property assertions +

- hasIngredientDescription
RedWineVinegarDescription
- hasIngredientDescription
BasilLeafDescription
- hasIngredientDescription
GarlicDescription
- hasIngredientDescription
ExtraVirginOilDescription
- hasIngredientDescription
TomatoDescription
- hasIngredientDescription
SaltDescription
- hasIngredientDescription
PineNutDescription

SPARQL query:

```
PREFIX : <http://www.protege.stanford.edu/dinner/>  
SELECT ?object  
WHERE { :Garlic-ScentedTomatoSaladRecipe :hasIngredientDescription ?object }
```

object
SaltDescription
ExtraVirginOilDescription
RedWineVinegarDescription
BasilLeafDescription
PineNutDescription
GarlicDescription
TomatoDescription

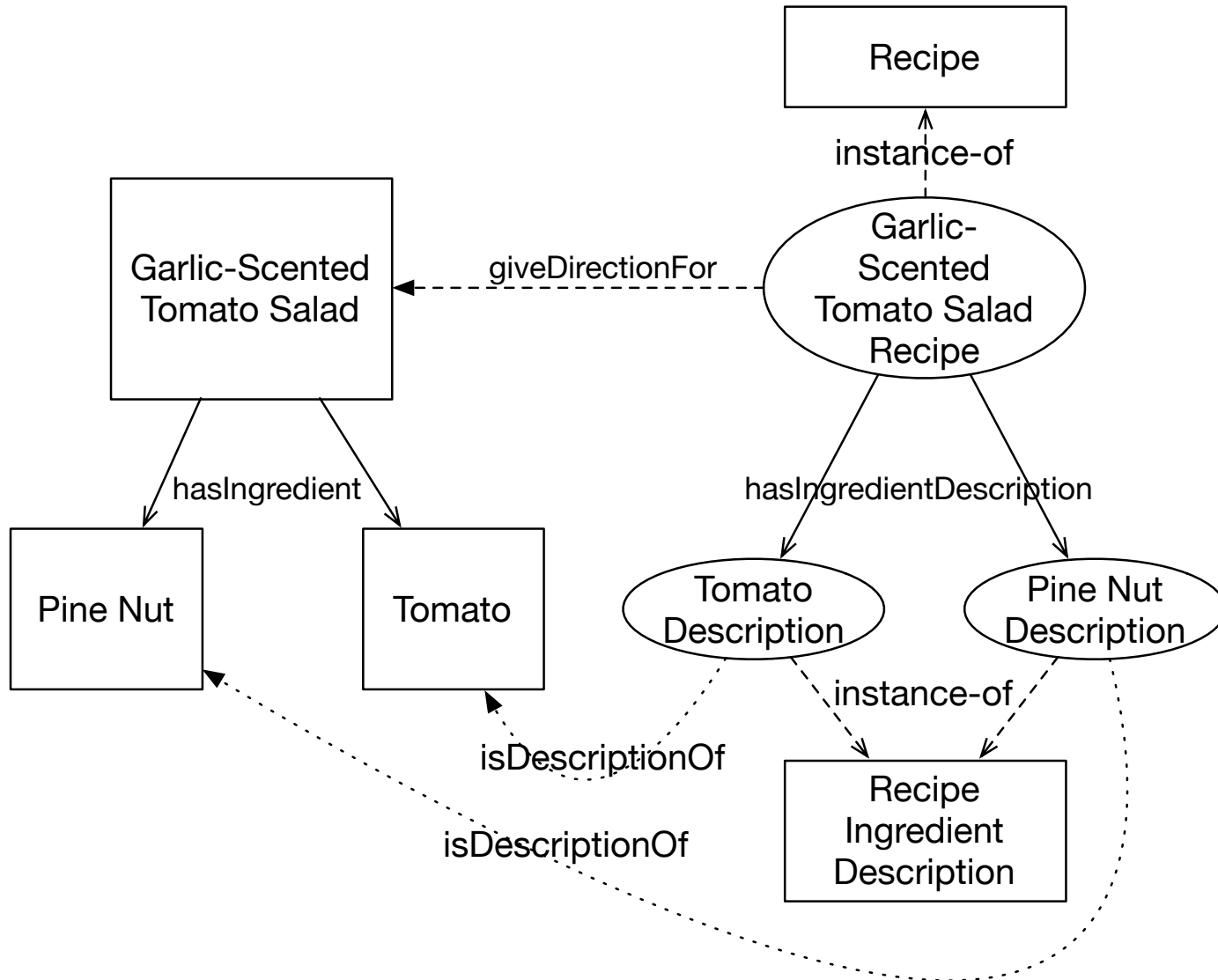
Class Expression for Ingredient Descriptions of a Recipe?

Property assertions: Garlic-ScentedTomatoSaladRecipe		
Object property assertions +		
<input checked="" type="checkbox"/> hasIngredientDescription	?	@
RedWineVinegarDescription		x
<input checked="" type="checkbox"/> hasIngredientDescription	?	@
BasilLeafDescription		x
<input checked="" type="checkbox"/> hasIngredientDescription	?	@
GarlicDescription		x
<input checked="" type="checkbox"/> hasIngredientDescription	?	@
ExtraVirginOilDescription		x
<input checked="" type="checkbox"/> hasIngredientDescription	?	@
TomatoDescription		x
<input checked="" type="checkbox"/> hasIngredientDescription	?	@
SaltDescription		x
<input checked="" type="checkbox"/> hasIngredientDescription	?	@
PineNutDescription		x

- Find the set of **ingredient descriptions** that *are mentioned in the Garlic-Scented Tomato Salad recipe*

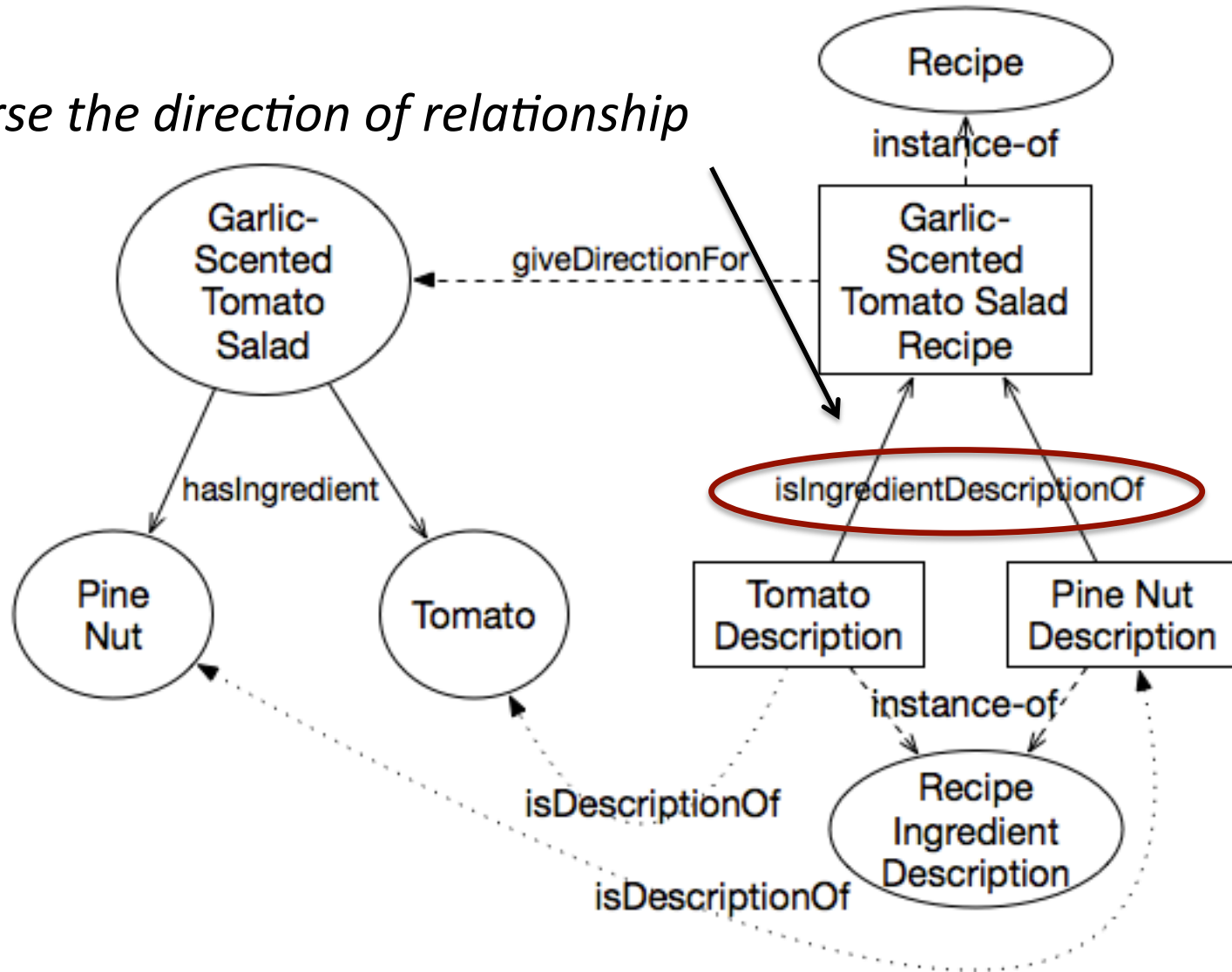
RecipeIngredientDescription and (?? ?? GarlicScentedTomatoSaladRecipe)

“Recipe” Modeling Choice 3



Ingredients Mentioned in a Recipe

Reverse the direction of relationship



Query Ingredients Mentioned in a Recipe

DL query:

Query (class expression)

RecipeIngredientDescription and isIngredientDescriptionOf value Garlic-ScentedTomatoSaladRecipe

Execute

Add to ontology

Query results

Instances (7)

◆ ExtraVirginOilDescription	?
◆ BasilLeafDescription	?
◆ PineNutDescription	?
◆ GarlicDescription	?
◆ RedWineVinegarDescription	?
◆ TomatoDescription	?
◆ SaltDescription	?

☐ Direct superclasses

☐ Superclasses

☐ Equivalent classes

☐ Direct subclasses

☒ Subclasses

☒ Instances

Query Ingredients Mentioned in a Recipe (Use Inverse Property)

DL query:

Query (class expression)

RecipeIngredientDescription and (inverse hasIngredientDescription value Garlic-ScentedTomatoSaladRecipe)

Execute

Add to ontology

Query results

Instances (7)

- ◆ ExtraVirginOilDescription
- ◆ BasilLeafDescription
- ◆ PineNutDescription
- ◆ GarlicDescription
- ◆ TomatoDescription
- ◆ SaltDescription
- ◆ RedWineVinegarDescription

?

?

?

?

?

?

?

☐☐☐☐☐☒

What Ingredients Do You Have to Get?

DL query:

Query (class expression)

RecipeIngredientDescription and isIngredientDescriptionOf some {
Garlic-ScentedTomatoSaladRecipe, GrilledT-BoneSteakFlorentineStyleRecipe, StrawberryGelatoRecipe}

Execute

Add to ontology

Query results

Instances (12)

◆ ExtraVirginOilDescription	?
◆ BasilLeafDescription	?
◆ T-BoneBeefSteakDescription	?
◆ StrawberryDescription	?
◆ PineNutDescription	?
◆ SugarDescription	?
◆ GarlicDescription	?
◆ BlackPepperCornDescription	?
◆ WhippingCreamDescription	?
◆ RedWineVinegarDescription	?
◆ TomatoDescription	?
◆ SaltDescription	?

☐ Direct superclasses

☐ Superclasses

☐ Equivalent classes

☐ Direct subclasses

☐ Subclasses

☒ Instances

Can you write a DL query to get the ingredients of the dishes?

Description: GrilledT-BoneSteakFlorentineStyle

Equivalent To +

SubClass Of +

- BeefDish
- hasIngredient some BlackPepperCorn
- hasIngredient some ExtraVirginOliveOil
- hasIngredient some Salt
- hasIngredient some T-BoneBeefSteak
- ☰ MeatDish

DL query:

Query (class expression)

???

Execute

Add to ontology

Query results

Superclasses (1)

● Thing

Subclasses (65)

● AlcoholicDrink

● Apple

● Artichoke

● Arugula

● Banana

Querying for Ingredients of Dishes

- DL query is a class expression for which ingredients need to be subclasses/superclasses/individuals
- Each dish uses **some**, not all, individuals of ingredient class
- Easier to query for ingredient descriptions of recipes: construct a class whose individuals are the desired ingredient descriptions

DL query:

Query (class expression)

???

Execute Add to ontology

Query results

Superclasses (1)

- Thing

Subclasses (65)

- AlcoholicDrink
- Apple
- Artichoke
- Arugula
- Banana

Modeling Exercise

- Conceptualization of domain
 - Food stuff, food dish, dinner and their properties
- Modeling decisions
 - Recipe and its relationship to food dish
- OWL language
 - Classes, properties, individuals, restrictions
- Queries
 - SPARQL, DL query