# Specification Pattern

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May 16, 2012

## Software Patterns

- There is a large and growing literature & community centered around “software patterns”
- “Software patterns” are (frequently informally) identified interactions among software elements that serve some need
- Frequently the same sort of pattern can play a role in many different contexts

## Motivations

- A rule is duplicated in many different forms in different code
  - Some to see if particular object  matches (if or switch/case stmts.)
  - Some as SQL query
  - Some as test to collect from collection
  - Some as assertions
- Burying of rule abstraction in somewhat arbitrary object
- There is a combinatorial explosion of different methods for varying subsets of data

## Bad Smell 1: Combinatorial Explosion

- Count Males/Females/young/elderly/First Nations/Metis/Caucasians/Male First Nations/Female First Nations/…/Susceptible/Infective/…Combiations...
- Compute prevalence among Males/Females/young/elderly/First Nations/Metis/Caucasians/Male First Nations/Female First Nations/…/Susceptible/Infective/…Combiations...
- Perform intervention on Males/Females/young/elderly/First Nations/Metis/Caucasians/Male First Nations/Female First Nations/…/Susceptible/Infective/…Combiations...

## Bad Smell 2: Many Independent Statistics

- When called, each statistic performs a separate pass over the population

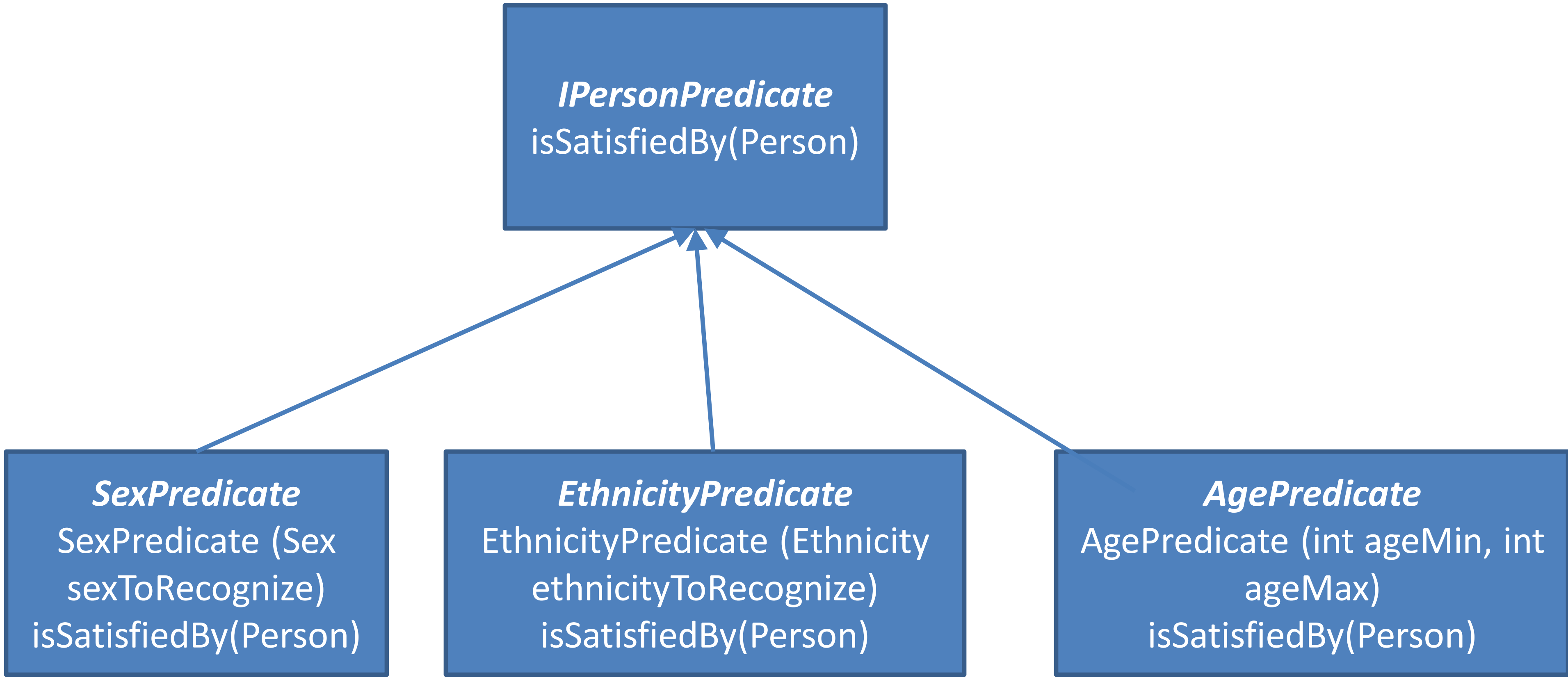
# Key Idea

- Single immutable object that specifies some subset of domain objects
  - Often encapsulates general *criteria*
  - collects all related logic for a condition
    - Count agents matching condition
    - Count fraction of agents matching condition A & B out of those matching just A (e.g. fraction of Children that are infected)
    - Select objects (retrieves a list)
      - matching specific criteria
      - matching range of criteria
    - Specify conditions for who is acted upon (e.g. via intervention)
- Factory creates with enough context to evaluate predicate from simple arguments (e.g. agent)

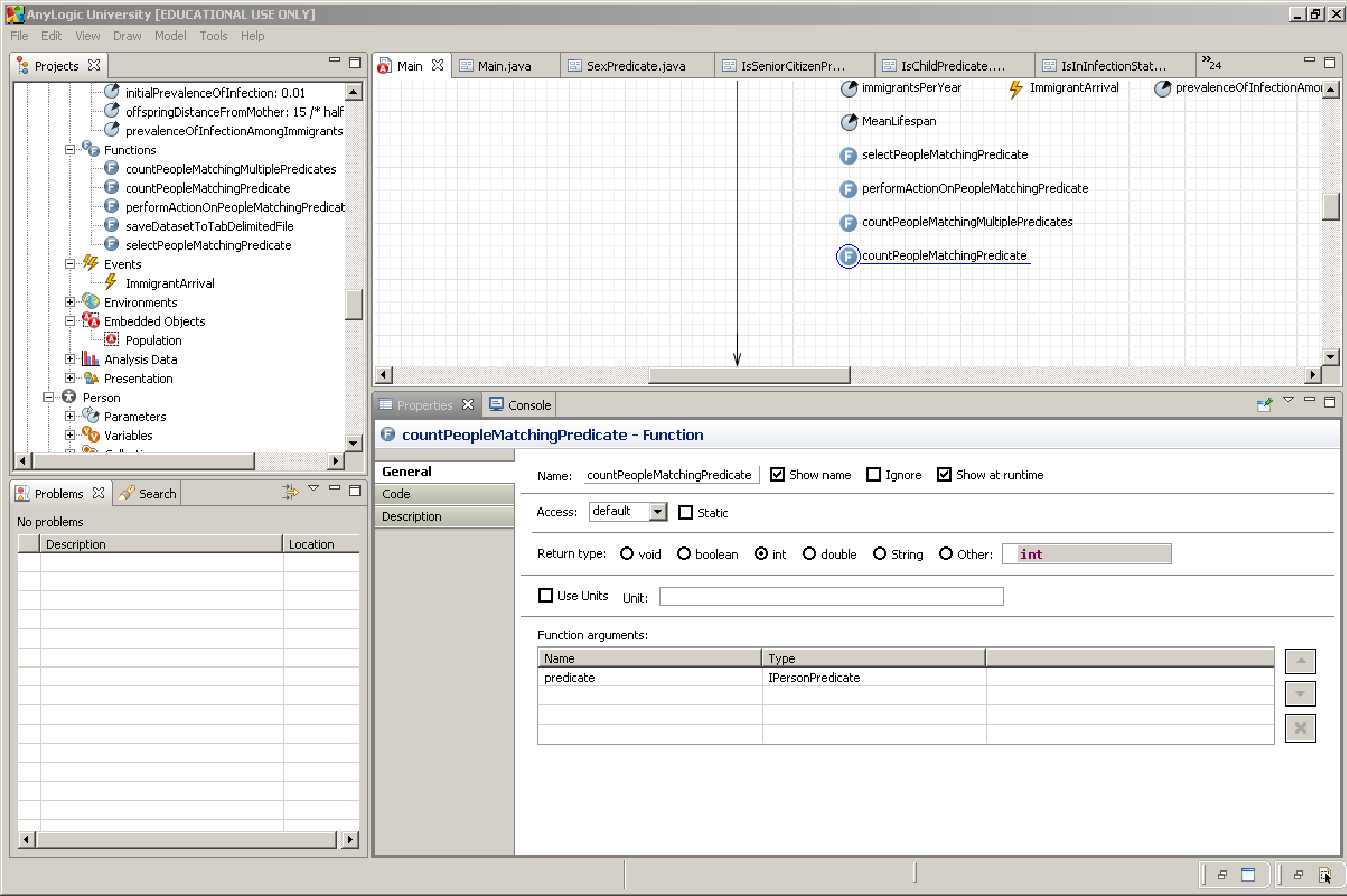
## Enhancing the Concept

- Subtyping of specifications
- Enabling combination of specifications

# Specification Subtyping



# Counting Persons Matching a Specification



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offspringDistanceFromMother: 15 /* half
prevalenceOfInfectionAmongImmigrants
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saveDatasetToTabDelimitedFile
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Console
General
Code
Description

countPeopleMatchingPredicate - Function

Name: countPeopleMatchingPredicate [✓ Show name] [ Ignore] [✓ Show at runtime]

Access: default [ Static]

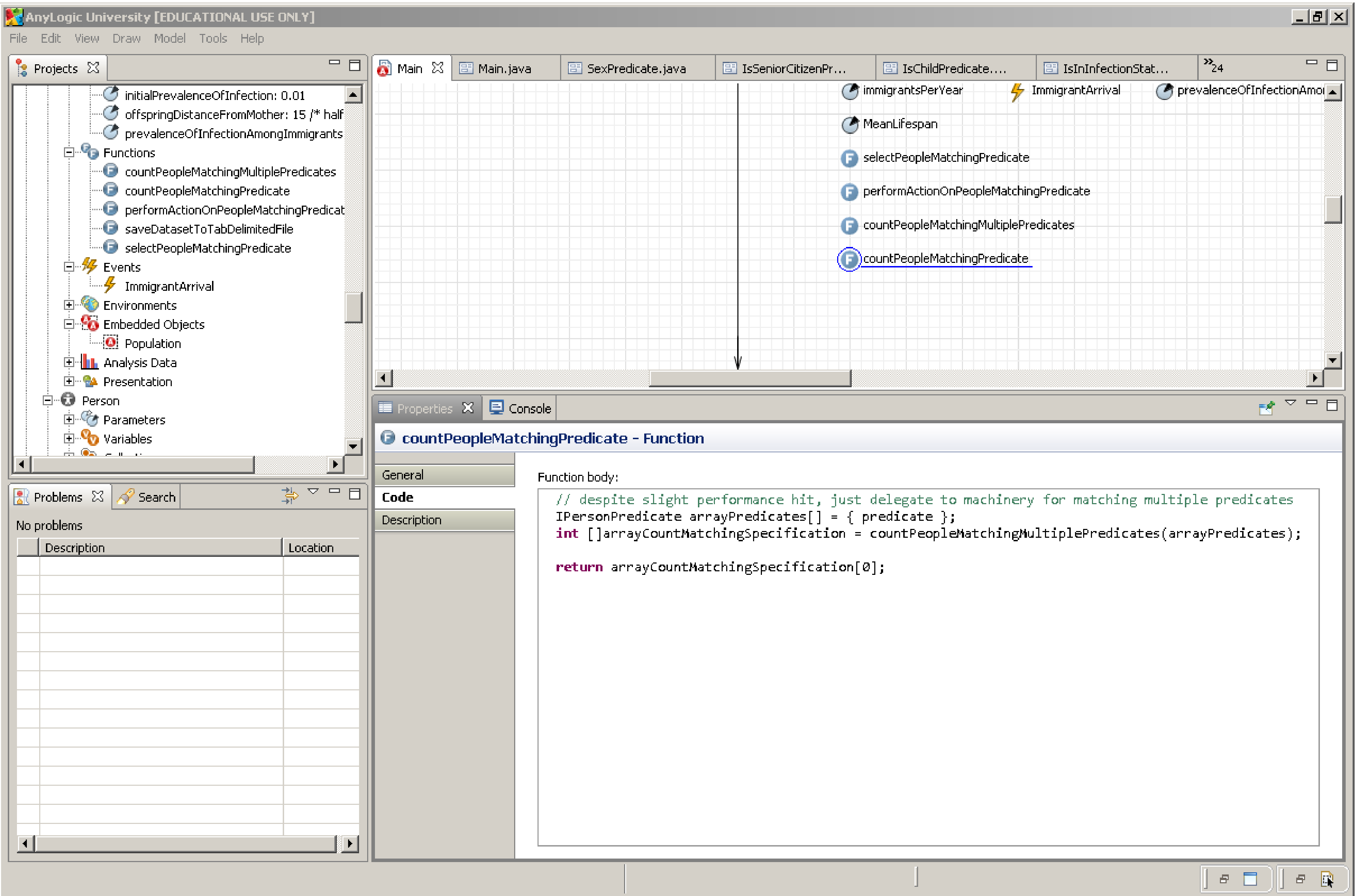
Return type: void boolean [✓ int] double String Other: int

[ Use Units] Unit:

Function arguments:

| Name | Type |
|---|---|
| predicate | IPersonPredicate |

# Method Body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Description

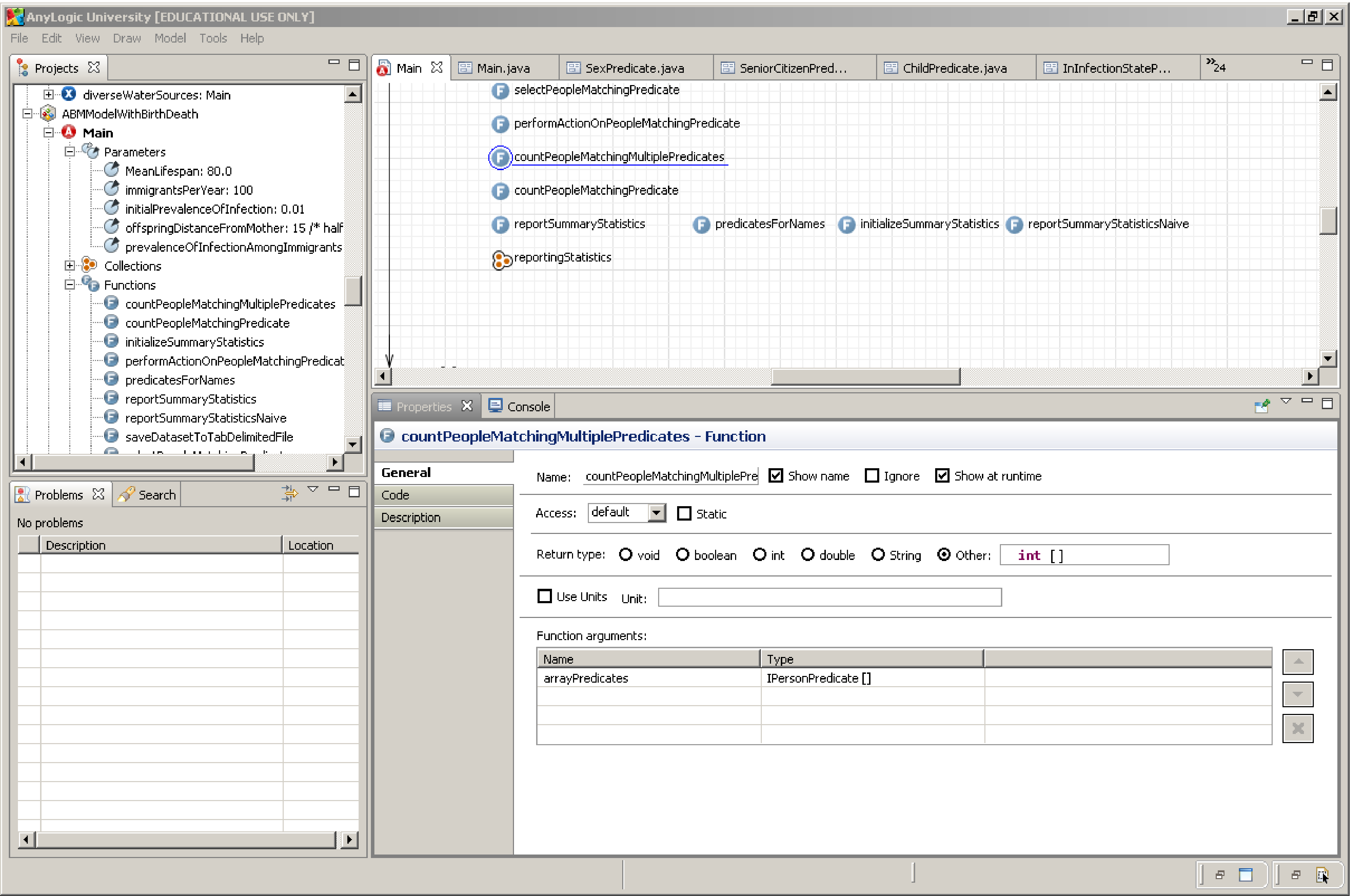
**countPeopleMatchingPredicate - Function**

Function body:

```
// despite slight performance hit, just delegate to machinery for matching multiple predicates
IPersonPredicate arrayPredicates[] = { predicate };
int []arrayCountMatchingSpecification = countPeopleMatchingMultiplePredicates(arrayPredicates);

return arrayCountMatchingSpecification[0];
```

# Method to Count Matching Multiple Specifications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offspringDistanceFromMother: 15 /* half
prevalenceOfInfectionAmongImmigrants
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countPeopleMatchingPredicate
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reportingStatistics
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Description

**countPeopleMatchingMultiplePredicates - Function**

Name: countPeopleMatchingMultiplePre [✓ Show name] ☐ Ignore [✓ Show at runtime]

Access: default ☐ Static

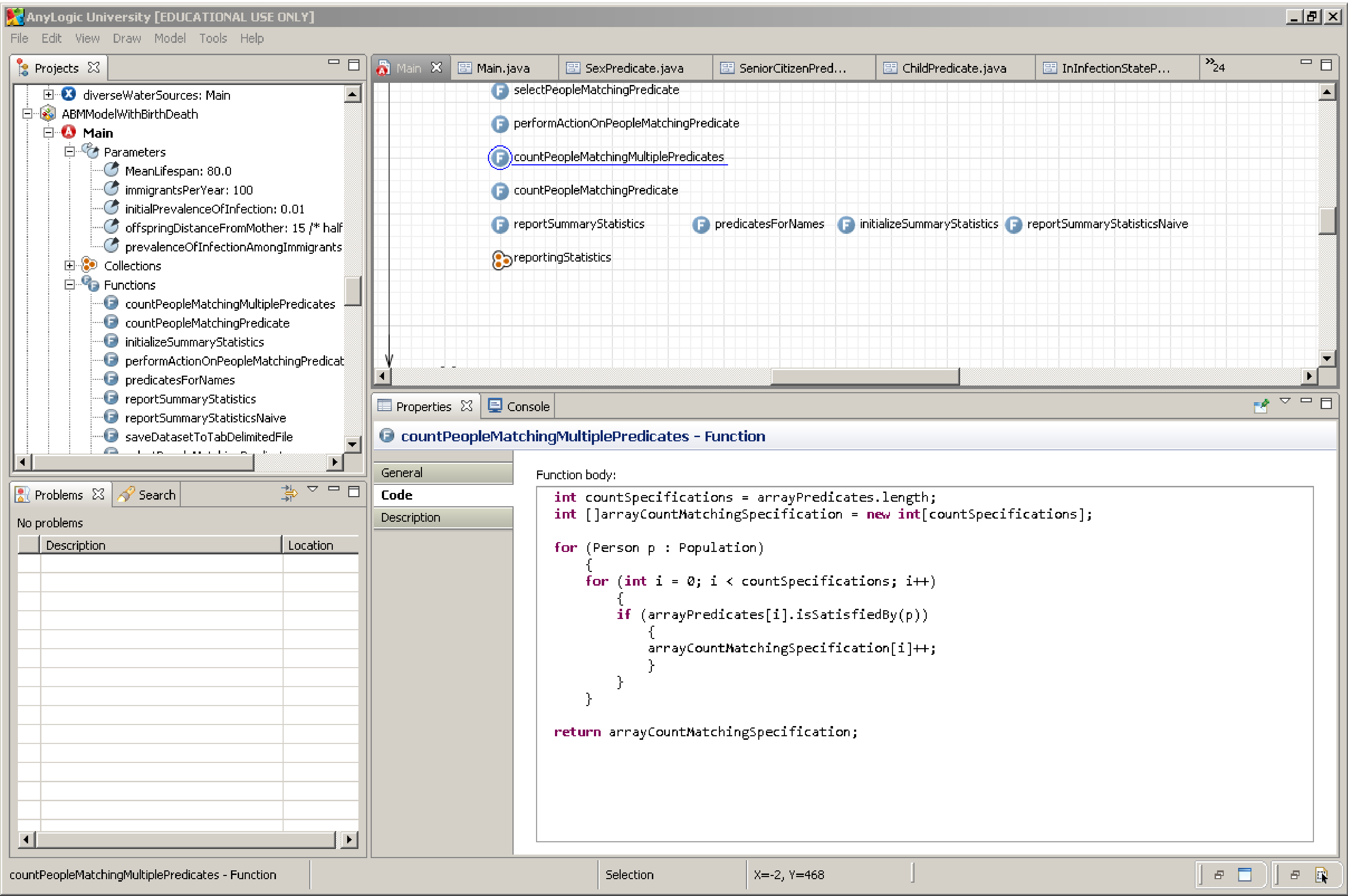
Return type: ○ void ○ boolean ○ int ○ double ○ String [✓ Other:] `int []`

☐ Use Units Unit:

Function arguments:

| Name | Type | |
|---|---|---|
| arrayPredicates | IPersonPredicate [] | |

# Count



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countPeopleMatchingMultiplePredicates - Function
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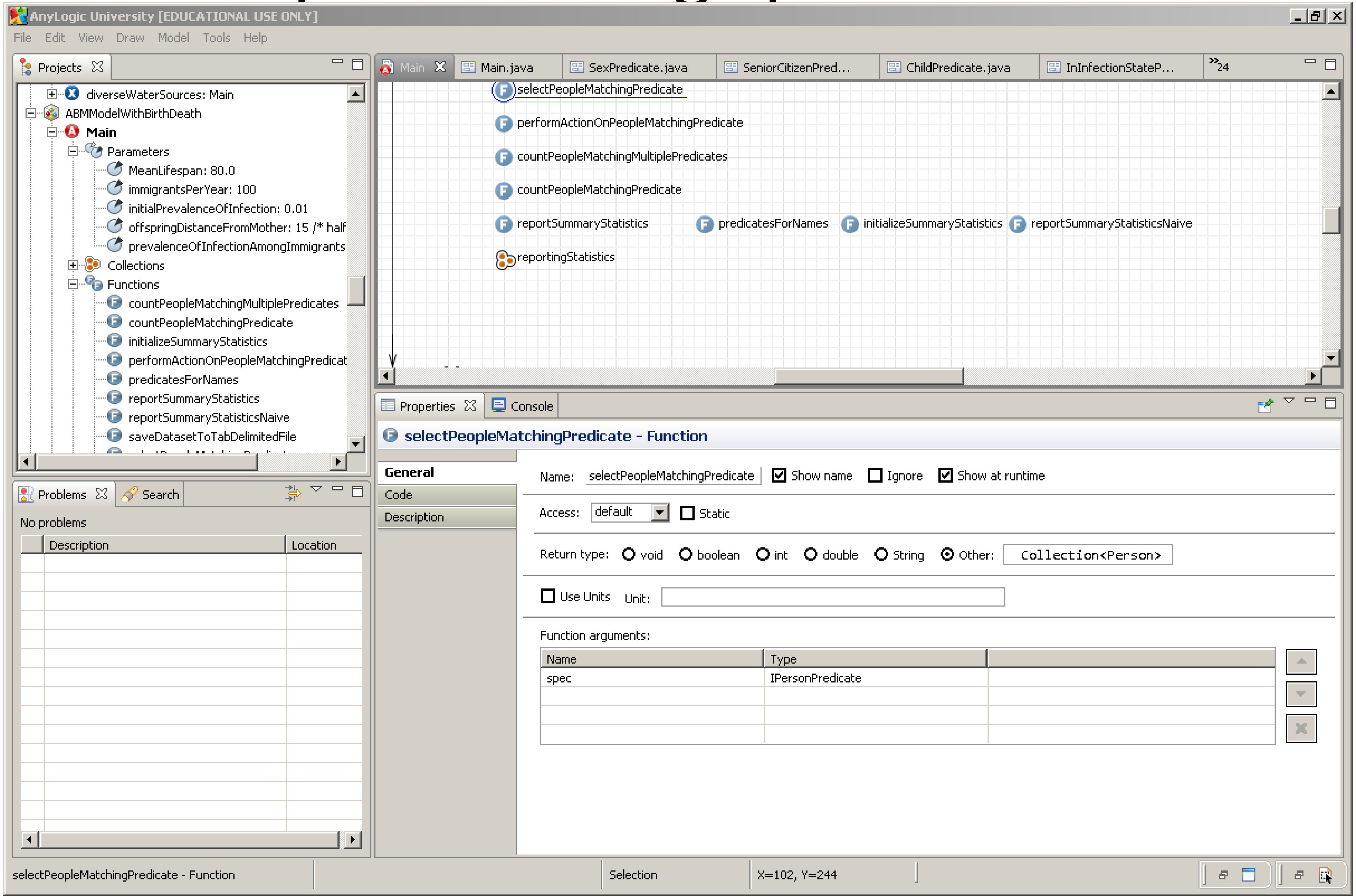
Function body:
countPeopleMatchingMultiplePredicates - Function
Selection
X=-2, Y=468

```
int countSpecifications = arrayPredicates.length;
int []arrayCountMatchingSpecification = new int[countSpecifications];

for (Person p : Population)
    {
    for (int i = 0; i < countSpecifications; i++)
        {
        if (arrayPredicates[i].isSatisfiedBy(p))
            {
            arrayCountMatchingSpecification[i]++;
            }
        }
    }

return arrayCountMatchingSpecification;
```

# Function to Retrieve People Matching Specification



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Projects tree:

- diverseWaterSources: Main
- ABMModelWithBirthDeath
  - Main
    - Parameters
      - MeanLifespan: 80.0
      - immigrantsPerYear: 100
      - initialPrevalenceOfInfection: 0.01
      - offspringDistanceFromMother: 15 /* half
      - prevalenceOfInfectionAmongImmigrants
    - Collections
    - Functions
      - countPeopleMatchingMultiplePredicates
      - countPeopleMatchingPredicate
      - initializeSummaryStatistics
      - performActionOnPeopleMatchingPredicat
      - predicatesForNames
      - reportSummaryStatistics
      - reportSummaryStatisticsNaive
      - saveDatasetToTabDelimitedFile

Canvas elements: selectPeopleMatchingPredicate, performActionOnPeopleMatchingPredicate, countPeopleMatchingMultiplePredicates, countPeopleMatchingPredicate, reportSummaryStatistics, predicatesForNames, initializeSummaryStatistics, reportSummaryStatisticsNaive, reportingStatistics

Problems: No problems

| Description | Location |
|---|---|

**selectPeopleMatchingPredicate - Function**

Name: selectPeopleMatchingPredicate [✓ Show name] ☐ Ignore [✓ Show at runtime]

Access: default ☐ Static

Return type: ○ void ○ boolean ○ int ○ double ○ String [✓ Other:] Collection<Person>

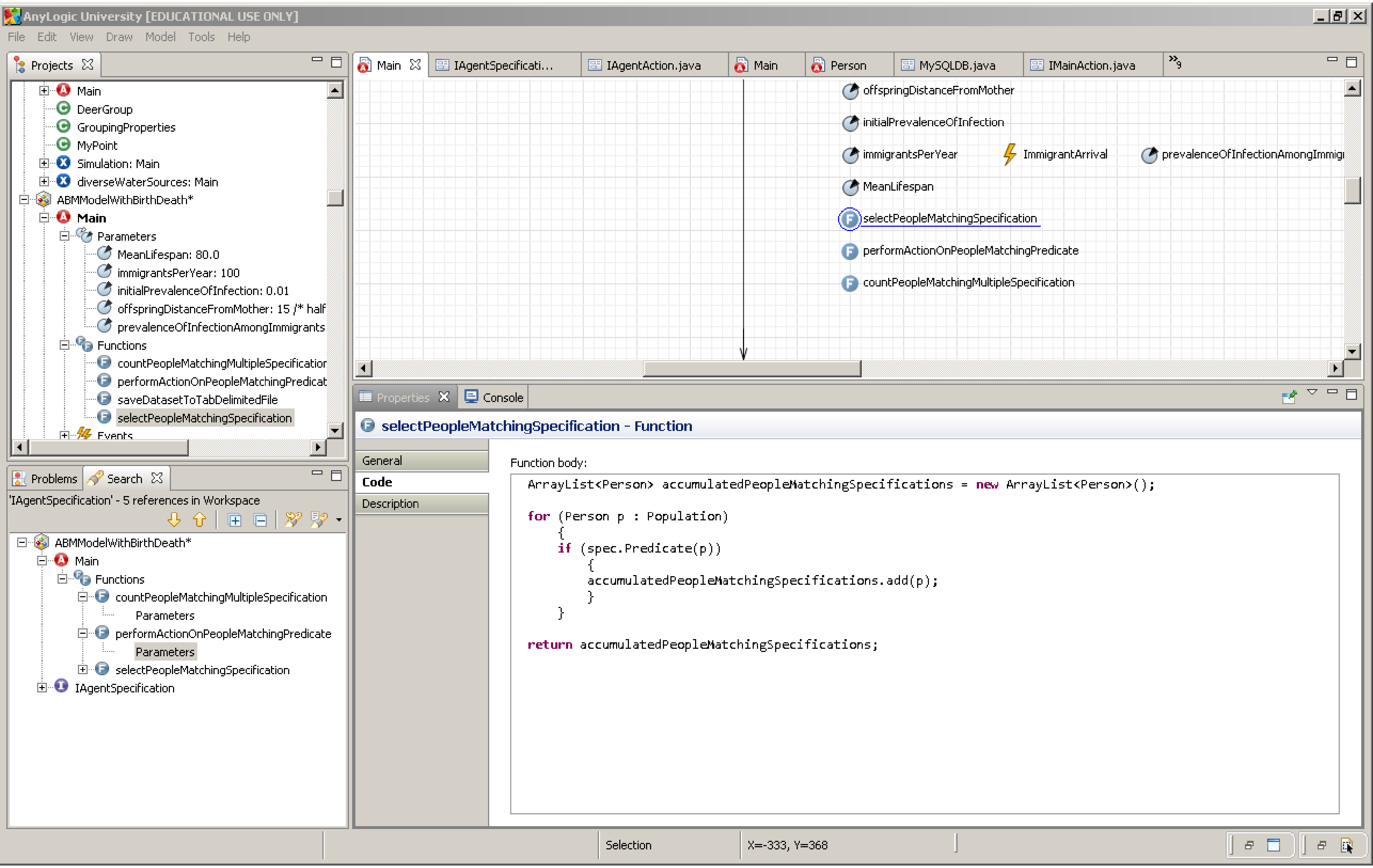
☐ Use Units Unit:

Function arguments:

| Name | Type |
|---|---|
| spec | IPersonPredicate |

selectPeopleMatchingPredicate - Function | Selection | X=102, Y=244

# Body of Code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selectPeopleMatchingSpecification - Function
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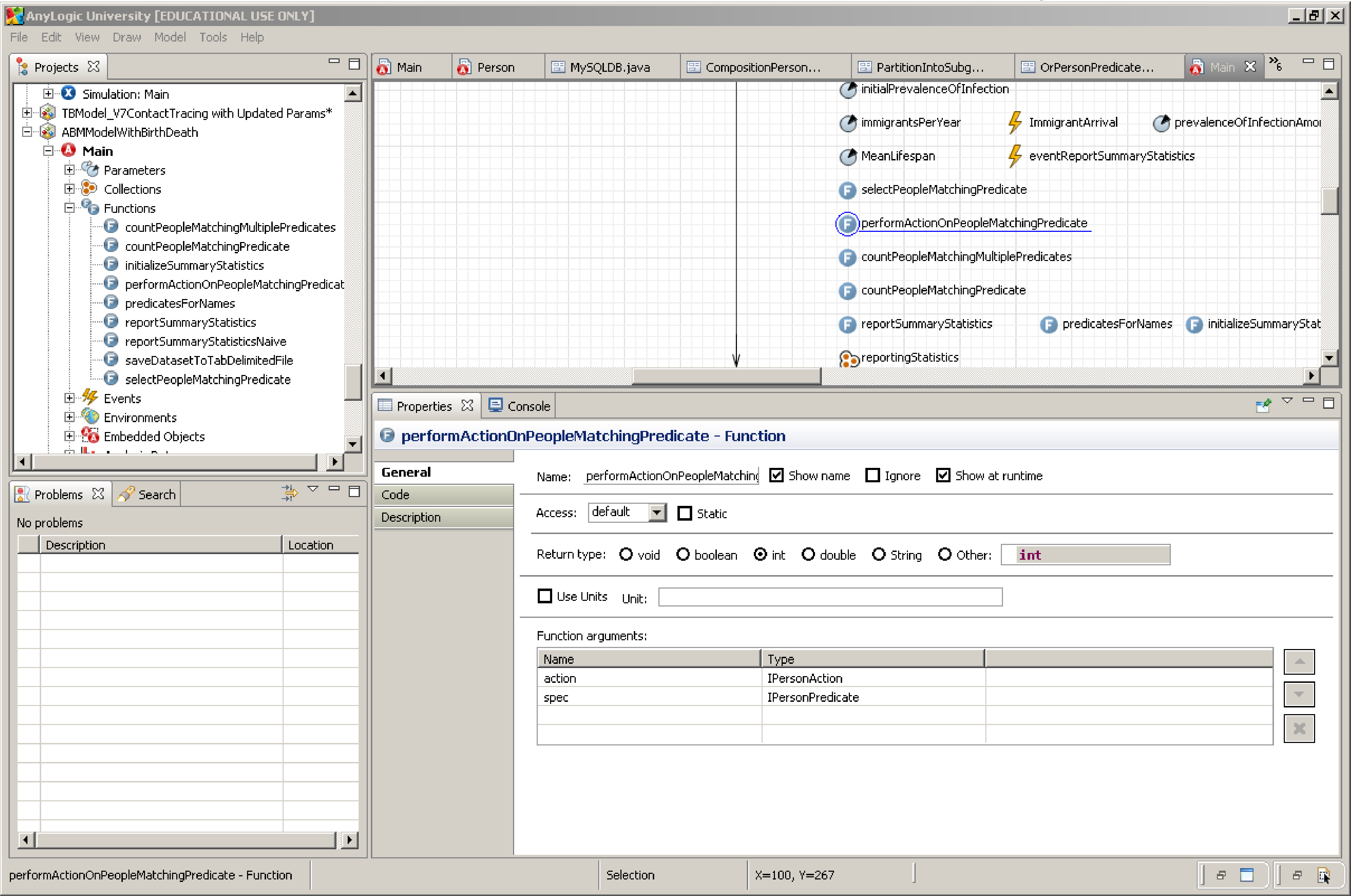
Function body:
Selection
X=-333, Y=368

```
ArrayList<Person> accumulatedPeopleMatchingSpecifications = new ArrayList<Person>();

for (Person p : Population)
    {
    if (spec.Predicate(p))
        {
        accumulatedPeopleMatchingSpecifications.add(p);
        }
    }

return accumulatedPeopleMatchingSpecifications;
```

# Method to Perform Action Based on Specification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Description
Selection
X=100, Y=267

performActionOnPeopleMatchingPredicate - Function

Name: performActionOnPeopleMatching [✓ Show name] [ ] Ignore [✓ Show at runtime]

Access: default [ ] Static

Return type: void boolean [✓ int] double String Other: int

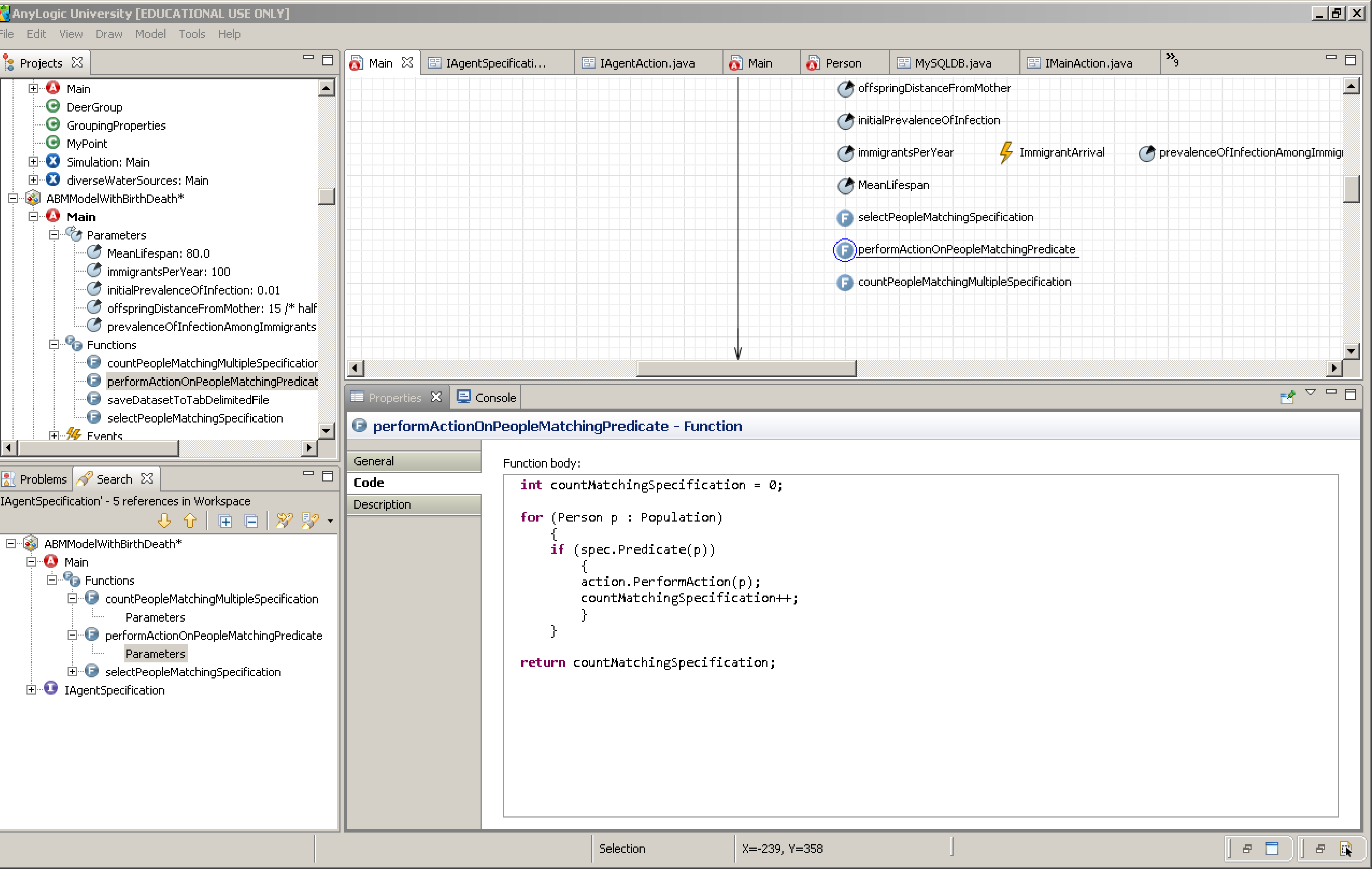
[ ] Use Units Unit:

Function arguments:

| Name | Type |
|---|---|
| action | IPersonAction |
| spec | IPersonPredicate |

performActionOnPeopleMatchingPredicate - Function

# Performing Action



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Selection
X=-239, Y=358

performActionOnPeopleMatchingPredicate - Function

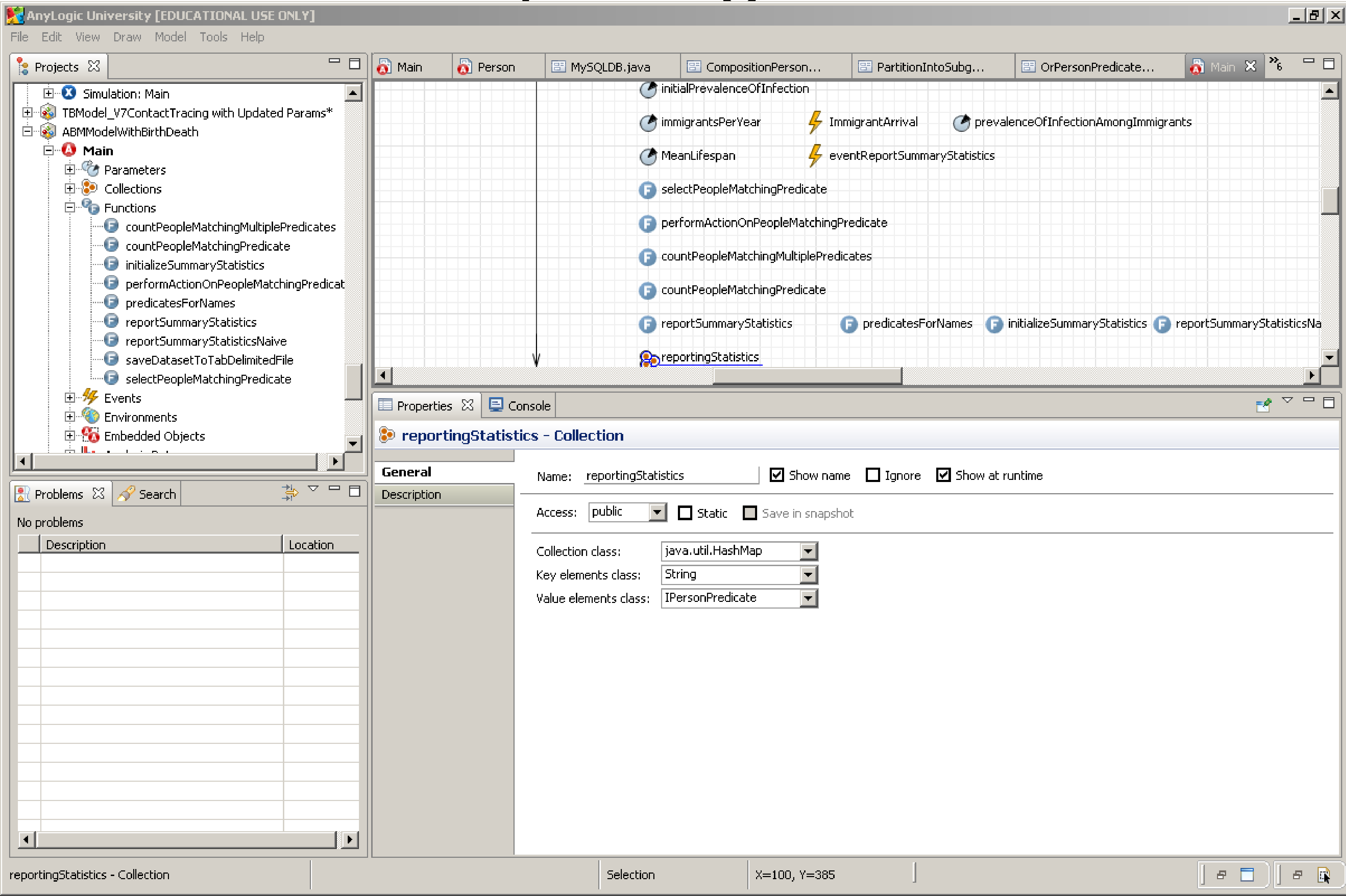
Function body:

```
int countMatchingSpecification = 0;

for (Person p : Population)
    {
    if (spec.Predicate(p))
        {
        action.PerformAction(p);
        countMatchingSpecification++;
        }
    }

return countMatchingSpecification;
```

# Reporting List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Description
reportingStatistics - Collection
Selection
X=100, Y=385

**reportingStatistics - Collection**

Name: reportingStatistics [✓ Show name] [ ] Ignore [✓ Show at runtime]

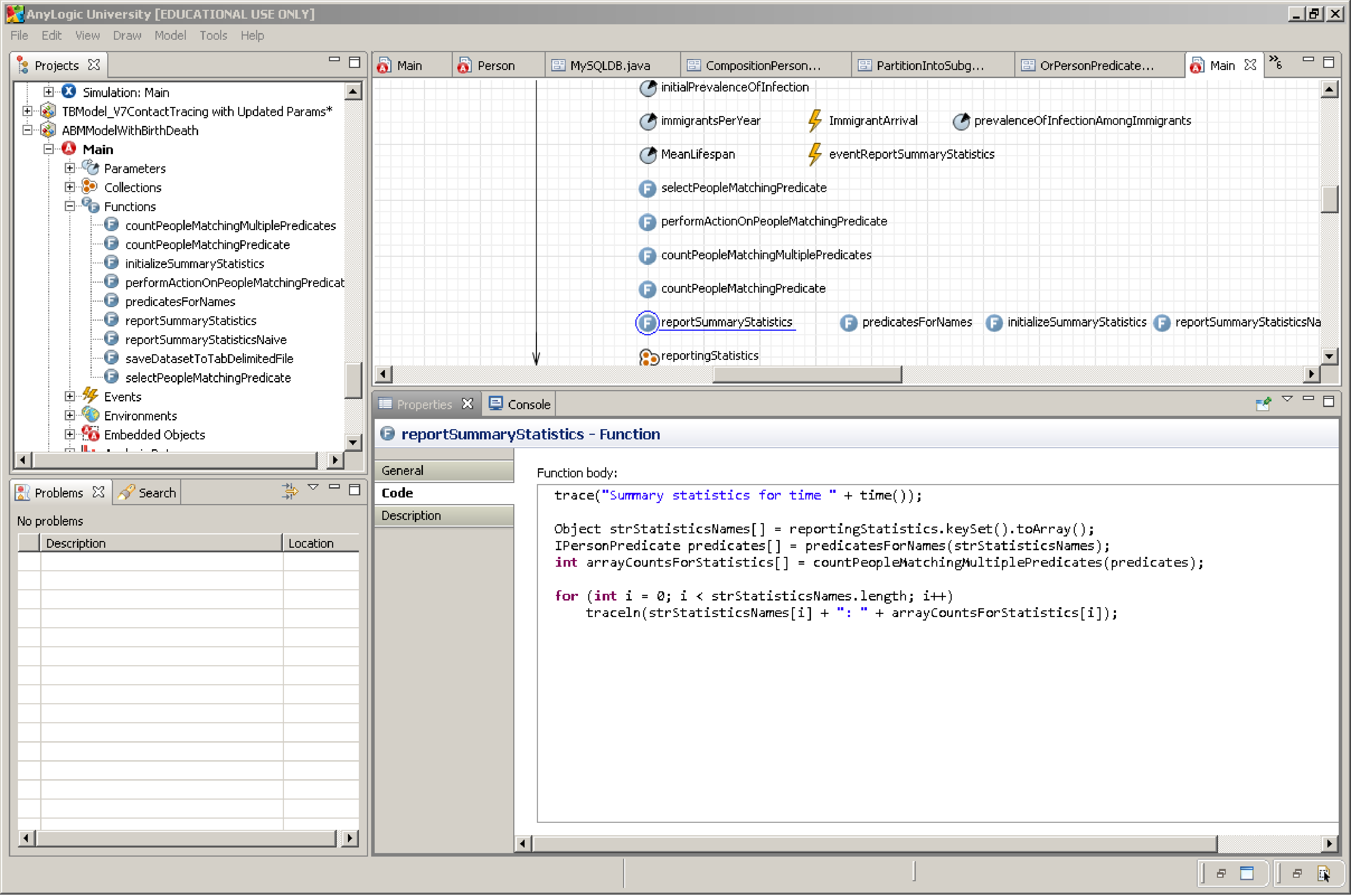
Access: public [ ] Static [ ] Save in snapshot

Collection class: java.util.HashMap

Key elements class: String

Value elements class: IPersonPredicate

# Reporting Summary Statistics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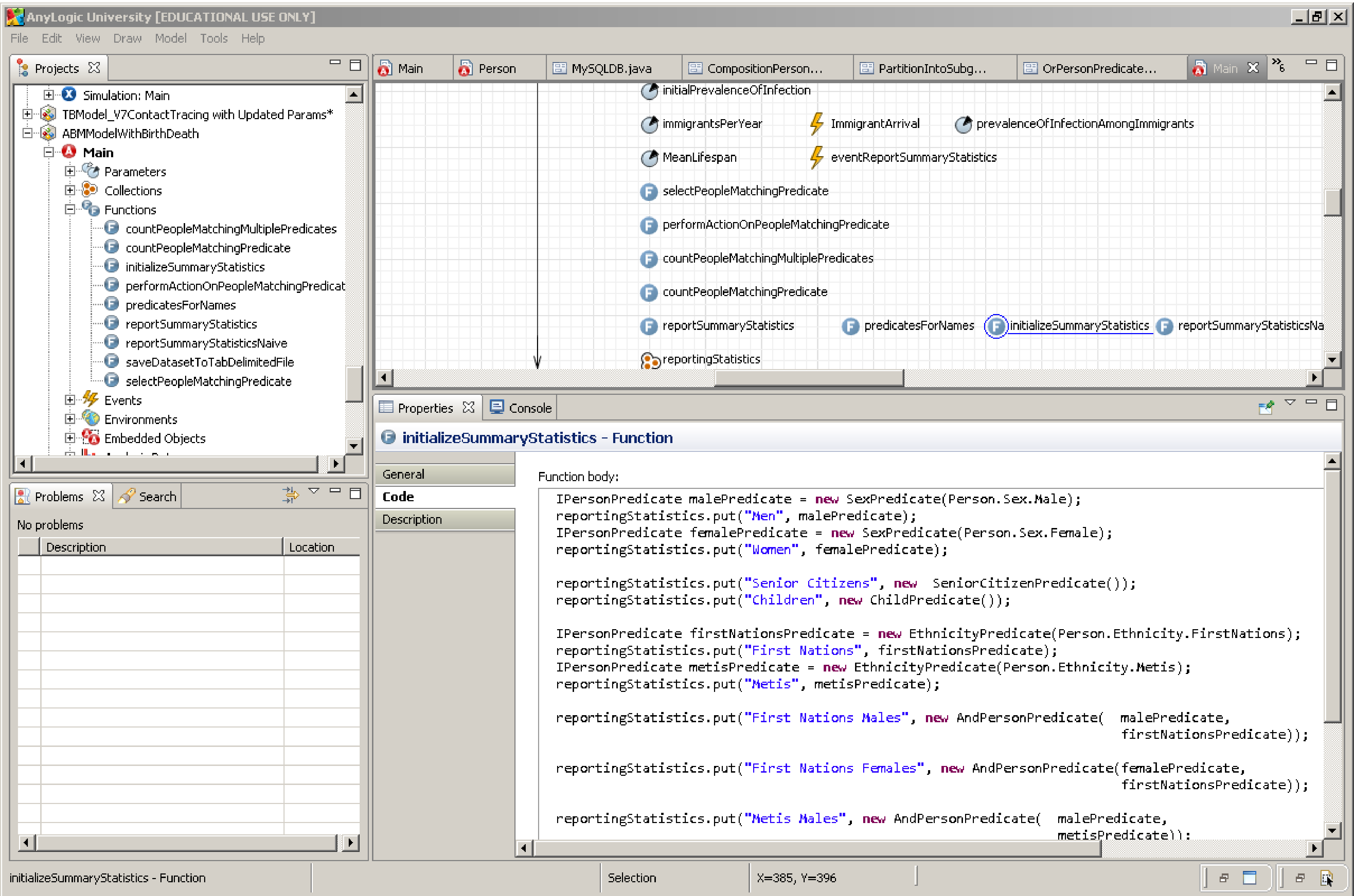
Function body:

```
trace("Summary statistics for time " + time());

Object strStatisticsNames[] = reportingStatistics.keySet().toArray();
IPersonPredicate predicates[] = predicatesForNames(strStatisticsNames);
int arrayCountsForStatistics[] = countPeopleMatchingMultiplePredicates(predicates);

for (int i = 0; i < strStatisticsNames.length; i++)
    traceln(strStatisticsNames[i] + ": " + arrayCountsForStatistics[i]);
```

# Creating the Reporting List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Function body:
initializeSummaryStatistics - Function
Selection
X=385, Y=396

```
IPersonPredicate malePredicate = new SexPredicate(Person.Sex.Male);
reportingStatistics.put("Men", malePredicate);
IPersonPredicate femalePredicate = new SexPredicate(Person.Sex.Female);
reportingStatistics.put("Women", femalePredicate);

reportingStatistics.put("Senior Citizens", new  SeniorCitizenPredicate());
reportingStatistics.put("Children", new ChildPredicate());

IPersonPredicate firstNationsPredicate = new EthnicityPredicate(Person.Ethnicity.FirstNations);
reportingStatistics.put("First Nations", firstNationsPredicate);
IPersonPredicate metisPredicate = new EthnicityPredicate(Person.Ethnicity.Metis);
reportingStatistics.put("Metis", metisPredicate);

reportingStatistics.put("First Nations Males", new AndPersonPredicate(  malePredicate,
                                                                       firstNationsPredicate));

reportingStatistics.put("First Nations Females", new AndPersonPredicate(femalePredicate,
                                                                       firstNationsPredicate));

reportingStatistics.put("Metis Males", new AndPersonPredicate(  malePredicate,
                                                               metisPredicate));
```