Java Types and Enums

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Types in Java

- Types tell you the class of values from which a variable is drawn
- In Java we specify types for
  - Parameters
  - Variables
  - Return values
  - Class Fields
- Typically, we encode information described by elements of one or more different types

Types & Legal Operations

- For a given type, only certain “operators” can be used e.g.
  - e.g. a double precision value can be divided, multiplied, turned into a String etc.
  - A boolean can be tested for truthhood, turned into a String, etc.
  - A (reference to a) string can be used to
    - Extract prefixes or suffixes, find the length, concatenated, etc.
  - An enum’s values can be turned turned into a String, converted to integer, etc.

Java Primitive Types

- These are built-in to the Java language
- Primitive types in Java are the following
  - boolean
  - double
  - short (small integer)
  - int
  - char
  - byte
  - long
  - float

Non-Primitive Types

- Most types we used are not primitive types
- These are defined either
  - In our code
  - In the standard Java libraries

Why Types?

- Like specifying dimensions for an object (e.g. L, L^3/T), specifying types lets us
  - Know what we're dealing with (so we know what to do with it)
  - Avoid making a silly mistake
    - e.g. attempting to divide a number by a (reference to) a Person
    - Absent types, it is likely that these mistakes wouldn't be identified until runtime
      - If we don't happen to test that portion of the program, we won't be aware of the error
    - With types, we can discover these errors when we are building the program -- during our "Build"

Type Coercion ("Casting"): Why

- Sometimes we have something that is a member of one type, but that can be logically converted to another type
- Examples:
  - We have a double-precision value and we wish to convert it instead to an integer (by dropping fractional component)
  - We have an integer (or a double, char, boolean, etc.) and wish to convert it to a string
  - (Subtyping) We have an ActiveObject that we know is a Person and wish to treat it as a Person

Type Coercion (“Casting”): How

- To “cast” a value *v* in one type to another type, the following syntax is used

  (TargetType) v

- Examples:

  traceln((String) age)

  ((Female) item).stateChart.isStateActive(Pregnant)

  ((int) age) + 1

Parameterized Types

- Sometimes a type (A) is defined in terms of another type (B)
  - This allows the definition of A to take & give back information specific to type B
    - e.g. methods take an A as a “parameter”, or return a B, etc.
- Common examples:
  - Collections dependent on type of their content (“set of double precision values”, “a dictionary mapping strings to integer”)
  - Tuples: “a pair of a character string and integer”
- We say that the type A is “parameterized by” type B

Parameterized Types

- We can describe such “Parameterized Types” using Java “Generics”; Syntax used: A<B>, e.g. Set<Double>
  - Here, the definition of one class can be defined with respect to an arbitrary number of classes that are provided via “Type parameters”
- Examples: ArrayList<ClassName>, Set<ClassName>

This is an array list and set that can hold any type of classes (as specified by “ClassName”)

- A given use of such a “Generic” class will specify a specific class name for the type parameter

  e.g. Set<Person>, ArrayList<Double>, List<Deer>
- The definition of the generic can restrict the types that can be used for the type parameter via constraints

Examples of Parameterized Type (Generics)

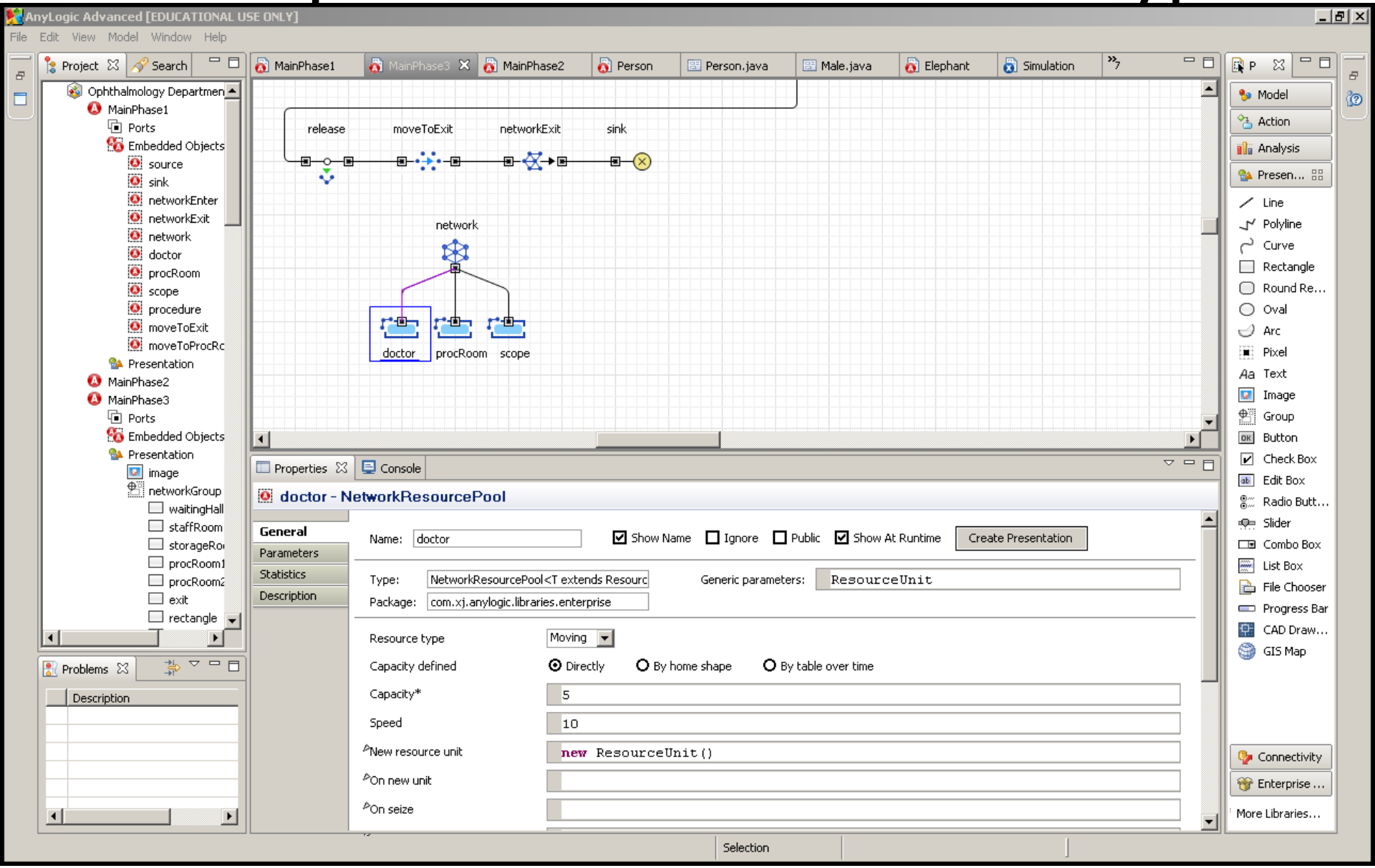
- A resource pool depending on what resources are included (ResourcePool<MyResourceUnit>)
- An “array list” (like an extensible vector) depending on the type of the elements (ArrayList<Person>)
- Hypothetical: A Pair defined in terms of the first and second element
  - Pair< String, Double>

Examples of Type Parameterization in AnyLogic

- Experiment<MainClass> (and other experiment classes)
- ResourcePool<ResourceUnit>
- NetworkResourcePool<ResourceUnit>
- ActiveObjectArrayList<ActiveObject>

  Typically used (among other things) for the population in a main class
- ActiveObjectList<ActiveObject>

Example of a Parameterized Type



Enums: Why

- Often we desire in our models to encode categorical information
- We can certainly encode such information using integers (or shorts, etc.)
  - e.g.
    - Male=0, Female=1
    - Province: NL=0,NB=1,PEI=2,QC=3,etc.

- Example using variables

```
int    sex
int province
```

Problem: This is fragile

- We could easily mistake a value “0” as encoding either Males or Newfoundland/Labrador
- e.g.
  - Reversing order of parameters given to a method, or entered into a file
  - Assigning value for one to another, due to a poorly named values

- e.g.

sex=province

Enumerations

- Enumerations help avoid manifest constants, group common names
- Good for bitwise operations : Consider values that will allow this rather than combinatorial names
- If language does not support enumerations, use carefully named global constants
- Leverage compiler checking
- If no class prefix, consider naming enumeration values with prefix giving type enumeration
- Make default enumeration value illegal
- Always explicitly handle all values

Enums in Java

- Enums let us
  - Give names to such information
  - Refer to the names in our code
  - Convert the names (where necessary) into their associated values
  - Compare names
  - Define operations on names

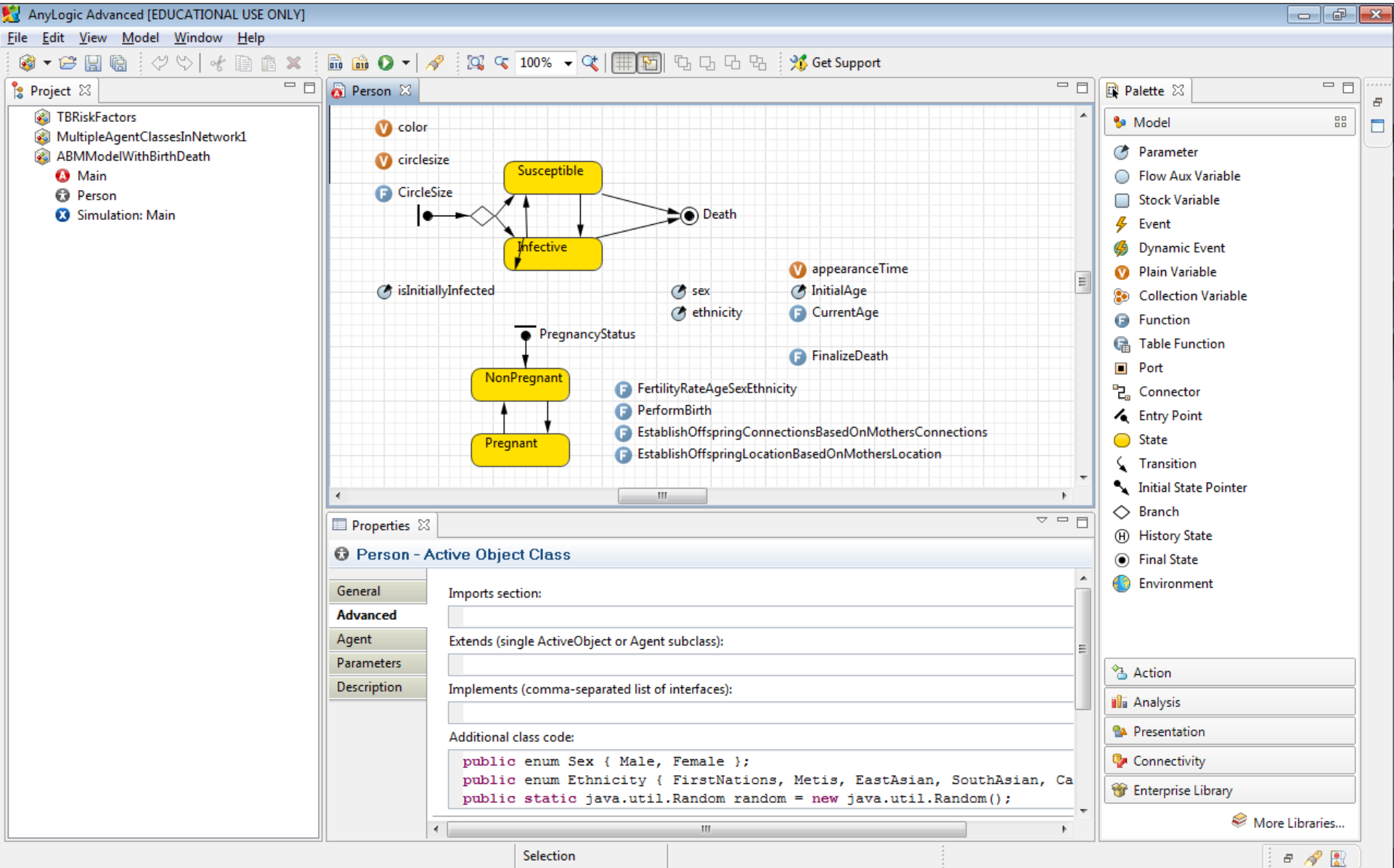
Simplest Examples

- enum Sex { Male, Female };
- enum Province { NL, NB, PEI, QC, ON, MB, SK, AB, BC};
- Variables using enum:

  Sex sex

  Province province
- Causes error: sex=province

Example of Enums in AnyLogic

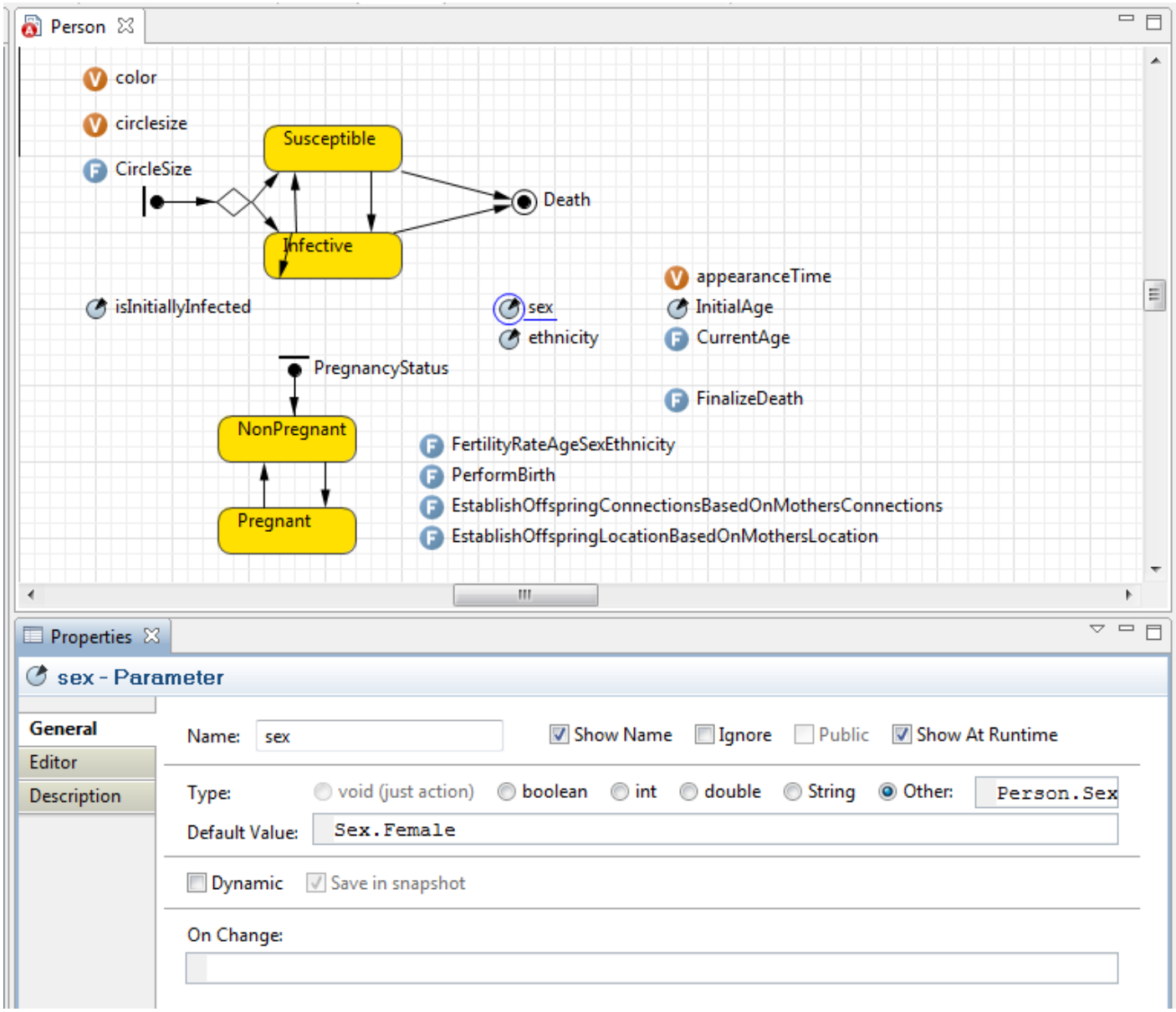


A Closer Look

Additional class code:

```
public enum Sex { Male, Female };
public enum Ethnicity { FirstNations, Metis, EastAsian, SouthAsian, Caucasian };
```

Use of Enums to Delineate Possible Parameter Values



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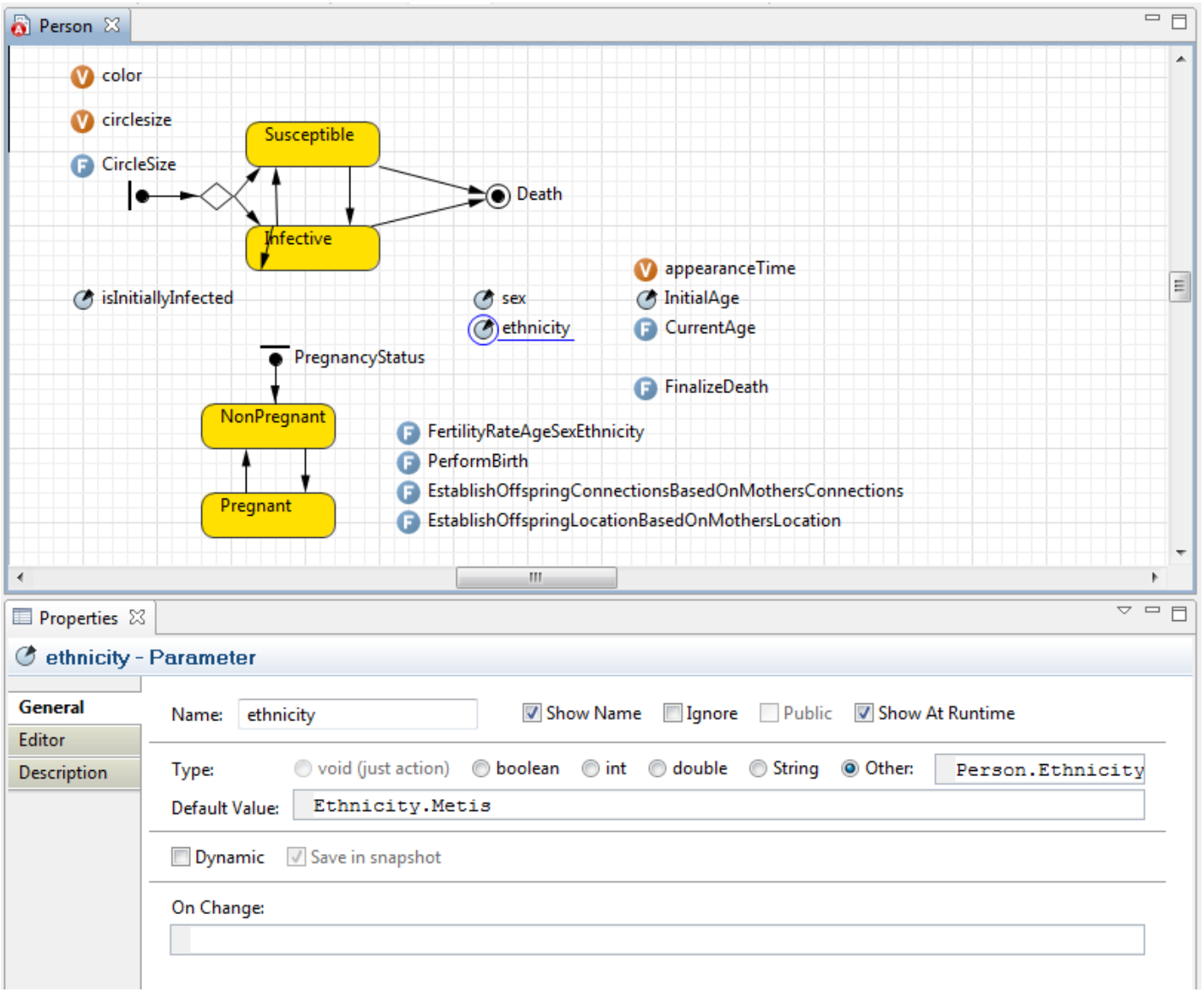
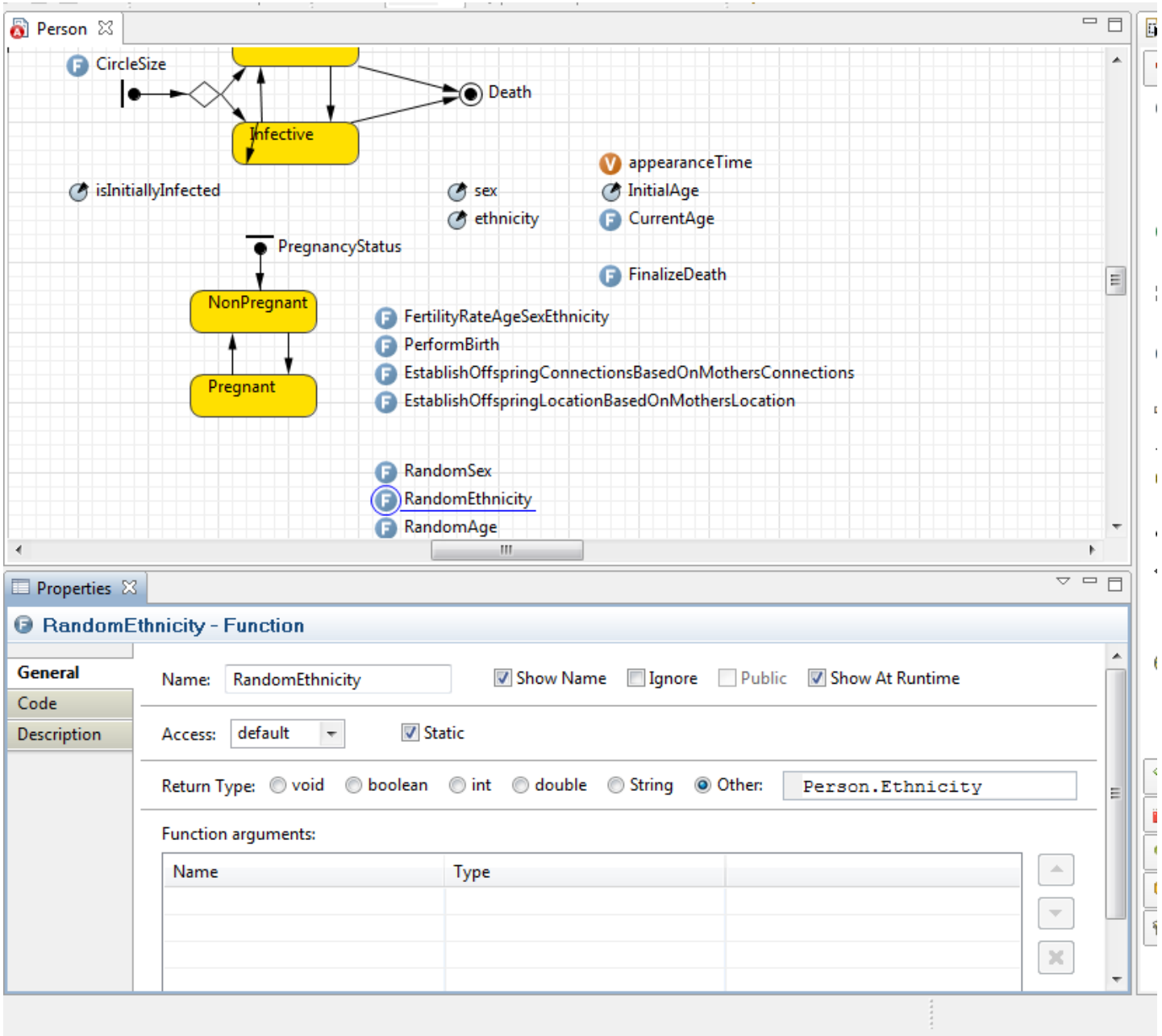


Generating Random Possible Values



The Associated Code…