Automated Software Engineering Exam 1 (December 19, 2024) Group B

Task 1: Short questions 15 points

3.1 We are developing an emergency braking system. At the current state of development, we have a very low code coverage test suite, and we want to improve this. Should we buy a test generator based on random search or symbolic execution? Please explain!

3.2 We want to create our test generator framework based on the large language models. The model's output looks promising, showing us the correct calculations (e.g., "*the value of x must be 2+7*"). Still, it must be cor-rected when calculating the concrete value (e.g., "*therefore, in the test x = 0*"). How to fix this problem?

3.3 We are measuring the performance of a process. We measure that the following throughputs at different arri-val rates (all measured in 1/s). For the arrival rate of 380/s, we see no served task. Please explain all your answers!

a) At which arrival rate the system is in balance?
b) What is the maximum throughput?
c) Please explain at which arrival rate the system is trashing.

Arrival rate	300	320	340	360	380
Throughput	299	310	270	40	-

Task 2: Graph modeling 25 points

a) Write a **Refinery metamodel** based on the following specification:

We would like to use graph modeling and logic to manage and integrate information in a deep-sea hydrothermal vent ecosystem database. The database stores information about the biological organisms living around the vents. A hydro-thermal vent may be the home of between 2 and 100 organisms and emits and least 1 mineral. Organisms may be chemosynthetic bacteria, archaea, or macrofauna. Each chemosynthetic bacteria consumes a specific mineral. A micro-bial mat has of at least 2 chemosynthetic bacteria and at least 2 archaea as its members. Macrofauna are partitioned into sessile macrofauna and mobile macrofauna. Each macrofauna preys on at least one other organism and may have another organism as a symbiont.

Only provide Refinery code and do NOT write Java code or draw an UML class diagram.

Use the following concept names: `Archaea, Bacteria, consumes, emits, Macrofauna, memberArchaea, memberBacteria, MicrobialMat, Mineral, MobileMacrofauna, Organism, organisms, preysOn, SessileMacrofauna, symbiont, Vent`

b) Draw a **graph model** based on the following data:

The Obsidian Tower vent emits hydrogen sulfide and iron sulfide. It is the home of the sulfur oxidizer bacteria, which consumes hydrogen sulfide, and the iron oxidizer bacteria, which consumes iron sulfide. It is also the home of the ther-mophilic archaea, and the giant tubeworm, a sessile macrofauna. The Pearl Spire vent emits copper sulfide and is the home of the methanogenic archaea and the yeti crab, which is a mobile macrofauna. The giant tubeworm preys on sulfur oxidizer and iron oxidizer bacteria, while the yeti crab preys on methanogenic archaea. The bacteria and archaea to-gether form the sulfur mat.

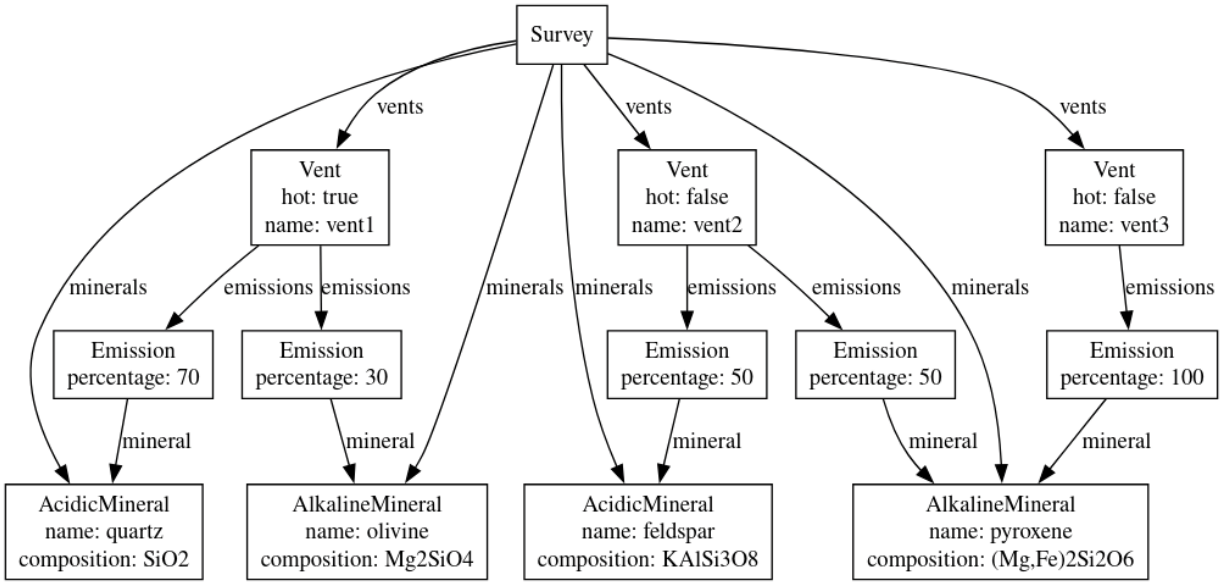
Only provide a graph model and do NOT write Java or Refinery code.

c) According to a domain expert, the following **constraint** holds: *no two bacteria that are members of the same microbial mat may consume the same mineral.* However, the expert suspects that this cannot be enforced by the current version of the metamodel. To confirm, draw a **graph model** that conforms to the metamodel but violates the constraint.

d) Recommend a way to incorporate the constraint mentioned in c) into the metamodel.

Task 3: Textual modeling — 30 points

We would like to create a **textual domain-specific modeling language** to describe the precise chemical composition of hydrothermal vent fields. The example below shows the desired **concrete syntax** (textual description) **and abstract syntax** (instance graph model) for the language:




```
acidic minerals {
    quartz = "SiO2";
    feldspar = "KAlSi3O8";
}

alkaline minerals {
    olivine = "Mg2SiO4";
    pyroxene = "(Mg,Fe)2Si2O6";
}

hot vent vent1 emits 70% quartz and 30% olivine;
cold vent vent2 emits 50% pyroxene and 50% feldspar;
cold vent vent3 emits 100% pyroxene;
```

a) Create a **Langium grammar** to parse this language! These declarations are available to you:

```
grammar Chemistry

hidden terminal WS: /\s+/;
terminal ID: /[_a-zA-Z][\w_]*/;
terminal INT: /\d+/;
terminal STRING: /"[^"]*"/;
```

Provide the rest of the grammar.

b) Create a **Jinja2 template** to generate a mineral catalog in HTML format. The input of the template is the `Survey` object parsed by the grammar you created in part a). An example mineral catalog is shown below:

```
<h1>Mineral catalog</h1>
<h2 id="quartz" class="acid">SiO2</h2>
<p>Emitted by vent1 at 70%</p>
<h2 id="feldspar" class="acid">KAlSi3O8</h2>
<p>Emitted by vent2 at 50%</p>
<h2 id="olivine" class="base">Mg2SiO4</h2>
<p>Emitted by vent1 at 30%</p>
<h2 id="pyroxene" class="base">(Mg,Fe)2Si2O6</h2>
<p>Emitted by vent2 at 50%</p>
<p>Emitted by vent3 at 50%</p>
```

To help you in reading the example, we emphasized text coming directly from instance model in **bold**. Make sure to output a heading (`<h2>`) for each mineral. Output the class "`acid`" for acidic minerals and "`base`" for alkaline minerals.

In the instance model, the `type` attribute contains the type of each object (e.g., use `x.type == "AcidicMineral"` to check if `x` is of type `AcidicMineral`). Cross-references are encoded as strings (or arrays of strings) equal to the `name` of the referenced object(s).