SWEN30006 Software Modelling and Design
Project 1: Robomail Revision

School of Computing and Information Systems
University of Melbourne
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Overview

You and your team of independent Software Contractors have been hired by *Robotic Mailing Solutions Inc. (RMS)* to provide some much-needed assistance in delivering the latest version of their product *Automail* to market. Automail is an automated mail sorting and delivery system designed to operate in large buildings that have dedicated mail rooms. It offers end-to-end receipt and delivery of mail items within the building, and can be tweaked to fit many different installation environments. The system consists of two key components:

- **Delivery Robots** (see Figure 1) which take mail items from the mail room and deliver them throughout the building. Each robot can hold one item in its "hands" and one item in its "tube" (a backpack-like container attached to each robot). If a robot is holding two items (i.e., one in its hands and one it its tube) it will always deliver the item in its hands first. An installation of Automail can manage a team of delivery robots of any reasonable size (including zero!).

- A **Mail Pool** subsystem which holds mail items after their arrival at the building's mail room. The mail pool decides the order in which mail items should be delivered.

Figure 1: Artistic representation of one of our robots

The hardware of this system has been well tested, and the current software seems to perform reasonably well but is not well documented. Currently, the robots offered by *RMS* are only able to move up or down one floor in a building in one step. Due to changes in market requirements, *RMS* recently developed a new capability for their robots which allows them to go into a 'caution' mode. The 'caution' mode allows the robot to deliver 'fragile' mail item. However, RMS needs to install an extra pair of 'special' arms which is used to deliver a fragile item. Therefore, it increases the delivery time of fragile item. Additionally, there are a few limitations placed on the robots when they enter 'caution' mode:

1. The robot can carry fragile items only with the special arms (not in the tube or with its other arms).
2. The special arms can handle the tasks of wrapping the fragile item with a protective shield (*which takes two units of time*) before moving and unwrapping the item (*which takes one unit of time*) before delivery.

3. A robot delivering a fragile item must have sole access to the delivery floor for that item while it unwraps and delivers the item. That is, it can't deliver that item on a floor with another robot present, and another robot can't enter that floor while the robot with the fragile item is delivering it.

Your task is to update the simulation software maintained by *RMS* to show how the 'caution' ability could be incorporated into the robot management system. In doing this you should apply your software engineering and patterns knowledge to refactor and extend the system to support this new behaviour. Note that the caution behaviour described in this document is just one possible use of this functionality. When designing your solution, you should consider that *RMS* may want to incorporate or trial other uses of the caution ability in the future.

The behaviour of the system when delivering non-fragile packages should not change. Additionally, *RMS* expect the behaviour of the system to remain **exactly** the same when the caution ability is turned off, or if no fragile packages arrive. *RMS* would also like you to add some statistics tracking to the software so that they can see how the caution ability is being used. This will help them to understand the wear and tear that their robots are going to go through. For now, *RMS* would like you to record:

1. The **number** of packages delivered normally (i.e., not using caution).
2. The **number** of packages delivered using caution.
3. The **total weight** of the packages delivered normally (i.e., not using caution).
4. The **total weight** of the packages delivered using caution.
5. The **total amount of time** spent by the special arms wrapping & unwrapping items.

When the simulation ends you should print this information to the console. As with the caution behaviour, you should apply software engineering and patterns knowledge to support this statistics tracking. Your design should consider that *RMS* may want to track additional statistical information relating to robot performance in the future. Once you have made your changes, your revised system will be benchmarked against the original system to provide feedback on your results to *RMS*.

Other useful information:
- The **mailroom** is on the ground floor (floor 1).
- All **mail items** are stamped with their **time of arrival**.
- Fragile mail items arrive at the mailpool and are registered one at a time, so **timestamps are unique for fragile items**. Normal (non-fragile) mail items arrive at the mailpool in batches, so **all items in a normal batch receive the same timestamp**.
- If a mail item is 'fragile' and 'caution' mode is turned on, the system must handle the item as described above (wrap, deliver in isolation, unwrap).
- The mailpool is responsible for giving mail items to the robots for delivery.
- A **Delivery Robot** carries at most three items including one fragile item on the special arms, and it can be sent to deliver mail if it has at least one item on either normal or special arms.
- All mail items have a **weight**. Delivery robots can carry items of any weight, and place items of any weight in their tube if the items are not fragile.
- The system generates a measure of the effectiveness of the system in delivering all mail items, taking into account time to deliver and types of mail items (normal, non-fragile). *You do not need to be concerned about the detail of how this measure is calculated.*

The Sample Package

You have been provided with an Eclipse project export representing the current system, including an example configuration file. This export includes the full software simulation for the Automail product, which will allow you to implement your approach to supporting the delivery robot's new caution mode.

To begin:

1. Import the project zip file as you did for Workshop 1.
2. Try running by right clicking on the project and selecting **Run as... Java Application**.
3. You should see output similar to that in Figure 2 showing you the current behaviour of the Automail system.

This simulation should be used as a starting point. Please carefully study the sample package and ensure that you are confident you understand how it is set up and functions before continuing. If you have any questions, please make use of the discussion board or ask your tutor directly as soon as possible; it is assumed that you will be comfortable with the package provided.

```
T: 427 >    R0(0) changed from DELIVERING to RETURNING
T: 428 >    R1(0) changed from RETURNING to WAITING
T: 428 > Deliv( 159) [Mail Item:: ID:     59 | Arrival:  94 | Destination: 12 | Weight: 1790 |    normal]
T: 428 >      R2(0)-> [Mail Item:: ID:     28 | Arrival: 105 | Destination: 12 | Weight:  863 |    normal]
T: 429 >    R1(0) changed from WAITING to DELIVERING
T: 429 >      R1(0)-> [Mail Item:: ID:     25 | Arrival: 113 | Destination: 12 | Weight:  793 |    normal]
T: 429 > Deliv( 160) [Mail Item:: ID:     28 | Arrival: 105 | Destination: 12 | Weight:  863 |    normal]
T: 429 >    R2(0) changed from DELIVERING to RETURNING
T: 439 >    R0(0) changed from RETURNING to WAITING
T: 441 > Deliv( 161) [Mail Item:: ID:     25 | Arrival: 113 | Destination: 12 | Weight:  793 |    normal]
T: 441 >    R1(0) changed from DELIVERING to RETURNING
T: 441 >    R2(0) changed from RETURNING to WAITING
T: 442 | Simulation complete!
Final Delivery time: 442
Final Score: 57715.31
```

Figure 2: Sample output.

Note: By default, the simulation will run without a fixed seed, meaning the results will be random on every run. In order to have a consistent test outcome, you need to specify the seed. You can do this in the configuration file or by editing the Run Configurations (Arguments tab) under Eclipse and adding an argument. Any integer value will be accepted, e.g. 11111 or 30006.

Project Deliverables

As discussed above, and for the users of Automail to have confidence that changes have been made in a controlled manner, you are required to preserve the Automail simulation's existing behaviour. Your extended design and implementation must account for the following:

- Preserve the behaviour of the system for configurations where fragile items are not generated and statistical logging is turned off (i.e. Fragile=false; Statistics=false). Note that "preserve" implies identical output. We will use a file comparison tool to check this.
- Add caution behaviour to deal with delivering fragile mail items by special arms.
- Add statistics tracking to show the total weight and number of packages delivered with and without the caution behaviour, and the total amount of time taken in wrapping and unwrapping fragile items.

In support of your updated and extended design, you need to also provide the following:

1. A **domain class diagram** for the robot mail delivery domain, as reflected in the revised simulation. There is no reason you can't be guided by your design class diagram but be very careful that you end up with a description of the problem space, without reference to your solution.

2. A **static design model (design class diagram)** for your submitted system of **all changed and directly related components**, complete with (for the changed components) visibility modifiers, attributes, associations, and public (at least) methods. You should refer to this model in report. You may use a tool to reverse engineer a design class model from your implementation as a basis for your submission. However, your diagram must contain all relevant associations and dependencies (few if any tools do this automatically) and be well laid-out/readable. You should not expect to receive any marks for a diagram that is reverse engineered and submitted unchanged.

3. A **dynamic design model (design sequence diagram)** illustrating how a fragile mail item is assigned to a robot for delivery, how that robot uses caution mode to deliver the item. You should self-assess your dynamic model based on how useful it would be in explaining how the system works to a hypothetical new team member. Too little detail and it will have little value, too much detail and it won't add much value over reading the code. The choice of detail level is yours. Again, you should refer to this model in your report.

4. A **brief report**, describing the changes you have made with reference to your diagrams, and providing a rationale for these changes **using design patterns and principles**. Note that to do this well, you should be able to talk about other reasonable options you considered, and why you did not choose these options. Around 2-4 pages should be enough to provide a concise rationale. Your submitted implementation must be consistent with your design models, and should include all appropriate comments, visibility modifiers, and code structure. As such, your submitted DCD and DSD must be consistent with your submitted implementation.

Hints: There are three required tasks here – diagram, code, and report – which are interrelated. You should work on these tasks **as a team**, not separately. Every team member needs to be able to demonstrate their understanding of and contributions to all deliverables. To help understand the task, you can:

1. Start by putting together your domain model; you can use this project spec and a reverse engineered static design model for the existing system as a basis for this.
2. Then narrow down which parts of the system you need to understand in detail and look at the static design and code for those parts. While you are doing this, you should be considering options for the changes you will require to refactor and extend the system: keep track of serious options for your report.
3. When it comes to making changes, separate out the refactoring and extension. Be careful about the changes you make; reordering operations (especially those involving generation of random numbers) will change the behaviour of the system and therefore the output. If you make such changes and proceed without detecting the problem, recovering may require substantial backtracking on the changes you've made or even reapplying them to the original system. As such we would recommend that you only make refactoring changes that are required to support improving the design.

You do not need to understand or even read all the code provided; you only need to understand the parts you are changing and those they depend on. So, for example, you really don't need to pay any attention to the MailGenerator.

Testing Your Solution
We will be testing your application programmatically, so we need to be able to build and run your program without using an integrated development environment. The entry point must remain as "swen30006.automail.Simulation.main()". You must not change the names of properties in the provided property file or require the presence of additional properties.

Note: It is **your responsibility** to ensure that you have thoroughly tested your software before you submit it.

Marking Criteria

This project will account for 12 marks out of the total 100 available for this subject. It will be assessed against the following rubric:

- H1 [10-12]: Preserves original behaviour and implements new capability appropriately. Good extended or extendable design/implementation with generally consistent, clear, and helpful diagrams. Clear design rationale in terms of patterns. Few if any minor errors or omissions (no major ones).
- H2B-H2A [8.5-9.5]: Preserves original behaviour with at most minor variations in output and implements new capability appropriately. Extended or extendable design/implementation with generally consistent, clear, and helpful diagrams. Fairly clear design rationale in terms of patterns. Few errors or omissions.
- P-H3 [6-8]: Similar behaviour to original and implements new capability appropriately. Reasonable design/implementation with generally consistent and clear diagrams. Fairly clear design rationale with some reference to patterns. Some errors or omissions.
- F+ [2.5-5.5]: Plausible implementation and reasonable design with related diagrams. Plausible attempt at design rationale with some reference to patterns. Includes errors and/or omissions.
- F [0-2.5]: No plausible implementation. Design diagrams and design rationale provided but not particularly plausible/coherent.

Note: Your implementation must not violate the principle of the simulation by using information that would not be available in the system being simulated. For example, it would not be appropriate to use information about mail items which have not yet been delivered to the mail pool. It would also not be appropriate to violate the implied physical limitations, for example by having the robots teleport. We also reserve the right to award or deduct marks for clever or very poor code quality on a case by case basis outside of the prescribed marking scheme. Further, we expect to see good variable names, well commented functions, inline comments for complicated code. We also expect good object-oriented design principles and functional decomposition. For UML diagrams you are expected to use UML 2+ notation.

On Plagiarism: We take plagiarism very seriously in this subject. You are not permitted to submit the work of others under your own name. This is a **team** project. More information can be found here: https://academichonesty.unimelb.edu.au/advice.html.

Submission

Detailed submission instructions will be posted on the LMS. You should submit all items shown in the checklist below. You must include your team number in all your pdf submissions, and as a comment in all changed or new source code files provided as part of your submission.

Submission Checklist

1. Your complete updated source code package reflecting your new design and implementation (all Java source with top-level folder called "swen30006").
2. Design Analysis Report (pdf).
3. Static Domain Model (pdf or png).
4. Static Design Model reflecting your new design and implementation (pdf or png).
5. Dynamic Design Diagram reflecting your new design and implementation (pdf or png).

Submission Date

This project is due at **11:59pm on Friday May 8**. Any late submissions will incur a 1-mark penalty per day unless you have supporting documents. If you have any issues with submission, please email Peter at peter.eze@unimelb.edu.au **before** the submission deadline.