

Microkernel Architecture Using OSGi Framework

Calculator

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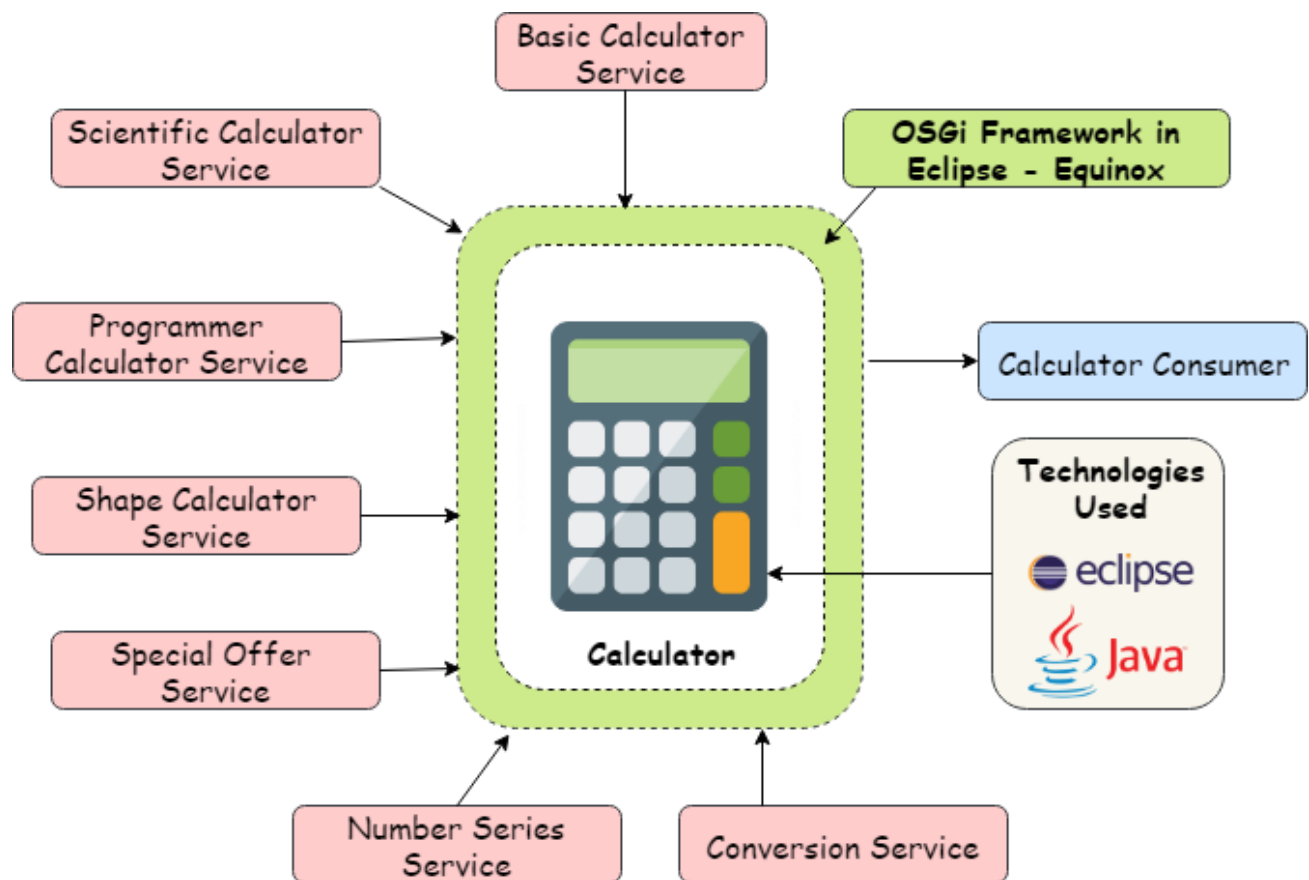
1 Introduction

As per the academic requirement, this report consists the implementation of a “Calculator” using the OSGi Framework. We have created 7 services and these services are consumed by the consumer depending on the consumer’s need. Therefore, there are altogether 8 bundles in this project (7- Service and 1- Consumer). Following are the services implemented.

1. Basic calculator service – This service provides the basic mathematical operation like addition, subtraction, multiplication and division of 2 numbers.
2. Scientific calculator service – This service provides the user to enter a complex sum and the answer is generated using the BODMAS operation.
3. Programmer service - This service helps the user to convert any decimal or binary or octal or hexadecimal number to any of the format.
4. Shape Calculator Service - This service calculates the area and perimeter for 2D shapes and for 3D shapes volume and surface areas are calculated.
5. Special offer service – This service provides the functionality to calculate discount and bonus.
6. Number Series Service – This service includes the number series like Fibonacci, prime etc. and it provides a functionality to check whether the input is a valid term in that specific series.
7. Conversion Service – This service includes the conversion Length, Temperature and Weight.

In order to build this project, we have used Eclipse as our IDE and Equinox is used as the OSGi framework.

2 Descriptive Diagram



3 Manifest Implementation

3.1 Consumer

```

1Manifest-Version: 1.0
2Bundle-ManifestVersion: 2
3Bundle-Name: CalculatorConsumer
4Bundle-SymbolicName: CalculatorConsumer
5Bundle-Version: 1.0.0.qualifier
6Bundle-Activator: calculatorconsumer.Activator
7Bundle-RequiredExecutionEnvironment: JavaSE-10
8Import-Package: org.osgi.framework;version="1.3.0"
9Automatic-Module-Name: CalculatorConsumer
10Require-Bundle: org.eclipse.equinox.console;bundle-version="1.3.0",
11 org.eclipse.osgi;bundle-version="3.13.0",
12 org.apache.felix.gogo.command;bundle-version="1.0.2",
13 org.apache.felix.gogo.runtime;bundle-version="1.0.6",
14 org.apache.felix.gogo.shell;bundle-version="1.0.0",
15 ProgrammerService;bundle-version="1.0.0",
16 ScientificService;bundle-version="1.0.0",
17 BasicService;bundle-version="1.0.0",
18 ShapeCalculatorService;bundle-version="1.0.0",
19 DiscountBonusCalService;bundle-version="1.0.0",
20 NumberSeriesService;bundle-version="1.0.0",
21 ConversionService;bundle-version="1.0.0"

```

Figure 1 Consumer - Manifest File

In this bundle, org.osgi.framework is explicitly imported to this bundle (line 8) in order to have a OSGi framework. As this is the consumer bundle, it needs the access of producer bundles to obtain the functionality. The bundles from line 10 to line 14 are the default bundles required to run the OSGi framework and the bundles mentioned from line 15 to 21 are the services implemented by our group members.

3.2 Producer

In all the producer services, org.osgi.framework is explicitly imported to access the OSGi framework and all the producer services explicitly exports the packages which are implemented in the specific service.

```

1Manifest-Version: 1.0
2Bundle-ManifestVersion: 2
3Bundle-Name: BasicService
4Bundle-SymbolicName: BasicService
5Bundle-Version: 1.0.0.qualifier
6Bundle-Activator: basicservice.Activator
7Bundle-RequiredExecutionEnvironment: JavaSE-10
8Import-Package: org.osgi.framework;version="1.3.0"
9Automatic-Module-Name: BasicService
10Export-Package: basicservice,
11 com.sliit.sa.implementations,
12 com.sliit.sa.interfaces

```

Figure 2 Basic Calculator Service

```

1Manifest-Version: 1.0
2Bundle-ManifestVersion: 2
3Bundle-Name: ScientificService
4Bundle-SymbolicName: ScientificService
5Bundle-Version: 1.0.0.qualifier
6Bundle-Activator: scientificservice.Activator
7Bundle-RequiredExecutionEnvironment: JavaSE-10
8Import-Package: org.osgi.framework;version="1.3.0"
9Automatic-Module-Name: ScientificService
10Export-Package: com.sliit.sa.implementations,
11 com.sliit.sa.interfaces,
12 scientificservice
13

```

Figure 3 Scientific Calculator Service

```

1 Manifest-Version: 1.0
2 Bundle-ManifestVersion: 2
3 Bundle-Name: ProgrammerService
4 Bundle-SymbolicName: ProgrammerService
5 Bundle-Version: 1.0.0.qualifier
6 Bundle-Activator: programmerservice.Activator
7 Bundle-RequiredExecutionEnvironment: JavaSE-10
8 Import-Package: org.osgi.framework;version="1.3.0"
9 Automatic-Module-Name: ProgrammerService
10 Export-Package: com.sliit.sa.implementations,
11 com.sliit.sa.interfaces,
12 programmerservice
13

```

Figure 4 Programmer Service

```

1 Manifest-Version: 1.0
2 Bundle-ManifestVersion: 2
3 Bundle-Name: ShapeCalculatorService
4 Bundle-SymbolicName: ShapeCalculatorService
5 Bundle-Version: 1.0.0.qualifier
6 Bundle-Activator: shapecalculatorservice.Activator
7 Bundle-RequiredExecutionEnvironment: JavaSE-10
8 Import-Package: org.osgi.framework;version="1.3.0"
9 Automatic-Module-Name: ShapeCalculatorService
10 Export-Package: com.sliit.sa.factory,
11 com.sliit.sa.implementations,
12 com.sliit.sa.interfaces,
13 shapecalculatorservice
14

```

Figure 5 Shape Calculator Service

```

1 Manifest-Version: 1.0
2 Bundle-ManifestVersion: 2
3 Bundle-Name: DiscountBonusCalService
4 Bundle-SymbolicName: DiscountBonusCalService
5 Bundle-Version: 1.0.0.qualifier
6 Bundle-Activator: discountbonuscalservice.Activator
7 Bundle-RequiredExecutionEnvironment: JavaSE-10
8 Import-Package: org.osgi.framework;version="1.3.0"
9 Automatic-Module-Name: DiscountBonusCalService
10 Export-Package: com.sliit.sa.implementations,
11 com.sliit.sa.interfaces,
12 discountbonuscalservice
13

```

Figure 6 Discount Calculator Service


```

1 Manifest-Version: 1.0
2 Bundle-ManifestVersion: 2
3 Bundle-Name: NumberSeriesService
4 Bundle-SymbolicName: NumberSeriesService
5 Bundle-Version: 1.0.0.qualifier
6 Bundle-Activator: numberseriesservice.Activator
7 Bundle-RequiredExecutionEnvironment: JavaSE-10
8 Import-Package: org.osgi.framework;version="1.3.0"
9 Automatic-Module-Name: NumberSeriesService
10 Export-Package: com.sliit.sa.implementations,
11 com.sliit.sa.interfaces,
12 numberseriesservice
13

```

Figure 7 Number Series Service

```

1 Manifest-Version: 1.0
2 Bundle-ManifestVersion: 2
3 Bundle-Name: ConversionService
4 Bundle-SymbolicName: ConversionService
5 Bundle-Version: 1.0.0.qualifier
6 Bundle-Activator: conversionservice.Activator
7 Bundle-RequiredExecutionEnvironment: JavaSE-10
8 Import-Package: org.osgi.framework;version="1.3.0"
9 Automatic-Module-Name: ConversionService
10 Export-Package: com.sliit.sa.implementations,
11 com.sliit.sa.interfaces,
12 conversionservice

```

Figure 8 Conversion Service

4 OSGi Framework Running Process

In OSGi each bundle is treated as an isolated module. Each bundle has bundle ID and a state (installed, resolved, start, stop). In eclipse when we run the project using OSGi framework, all the bundles will be installed and will be in active state. Following screenshot shows the bundles after running the project.

```
osgi> ss
"Framework is launched."
```

id	State	Bundle
0	ACTIVE	org.eclipse.osgi_3.13.0.v20180409-1500
1	ACTIVE	BasicService_1.0.0.qualifier
2	ACTIVE	CalculatorConsumer_1.0.0.qualifier
3	ACTIVE	ConversionService_1.0.0.qualifier
4	ACTIVE	DiscountBonusCalService_1.0.0.qualifier
5	ACTIVE	NumberSeriesService_1.0.0.qualifier
6	ACTIVE	ProgrammerService_1.0.0.qualifier
7	ACTIVE	ScientificService_1.0.0.qualifier
8	ACTIVE	ShapeCalculatorService_1.0.0.qualifier
9	ACTIVE	com.ibm.icu_58.2.0.v20170418-1837
10	ACTIVE	javax.annotation_1.2.0.v201602091430
11	ACTIVE	javax.inject_1.0.0.v20091030
12	ACTIVE	javax.servlet_3.1.0.v201410161800
13	ACTIVE	javax.xml_1.3.4.v201005080400

Figure 9 Initial running of the project

The bundle ID 2 represents the Consumer bundle and Bundle IDs 1,3,4,5,6,7,8 represents the services provided to the consumer.

In order to lunch the consumer again we should stop the specify consumer bundle and start it again. Following diagram shows this process.

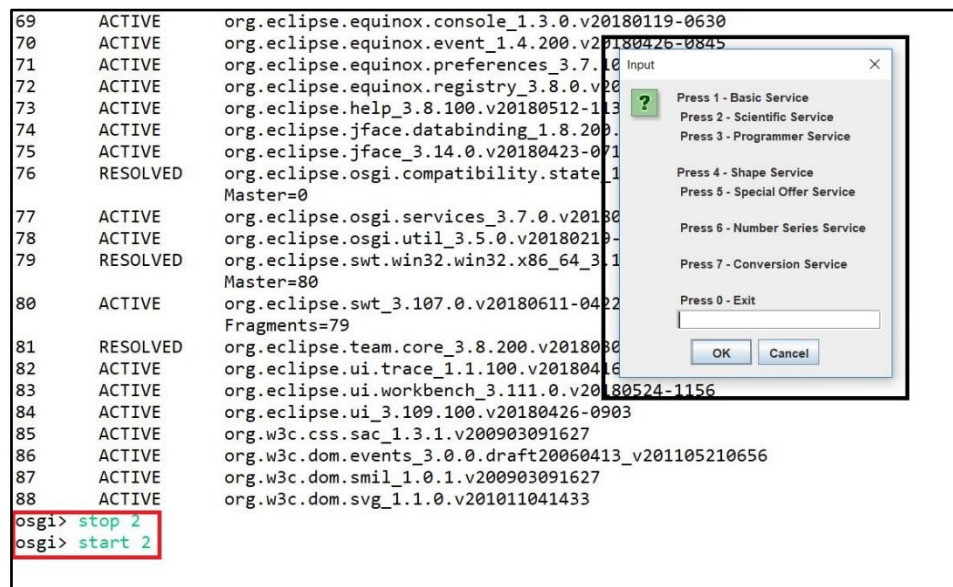


Figure 10 Restarting the consumer bundle

After the successful start, the user is prompted an interface to enter the required service. As all the services are in active state, the user can access any service by entering the appropriate number. Following image shows the interfaces prompted.

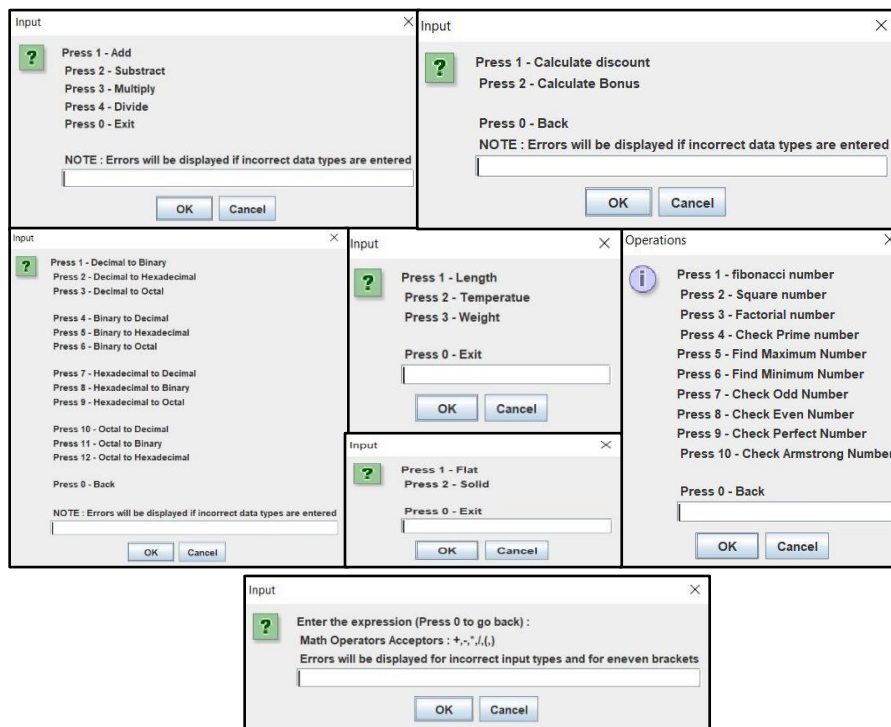
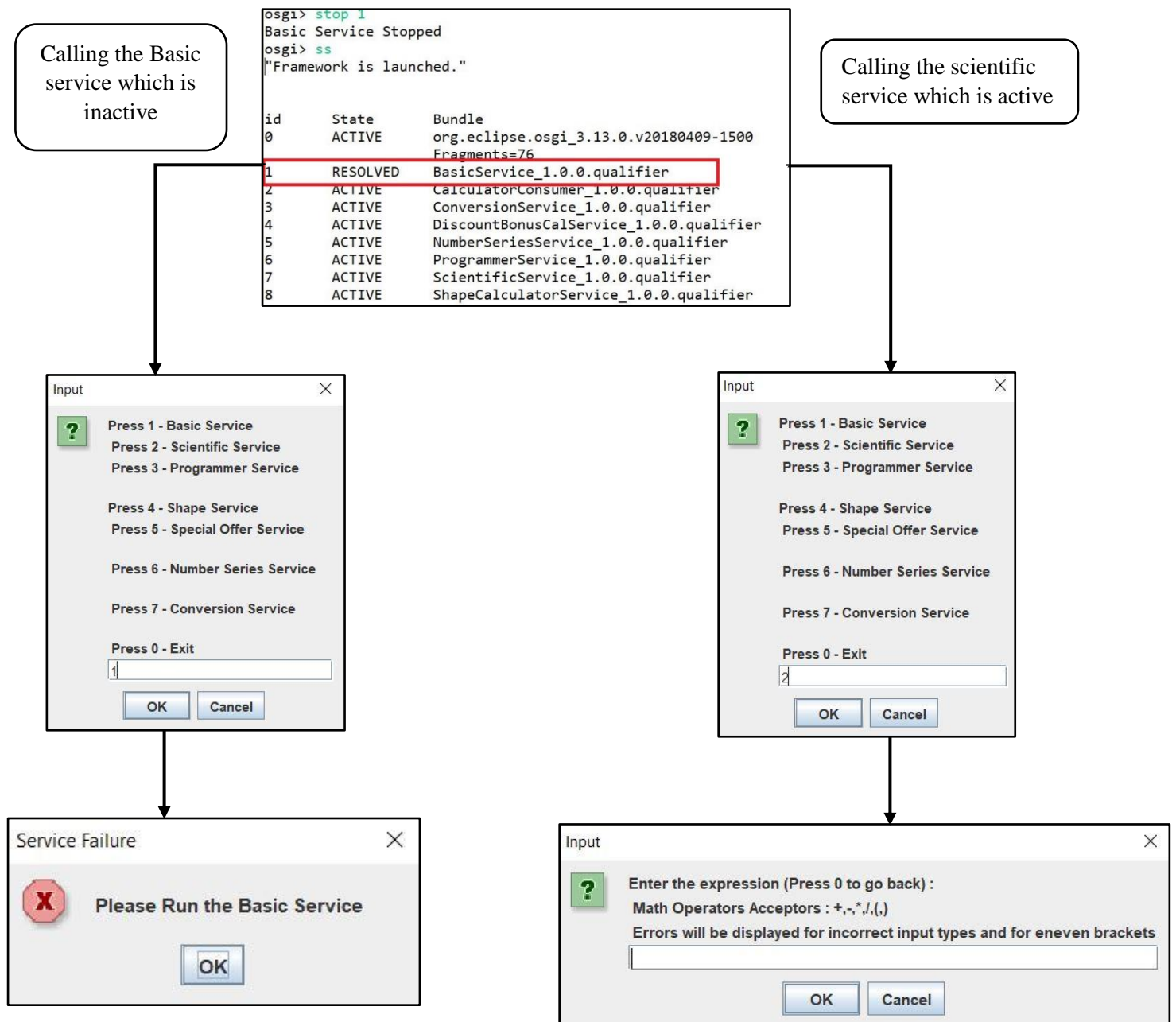


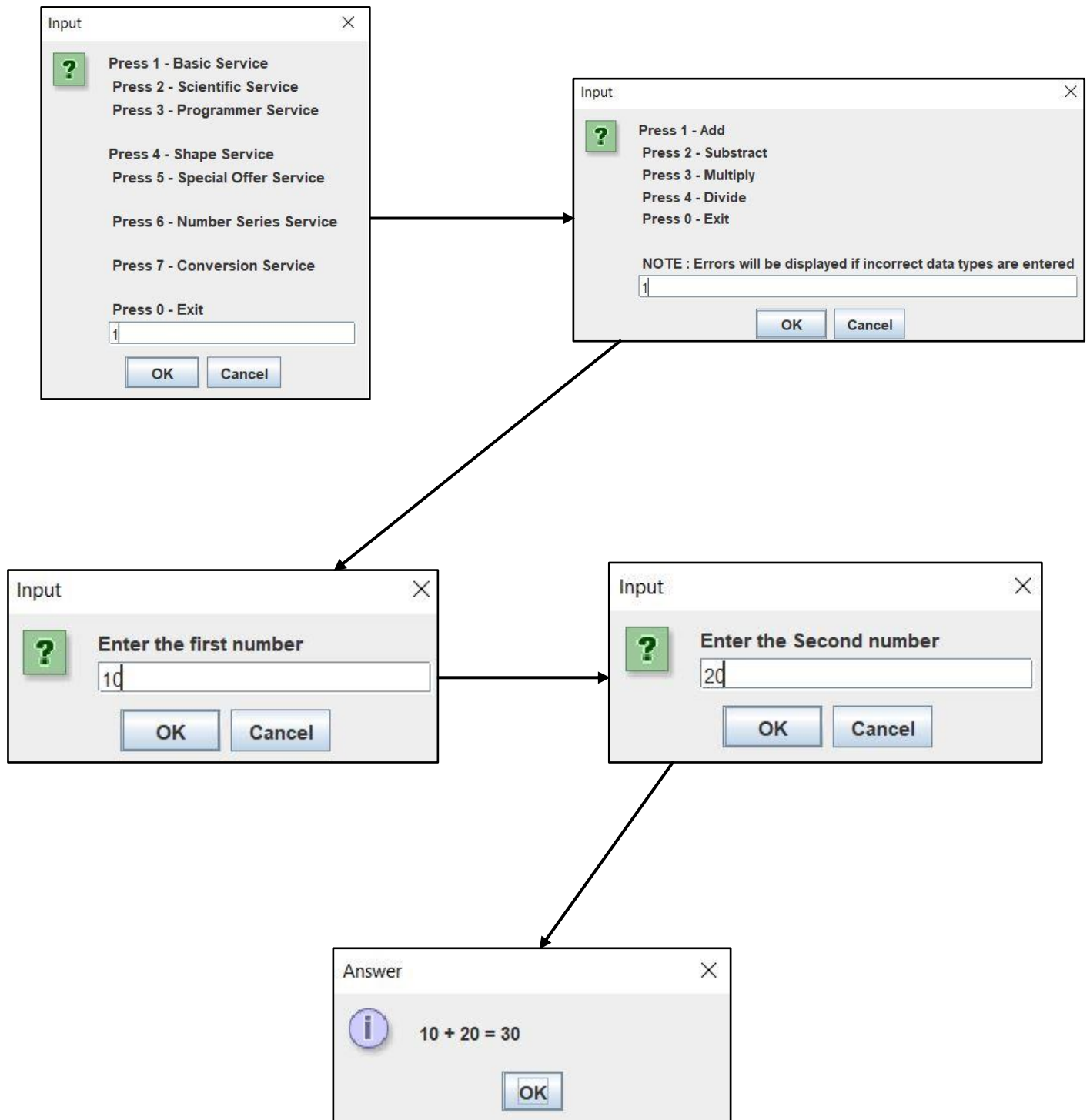
Figure 11 Initial Service Interface

But when we stop one of the service bundles, the user will not be able to access the specific bundle. This project will throw errors to the user when the bundle they are trying to access is stopped. In order to explain this behavior, we will stop the basic calculator service (refer figure 9, bundle ID is 1) and check the output.

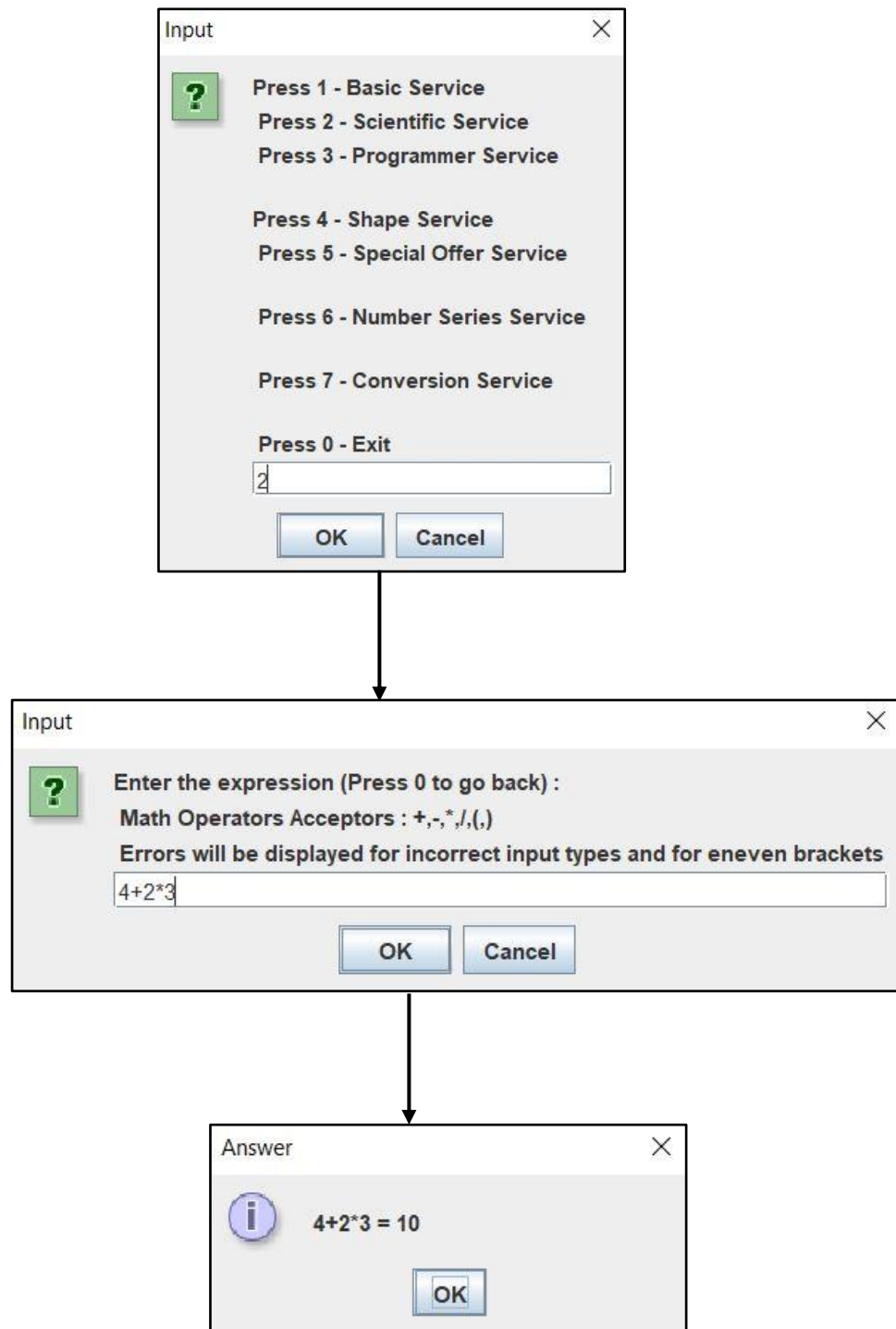


5 Screenshots on the behavior and output

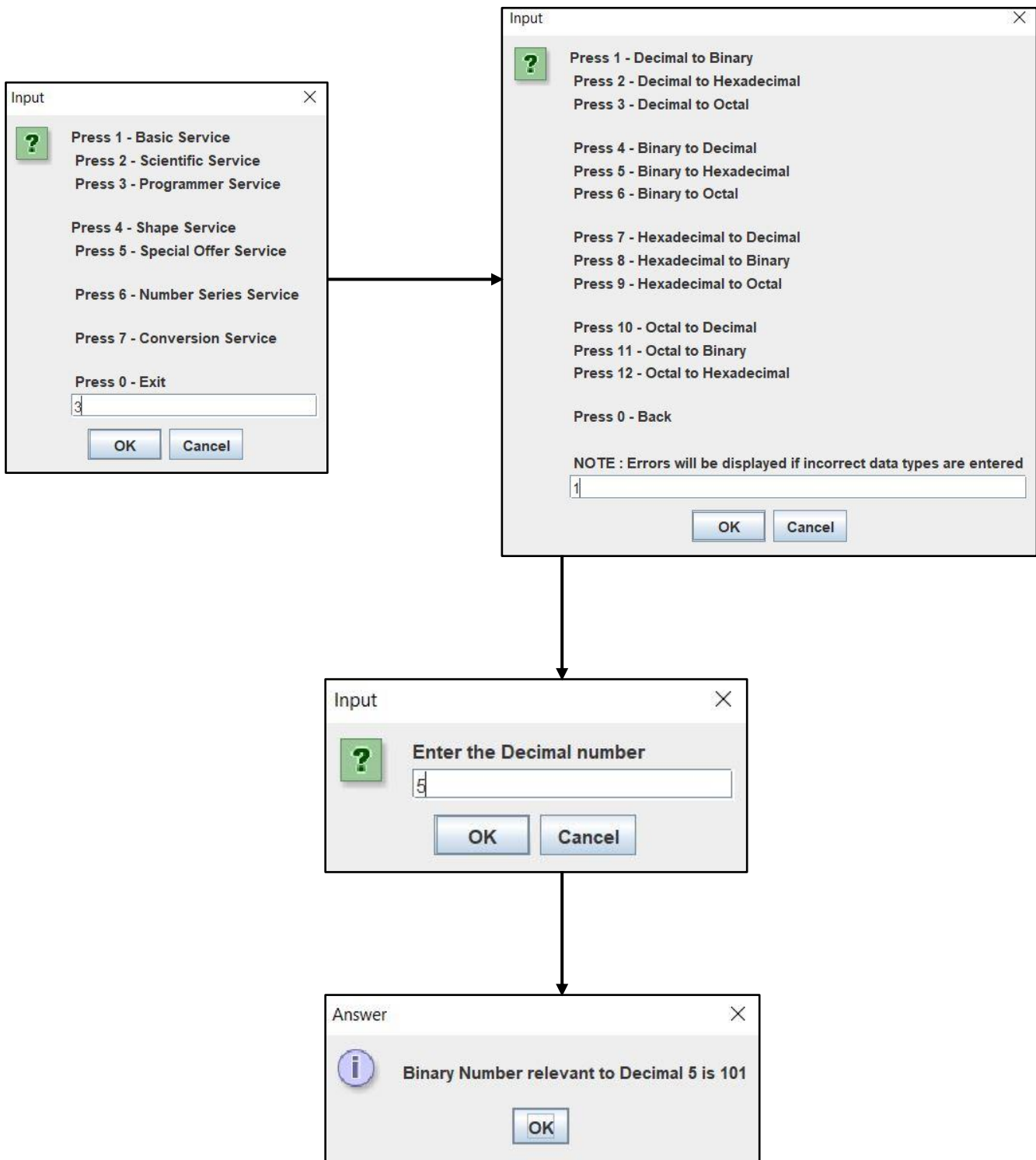
5.1 Basic Service



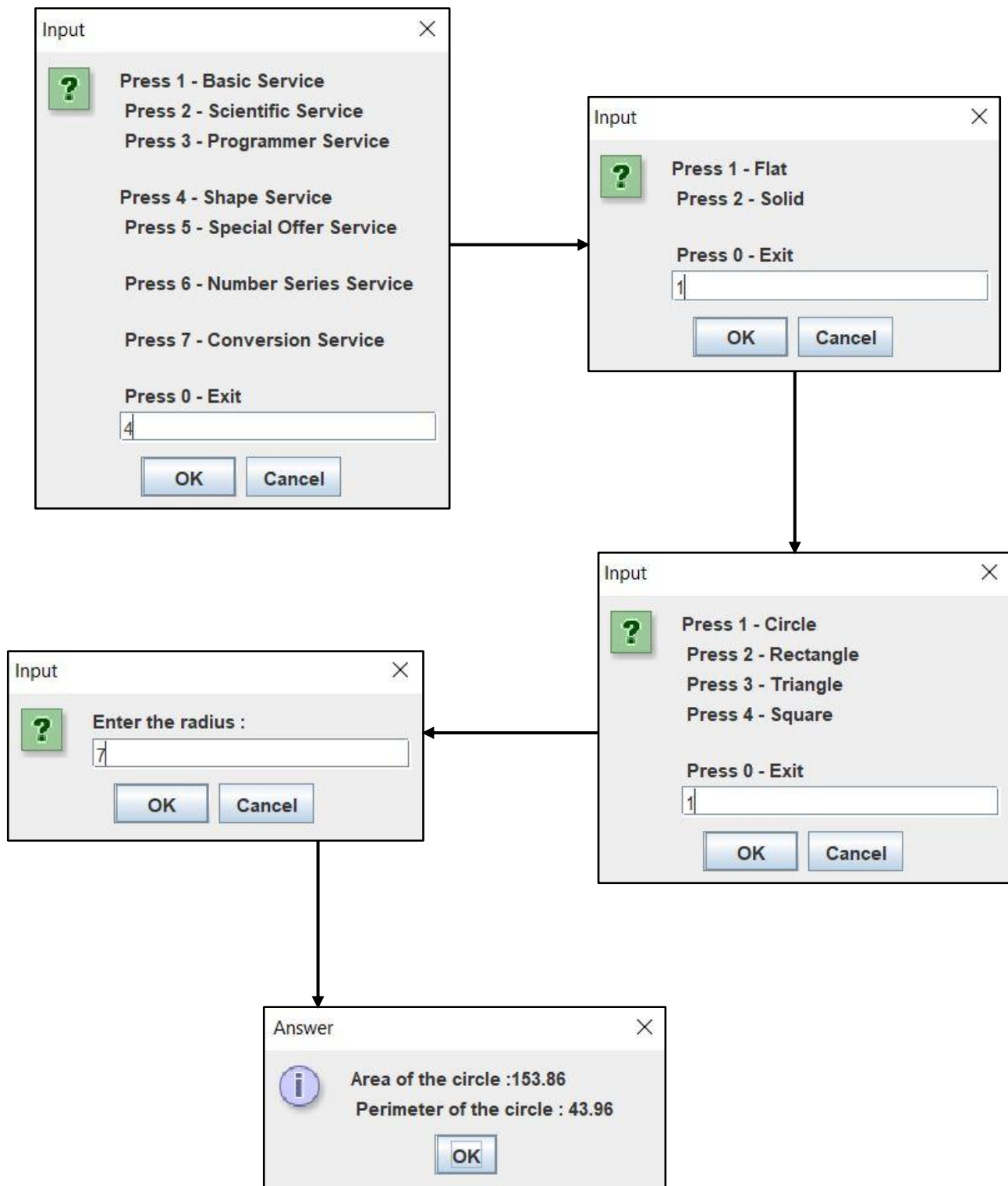
5.2 Scientific Service



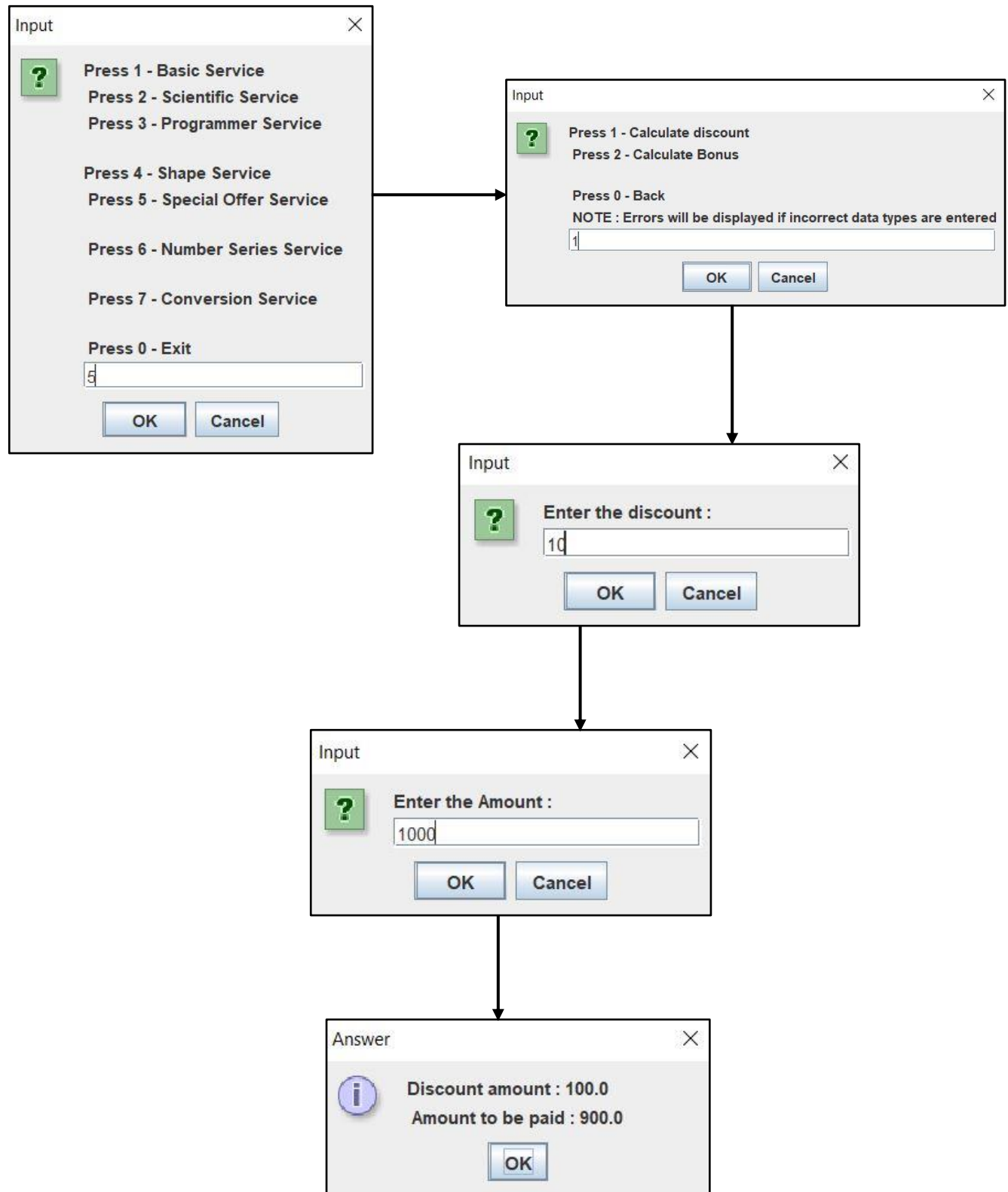
5.3 Programmer Service



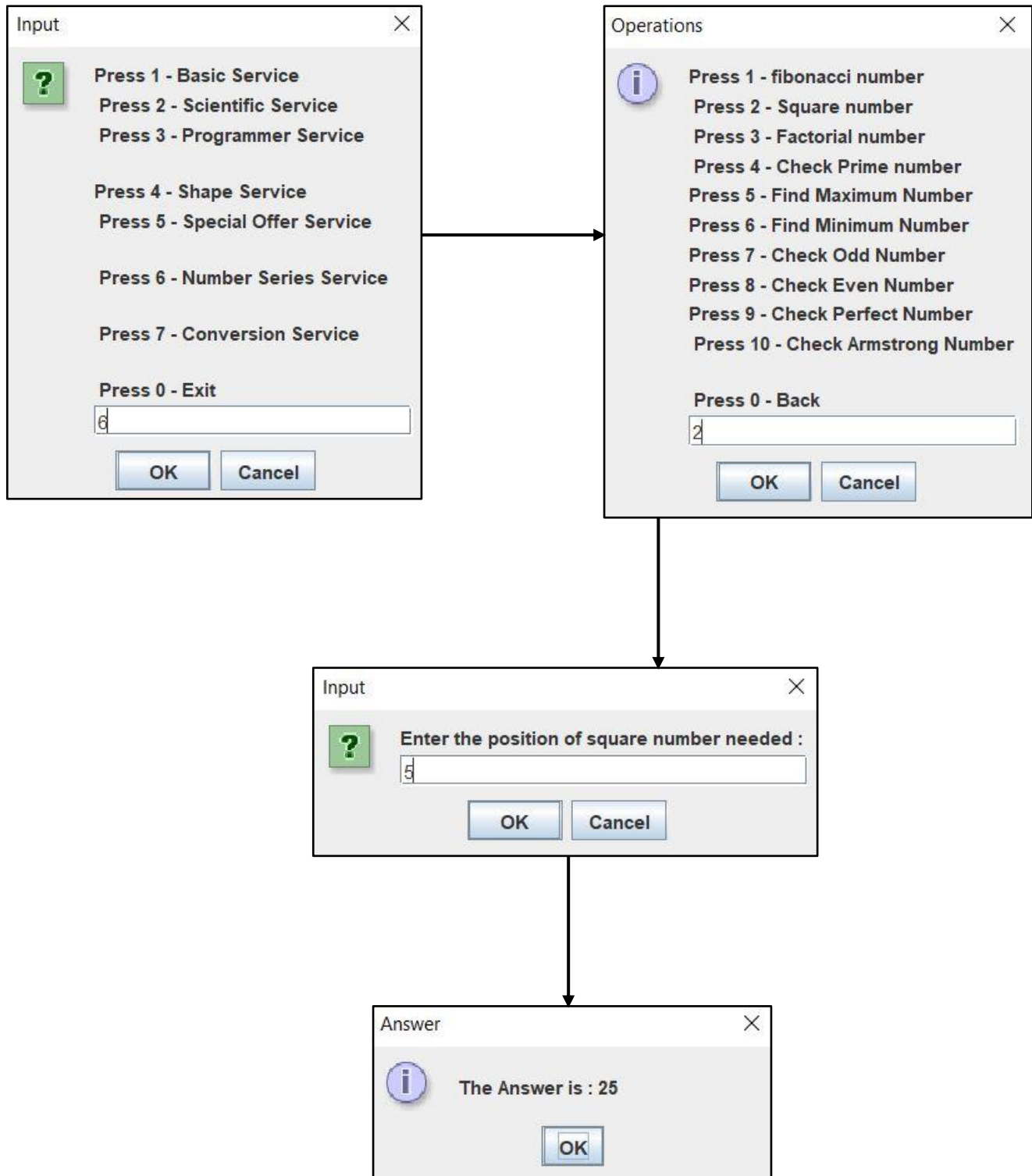
5.4 Shape Calculator Service



5.5 Special Offer Service



5.6 Number Series Service



5.7 Conversion Service

