Chapter 5: Fault Injection Development

Fault injection is a method by which the developer purposefully creates a fault in the program to see how it is handled. The idea for the project was to inject 5 faults into the code of the project and run the testing framework we had built and compared the results. The team chose to utilize mutation testing to see if there were any gaps in our current testing coverage. As stated above, there were 5 changes, some of which overlapped in their expected impact on the testing results. All changes took place in the GlucosioConverter.java.

Original method #1.	Mutation 1. Changed conversion value

public static double glucoseToA1C(double mgDl) {
return round((mgDl + 46.7) / 28.7, 2);
}
	public static double glucoseToA1C(double mgDl) {
	return round((mgDl + 44.7) / 28.7, 2);
	}

Original method #2	Mutation 2. Changed - to +

public static double a1cToGlucose(double a1c) {
return round((a1c * 28.7) - 46.7, 2);
}
	public static double a1cToGlucose(double a1c) {
	return round((a1c * 28.7) + 46.7, 2);
	}

Original method #3	Mutation 3. Changed rounding decimals.
public static double glucoseToMmolL(double mgDl) {	public static double glucoseToMmolL(double mgDl) {

return round(mgDl / MG_DL_TO_MMOL_CONSTANT, 2); }	return round(mgDl / MG_DL_TO_MMOL_CONSTANT, 0); }
Original method #4	Mutation 4. No longer rounds the output.

public static double glucoseToA1C(double mgDl) {
return round((mgDl + 46.7) / 28.7, 2);
}
	public static double glucoseToA1C(double mgDl) {
	return ((mgDl + 44.7) / 28.7);
	}

Original method #5	Mutation 5. Changed constant value
private static final double KG_TO_LB_CONSTANT = 2.20462;	private static final double KG_TO_LB_CONSTANT = 2.2;

Prior to injecting the faults, all 25 of our tests passed. After injecting the five faults, 17 out of 25 tests failed.

Test Number	Method Name	Requirement	Input Value	Output Value	Oracle	Result
1	kgToLb()	Double input converts from kilograms to pounds. Output must also be double. Used in other conversion methods.	0.0	0.0	0.0	PASSED
2	kgToLb()	Double input converts from kilograms to pounds. Output must also be double. Used in other conversion methods.	1.0	2.2	2.20462	FAILED
3	kgToLb()	Double input converts from kilograms to pounds. Output must also be double. Used in other conversion methods.	-1.0	-2.2	-2.20462	FAILED
4	lbToKg()	Double input converts from pounds to kilograms. Output must also be double. Used in other conversion methods.	0.0	0.0	0.0	PASSED
5	lbToKg()	Double input converts from pounds to kilograms. Output must also be double. Used in other conversion methods.	2.20462	1.0020999999999998	1.0	FAILED
6	lbToKg()	Double input converts from pounds to kilograms. Output must also be double. Used in other conversion methods.	-2.20462	-1.0020999999999998	-1.0	FAILED
7	lbToKg()	Double input converts from pounds to kilograms. Output must also be double. Used in other conversion methods.	2.20462	1.0020999999999998	1.0	FAILED
8	lbToKg()	Double input converts from pounds to kilograms. Output must also be double. Used in other conversion methods.	-2.20462	-1.0020999999999998	-1.0	FAILED
9	a1cToGlucose()	Converts from A1C to Glucose. A1C Input, Glucose Output (Double): A1C X 28.7 - 46.7.	0.0	46.7	-46.7	FAILED
10	a1cToGlucose()	Converts from A1C to Glucose. A1C Input, Glucose Output (Double): A1C X 28.7 - 46.7.	10000000.0	287000046.7	286999953.3	FAILED
11	a1cToGlucose()	Converts from A1C to Glucose. A1C Input, Glucose Output (Double): A1C X 28.7 - 46.7.	1.0	75.4	-18.0	FAILED
12	a1cToGlucose()	Converts from A1C to Glucose. A1C Input, Glucose Output (Double): A1C X 28.7 - 46.7.	-1.0	18.0	-75.4	FAILED
13	a1cToGlucose()	Converts from A1C to Glucose. A1C Input, Glucose Output (Double): A1C X 28.7 - 46.7.	10.0	333.7	240.3	FAILED
14	glucoseToA1C()	Converts from Glucose to A1C. Glucose Input, A1C Output (Double): AVG glucose + 46.7 / 28.7.	0.0	1.5574912891986064	1.63	FAILED
15	glucoseToA1C()	Converts from Glucose to A1C. Glucose Input, A1C Output (Double): AVG glucose + 46.7 / 28.7.	1.0	1.5923344947735194	1.66	FAILED
16	glucoseToA1C()	Converts from Glucose to A1C. Glucose Input, A1C Output (Double): AVG glucose + 46.7 / 28.7.	-1.0	1.5226480836236935	1.59	FAILED
17	glucoseToA1C()	Converts from Glucose to A1C. Glucose Input, A1C Output (Double): AVG glucose + 46.7 / 28.7.	10.0	1.9059233449477353	1.98	FAILED
18	glucoseToMmolL()	Calculate concentration of glucose. Input(Double): glucose, Output(Double): Millimoles per liter.	0.0	0.0	0.0	PASSED
19	glucoseToMmolL()	Calculate concentration of glucose. Input(Double): glucose, Output(Double): Millimoles per liter.	100.0	6.0	5.56	FAILED
20	glucoseToMmolL()	Calculate concentration of glucose. Input(Double): glucose, Output(Double): Millimoles per liter.	-100.0	-6.0	-5.56	FAILED
21	glucoseToMgDl()	Calculate concentration of glucose. Input(Double): glucose, Output(Double): Milligrams per 100 millilitres.	10.0	180.0	180.0	PASSED
22	glucoseToMgDl()	Calculate concentration of glucose. Input(Double): glucose, Output(Double): Milligrams per 100 millilitres.	0.0	0.0	0.0	PASSED
23	glucoseToMgDl()	Calculate concentration of glucose. Input(Double): glucose, Output(Double): Milligrams per 100 millilitres.	100.0	1800.0	1800.0	PASSED
24	glucoseToMgDl()	Calculate concentration of glucose. Input(Double): glucose, Output(Double): Milligrams per 100 millilitres.	-100.0	-1800.0	-1800.0	PASSED
25	glucoseToMgDl()	Calculate concentration of glucose. Input(Double): glucose, Output(Double): Milligrams per 100 millilitres.	1000.0	18000.0	18000.0	PASSED

Due to the nature of the methods tested, even a slight change was expected to fail. If the methods initially are chosen were more complicated the results of this testing may be more insightful. Although, because nearly every test failed, it seems that our current testing framework can identify issues that may arise as the code is changed.