
Software Engineering Methods

Assignment 4

Snake-Group-1



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Refactoring

Introduction

We have decided to use 'CodeMR' which is a plugin for IntelliJ to compute code metrics.

We noticed that methods in the gui package generally had more lines of code than other methods (each class only had one method).

Furthermore, in Snake class, the code metrics was fine according to the value, but there were still things that could be improved. We could have extract duplicated code and make new method which is simple but definitely improves our code quality.

Name	LOC	CMLOC	NOF	NOSF	NOM	NOSM
▼ sem-group-1						
▼ game	550					
▶ Game	159	133	14	0	12	0
▶ Snake	53	38	6	0	5	0
▶ SnakeApp	45	44	0	0	1	1
▶ CollisionManager	44	35	5	0	3	0
▶ Board	42	32	5	0	5	0
▶ Painter	36	32	1	0	7	0
▶ BodyPart	32	23	3	0	2	0
▶ Tile	26	10	4	0	3	0
▶ Fruit	24	20	1	0	2	0
▶ Directions	22	1	0	4	1	0
▶ BoardBuilder	17	12	4	0	4	0
▶ GameSettings	14	0	0	13	0	0
▶ Settings	13	0	0	4	0	0
▶ Sound	13	7	2	0	2	0
▶ Wall	10	9	0	0	1	0
▼ gui.controller	250					
▶ PasswordHash	57	47	1	8	4	5
▶ LoginController	55	42	8	0	4	0
▶ SettingController	49	32	16	0	5	0
▶ LeaderBoardController	47	27	15	0	4	0
▶ ScoreController	30	18	7	0	3	0
▶ EntryController	12	10	1	0	5	0
▼ database	237					
▶ DBconnect	152	140	8	1	12	1
▶ SessionManager	33	26	2	1	3	1
▶ GlobalDetails	26	22	3	0	10	0
▶ PersonalDetails	26	22	3	0	10	0
▼ gui	120					
▶ Gui	74	71	1	0	7	0
▶ MainRunner	28	26	0	1	1	1
▶ AlertBox	18	17	0	0	0	3

An obvious candidate for class refactorings was Game. It had a relatively high lack of cohesion (LCOM of 0.889, LCAM of 0.786 and LTCC of 0.9) so we tried to improve that.

Personal Details and Global Details also had a relatively high lack of cohesion, but not as much as Game. Since they were fulfilling similar purposes we merged them together and that increased cohesiveness.

Additionally, the Gui class had high LTCC which was improved by refactoring part of its functionality into a new class.

Name	NORM	LCOM	LCAM	LTCC	ATFD	SI
▼ sem-group-1						
▼ game						
▶ C Game	0	0.889	0.786	0.9	0	0.0
▶ C Snake	0	0.625	0.467	0.0	0	0.0
▶ C SnakeApp	0	0.0	0.333	0.0	0	0.0
▶ C CollisionManager	0	0.3	0.533	0.0	0	0.0
▶ C Board	0	0.667	0.52	0.667	0	0.0
▶ C Painter	0	0.0	0.694	0.0	0	0.0
▶ C BodyPart	0	0.0	0.4	1.0	0	0.0
▶ C Tile	0	0.5	0.467	0.0	0	0.0
▶ C Fruit	0	0.0	0.4	0.0	0	0.0
▶ C Directions	0	0.0	0.0	0.0	0	0.0
▶ C BoardBuilder	0	0.667	0.562	0.5	0	0.0
▶ C GameSettings	0	0.0	0.0	0.0	0	0.0
▶ C Settings	0	0.0	0.0	0.0	0	0.0
▶ C Sound	0	0.5	0.25	0.0	0	0.0
▶ C Wall	0	0.0	0.0	0.0	0	0.0
▼ gui.controller						
▶ C PasswordHash	0	0.963	0.556	0.7	0	0.0
▶ C LoginController	0	0.833	0.0	0.0	0	0.0
▶ C SettingController	0	1.0	0.0	1.0	0	0.0
▶ C LeaderBoardController	0	0.967	0.5	0.833	0	0.0
▶ C ScoreController	0	1.0	0.0	0.0	0	0.0
▶ C EntryController	0	0.0	0.0	0.0	0	0.0
▼ database						
▶ C DBconnect	0	0.704	0.615	0.282	0	0.0
▶ C SessionManager	0	0.833	0.5	0.833	0	0.0
▶ C GlobalDetails	0	0.667	0.625	0.6	0	0.0
▶ C PersonalDetails	0	0.667	0.625	0.6	0	0.0
▼ gui						
▶ C Gui	0	0.0	0.536	1.0	0	0.0
▶ C MainRunner	0	0.0	0.333	1.0	0	0.0
▶ C AlertBox	0	0.0	0.0	0.0	0	0.0

Method level refactoring

1) `gui.controller.leaderBoardController.populateLeaderboards()`

Problem: Number of Methods Call and Number of access fields in one method was a lot in one method. Therefore, separating this method by making helper functions was needed. The goal is to lower both of them to less than 0.7 Metric-Value. (Around medium)

#MC = 17, #AF= 23

Method: The technique used to lower #MC and #AF was 'Extract Method Refactoring.' There were some logics that could be separated, so I have extracted them out and made each of them into one method. One `populateLeaderBoard` method is now separated into 4 methods, and each has its own logic.

Result: #MC = 5 #AF = 6

2) `gui.Gui.startSnakeGame()`

Problem: This method has 75 lines of code (LOC).

Method: To reduce LOC two separate methods were created. One method initializes two Text elements and the other initializes two Buttons.

Result: LOC is reduced from 75 to 52.

3) `gui.MainRunner.start()`

Problem: The method had 25 effective lines of code, some of which fulfilled a different purpose from the others.

Method: Two separate methods were created : one initializes the stage and one manages the scene.

Result: effective lines of code are now only 14.

4) `game.Snake.changeDirection()`

Problem: Number of Methods called was 6.

Method: Extract duplicate code from each condition and made a new method.

Result: Number of Methods called is 4.

5) game.Game.init()

Problem: The method has a coupling of medium-high and a CBO of 7.

Method: Categorized Board as a gamePiece and moved its creation to the PieceCreator.

Result: Init now has low coupling and a CBO of 3;

Class level refactoring

1) gui.Gui.class

Problem: Gui class has methods that could be separated into another class by logic. Moreover, it is using multiple static methods from AlertBox which does not really need to be static and which also decreases the class cohesion.

LTCC = 1

Method: LTCC (Lack of Tight Class Cohesion) is lowered from 1 to 0.788. By extracting class refactoring, I have improved class cohesion. I have made a new class called 'GuiText' so that the class that does the similar operations gather in one class. Moreover, I have made one instance that could be shared among other methods rather than calling static methods every single time. This also contributed to class cohesion.

Result: LTCC = 0.788

2) database.PersonalDetails.class

Problem: This class is really similar to the GlobalDetails class. Therefore its existence doesn't really have any benefits. Also, both Personal- and GlobalDetails have a couple of excess methods that are not used.

Method: Removing the PersonalDetails class and generalizing GlobalDetails into Details which can be used instead of both classes. This removes all complexity that PersonalDetails had and even reduces the CBO of DBconnect from 4 to 3. As well as the removal of some methods from the now generalized Details class reduces the complexity of the Details class itself:

Metric	Before	Now	Metric	Before	Now
RFC	12	6	CMLOC	22	10
WMC	10	4	NOM	10	4
LOC	26	14	LCAM	0.6	0.5

3) game.Game.class

Problem: The complexity of the Game class is pretty high, some methods can be moved out of the game class to reduce the complexity and the length of the game class.

Method: The methods to create walls and create fruits are moved out of the Game class and moved into a new class called PieceCreator. The PieceCreator has the ability to create new walls and new fruit objects. The Game class interacts with the PieceCreator to get the elements for the board. The collisionManager also interacts with this class to get new fruit

objects. This reduces the complexity from Low-Medium to Low and also improves basically all other metrics.

Metric	Before	Now	Metric	Before	Now
CBO	10	9	NOF	14	12
RFC	43	39	NOM	12	8
SRFC	28	19	LCOM	0.881	0.85
WMC	28	15	LCAM	0.786	0.75
LOC	158	114	LTCC	0.8	0.833
CMLOC	132	92			

4) game.Wall.class

Problem: The weighted method count of the class was being increased by the amount of if conditions in the constructor of the class.

Method: The class was simplified by removing the additional if conditions that added minimal functionality.

Metric	Before	Now
WMC	5	1
LOC	10	5
CMLOC	9	149

5) Explanation why no 5th class refactor

We did not find any simple refactor that would really make sense or is really beneficial for the current state of the game. Some additional refactorings we tried were either too hard to implement within the given time or hurt the metrics rather than improving them (they were mainly focused on improving the Game class and making it look less like a blob).

Metrics before refactoring

Name	Complexity	Coupling	Size	Lack of Cohesion
▼ sem-group-1				
▼ game	low	low	medium-high	low
▶ Game	low-medium	low-medium	low-medium	medium-high
▶ Snake	low	low	low-medium	low
▶ SnakeApp	low-medium	low-medium	low	low
▶ CollisionManager	low	low-medium	low	low
▶ Board	low	low	low	low
▶ Painter	low	low	low	low-medium
▶ BodyPart	low-medium	low	low	low
▶ Tile	low	low	low	low
▶ Fruit	low-medium	low	low	low
▶ Directions	low-medium	low	low	low
▶ BoardBuilder	low	low	low	low
▶ GameSettings	low	low	low	low
▶ Settings	low	low	low	low
▶ Sound	low	low	low	low
▶ Wall	low-medium	low	low	low
▼ gui.controller	low	low	low-medium	low
▶ PasswordHash	low	low	low-medium	low
▶ LoginController	low-medium	low	low-medium	low
▶ SettingController	low	low	low	low
▶ LeaderBoardController	low	low	low	low
▶ ScoreController	low	low	low	low
▶ EntryController	low	low	low	low
▼ database	low	low	low	low
▶ DBconnect	low-medium	low	low-medium	low-medium
▶ SessionManager	low	low	low	low
▶ GlobalDetails	low	low	low	low-medium
▶ PersonalDetails	low	low	low	low-medium
▼ gui	low	low	low	low
▶ Gui	low	low-medium	low-medium	low
▶ MainRunner	low-medium	low	low	low
▶ AlertBox	low	low	low	low

Name	CBO	RFC	SRFC	DIT	NOC	WMC
▼ sem-group-1						
▼ game						101
▶ Game	10	43	28	1	0	27
▶ Snake	4	11	7	1	0	12
▶ SnakeApp	6	22	18	2	0	2
▶ CollisionManager	8	40	15	1	0	6
▶ Board	1	8	5	1	0	14
▶ Painter	3	17	10	1	0	13
▶ BodyPart	1	2	0	2	0	6
▶ Tile	0	3	0	1	3	3
▶ Fruit	0	5	3	2	0	6
▶ Directions	0	1	0	2	0	1
▶ BoardBuilder	1	4	0	1	0	4
▶ GameSettings	0	0	0	1	0	0
▶ Settings	0	0	0	1	0	0
▶ Sound	0	7	5	1	0	2
▶ Wall	0	2	1	2	0	5
▼ gui.controller						54
▶ PasswordHash	0	20	17	1	0	12
▶ LoginController	3	64	12	1	0	12
▶ SettingController	1	13	3	1	0	16
▶ LeaderBoardController	3	35	12	1	0	5
▶ ScoreController	4	36	12	1	0	4
▶ EntryController	1	37	3	1	0	5
▼ database						63
▶ DBconnect	4	50	22	1	0	36
▶ SessionManager	1	19	10	1	0	7
▶ GlobalDetails	0	12	2	1	0	10
▶ PersonalDetails	0	12	2	1	0	10
▼ gui						15
▶ Gui	8	40	26	1	0	8
▶ MainRunner	1	26	15	2	0	3
▶ AlertBox	0	8	5	1	0	4

Name	LOC	CMLOC	NOF	NOSF	NOM	NOSM
▼ sem-group-1						
▼ game	550					
▶ C Game	159	133	14	0	12	0
▶ C Snake	53	38	6	0	5	0
▶ C SnakeApp	45	44	0	0	1	1
▶ C CollisionManager	44	35	5	0	3	0
▶ C Board	42	32	5	0	5	0
▶ C Painter	36	32	1	0	7	0
▶ C BodyPart	32	23	3	0	2	0
▶ C Tile	26	10	4	0	3	0
▶ C Fruit	24	20	1	0	2	0
▶ C Directions	22	1	0	4	1	0
▶ C BoardBuilder	17	12	4	0	4	0
▶ C GameSettings	14	0	0	13	0	0
▶ C Settings	13	0	0	4	0	0
▶ C Sound	13	7	2	0	2	0
▶ C Wall	10	9	0	0	1	0
▼ gui.controller	250					
▶ C PasswordHash	57	47	1	8	4	5
▶ C LoginController	55	42	8	0	4	0
▶ C SettingController	49	32	16	0	5	0
▶ C LeaderBoardController	47	27	15	0	4	0
▶ C ScoreController	30	18	7	0	3	0
▶ C EntryController	12	10	1	0	5	0
▼ database	237					
▶ C DBconnect	152	140	8	1	12	1
▶ C SessionManager	33	26	2	1	3	1
▶ C GlobalDetails	26	22	3	0	10	0
▶ C PersonalDetails	26	22	3	0	10	0
▼ gui	120					
▶ C Gui	74	71	1	0	7	0
▶ C MainRunner	28	26	0	1	1	1
▶ C AlertBox	18	17	0	0	0	3



































Name	NORM	LCOM	LCAM	LTCC	ATFD	SI
▼ sem-group-1						
▼ game						
▶ C Game	0	0.889	0.786	0.9	0	0.0
▶ C Snake	0	0.625	0.467	0.0	0	0.0
▶ C SnakeApp	0	0.0	0.333	0.0	0	0.0
▶ C CollisionManager	0	0.3	0.533	0.0	0	0.0
▶ C Board	0	0.667	0.52	0.667	0	0.0
▶ C Painter	0	0.0	0.694	0.0	0	0.0
▶ C BodyPart	0	0.0	0.4	1.0	0	0.0
▶ C Tile	0	0.5	0.467	0.0	0	0.0
▶ C Fruit	0	0.0	0.4	0.0	0	0.0
▶ C Directions	0	0.0	0.0	0.0	0	0.0
▶ C BoardBuilder	0	0.667	0.562	0.5	0	0.0
▶ C GameSettings	0	0.0	0.0	0.0	0	0.0
▶ C Settings	0	0.0	0.0	0.0	0	0.0
▶ C Sound	0	0.5	0.25	0.0	0	0.0
▶ C Wall	0	0.0	0.0	0.0	0	0.0
▼ gui.controller						
▶ C PasswordHash	0	0.963	0.556	0.7	0	0.0
▶ C LoginController	0	0.833	0.0	0.0	0	0.0
▶ C SettingController	0	1.0	0.0	1.0	0	0.0
▶ C LeaderBoardController	0	0.967	0.5	0.833	0	0.0
▶ C ScoreController	0	1.0	0.0	0.0	0	0.0
▶ C EntryController	0	0.0	0.0	0.0	0	0.0
▼ database						
▶ C DBconnect	0	0.704	0.615	0.282	0	0.0
▶ C SessionManager	0	0.833	0.5	0.833	0	0.0
▶ C GlobalDetails	0	0.667	0.625	0.6	0	0.0
▶ C PersonalDetails	0	0.667	0.625	0.6	0	0.0
▼ gui						
▶ C Gui	0	0.0	0.536	1.0	0	0.0
▶ C MainRunner	0	0.0	0.333	1.0	0	0.0
▶ C AlertBox	0	0.0	0.0	0.0	0	0.0

Metrics after refactoring

Name	Complexity	Coupling	Size	Lack of Cohesion
▼ sem-group-1				
▼ database	low	low	low	low
▶ DBconnect	low-medium	low	low-medium	low-medium
▶ Details	low	low	low	low
▶ SessionManager	low	low	low	low
▼ game	low	low	medium-high	low
▶ Board	low	low	low	low
▶ BoardBuilder	low	low	low	low
▶ BodyPart	low-medium	low	low	low
▶ CollisionManager	low	low-medium	low	low
▶ Directions	low-medium	low	low	low
▶ Fruit	low-medium	low	low	low
▶ Game	low	low-medium	low-medium	medium-high
▶ GameSettings	low	low	low	low
▶ Painter	low	low	low	low
▶ PieceCreator	low	low-medium	low-medium	low
▶ Settings	low	low	low	low
▶ Snake	low	low	low-medium	low
▶ Sound	low	low	low	low
▶ Tile	low	low	low	low
▶ Wall	low-medium	low	low	low
▼ gui	low	low	low	low
▶ AlertBox	low	low	low	low
▶ Gui	low	low-medium	low-medium	low
▶ GuiButton	low	low	low	low
▶ GuiText	low	low	low	low
▶ MainRunner	low-medium	low	low	low
▼ gui.controller	low	low	low-medium	low
▶ EntryController	low-medium	low	low	low
▶ LeaderBoardController	low	low	low-medium	low
▶ LoginController	low-medium	low	low	low
▶ PasswordHash	low	low	low-medium	low
▶ ScoreController	low	low	low	low
▶ SettingController	low	low	low	low

Name	CBO	RFC	SRFC	DIT	NOC	WMC
▼ sem-group-1						
▼ database						50
▶ DBconnect	3	51	22	1	0	38
▶ Details	0	6	2	1	0	4
▶ SessionManager	1	23	13	1	0	8
▼ game						95
▶ Board	1	8	5	1	0	14
▶ BoardBuilder	1	4	0	1	0	4
▶ BodyPart	1	2	0	2	0	6
▶ CollisionManager	9	36	12	1	0	6
▶ Directions	0	1	0	2	0	1
▶ Fruit	0	4	2	2	0	6
▶ Game	6	40	12	1	0	15
▶ GameSettings	0	0	0	1	0	0
▶ Painter	3	15	9	1	0	12
▶ PieceCreator	7	18	13	1	0	12
▶ Settings	0	0	0	1	0	0
▶ Snake	4	12	8	1	0	13
▶ Sound	0	7	5	1	0	2
▶ Tile	0	3	0	1	3	3
▶ Wall	0	2	1	2	0	1
▼ gui						26
▶ AlertBox	0	8	5	1	0	4
▶ Gui	9	50	31	1	0	11
▶ GuiButton	0	5	3	1	0	2
▶ GuiText	0	7	4	1	0	3
▶ MainRunner	2	35	21	2	0	6
▼ gui.controller						58
▶ EntryController	3	53	6	1	0	5
▶ LeaderBoardController	3	40	16	1	0	9
▶ LoginController	3	66	11	1	0	12
▶ PasswordHash	0	19	16	1	0	12
▶ ScoreController	4	41	10	1	0	4
▶ SettingController	2	14	2	1	0	16

Name	LOC	CMLOC	NOF	NOSF	NOM	NOSM
▼ sem-group-1						
▼ database	218					
▶ DBconnect	167	148	8	1	13	1
▶ Details	14	10	3	0	4	0
▶ SessionManager	37	30	2	1	4	1
▼ game	497					
▶ Board	43	32	5	0	5	0
▶ BoardBuilder	17	12	4	0	4	0
▶ BodyPart	32	23	3	0	2	0
▶ CollisionManager	42	31	6	0	3	0
▶ Directions	22	1	0	4	1	0
▶ Fruit	23	19	1	0	2	0
▶ Game	106	84	12	0	8	0
▶ GameSettings	14	0	0	13	0	0
▶ Painter	34	30	1	0	6	0
▶ PieceCreator	53	50	1	0	4	0
▶ Settings	13	0	0	4	0	0
▶ Snake	54	39	6	0	6	0
▶ Sound	14	7	2	0	2	0
▶ Tile	25	10	4	0	3	0
▶ Wall	5	4	0	0	1	0
▼ gui	158					
▶ AlertBox	18	17	0	0	3	0
▶ Gui	85	79	3	0	10	0
▶ GuiButton	8	5	1	0	2	0
▶ GuiText	7	6	0	0	3	0
▶ MainRunner	40	38	0	1	3	1
▼ gui.controller	258					
▶ EntryController	22	14	3	0	5	0
▶ LeaderBoardController	56	36	15	0	8	0
▶ LoginController	48	35	8	0	4	0
▶ PasswordHash	55	45	1	8	4	5
▶ ScoreController	27	15	7	0	3	0
▶ SettingController	50	32	17	0	5	0

Name	NORM	LCOM	LCAM	LTCC	ATFD	SI
▼  sem-group-1						
▼  database						
▶  DBconnect	0	0.701	0.614	0.264	0	0.0
▶  Details	0	0.667	0.5	0.5	0	0.0
▶  SessionManager	0	0.778	0.45	0.7	0	0.0
▼  game						
▶  Board	0	0.667	0.52	0.667	0	0.0
▶  BoardBuilder	0	0.667	0.562	0.5	0	0.0
▶  BodyPart	0	0.0	0.4	1.0	0	0.0
▶  CollisionManager	0	0.333	0.533	0.0	0	0.0
▶  Directions	0	0.0	0.0	0.0	0	0.0
▶  Fruit	0	0.0	0.4	0.0	0	0.0
▶  Game	0	0.85	0.75	0.833	0	0.0
▶  GameSettings	0	0.0	0.0	0.0	0	0.0
▶  Painter	0	0.0	0.6	0.8	0	0.0
▶  PieceCreator	0	0.0	0.562	1.0	0	0.0
▶  Settings	0	0.0	0.0	0.0	0	0.0
▶  Snake	0	0.7	0.444	0.133	0	0.0
▶  Sound	0	0.5	0.25	0.0	0	0.0
▶  Tile	0	0.5	0.467	0.0	0	0.0
▶  Wall	0	0.0	0.0	0.0	0	0.0
▼  gui						
▶  AlertBox	0	0.0	0.0	0.0	0	0.0
▶  Gui	0	0.778	0.575	0.786	0	0.0
▶  GuiButton	0	0.0	0.333	1.0	0	0.0
▶  GuiText	0	0.0	0.417	0.0	0	0.0
▶  MainRunner	0	0.0	0.5	1.0	0	0.0
▼  gui.controller						
▶  EntryController	0	0.667	0.0	0.0	0	0.0
▶  LeaderBoardController	0	0.924	0.583	0.8	0	0.0
▶  LoginController	0	0.833	0.0	0.0	0	0.0
▶  PasswordHash	0	0.963	0.556	0.7	0	0.0
▶  ScoreController	0	0.857	0.0	0.0	0	0.0
▶  SettingController	0	0.956	0.0	0.4	0	0.0