FIT2102 Programming Paradigms 2025

Assignment 1: Flappy Birb

Due Date: 5 Sep 2025, 11:55 PM
Weighting: 30% of your final mark for the unit
Interview: During Week 7
Overview: Students will work **independently** to create a game using Functional Reactive Programming (FRP) techniques. Programs will be implemented in TypeScript and use RxJS Observable streams to handle animation, user interaction, and other similar stream behaviours. **The goal is to demonstrate a good understanding of functional programming techniques as explored in the first four weeks of the unit**, including written documentation of the design decisions and features.

Submission instructions

Submit a zipped file named <studentNo>_<name>.zip which extracts to a folder named <studentNo>_<name>

- **It must contain all the code for your program** along with all the supporting files as well as the **report**.
- It should include sufficient **documentation** that we can appreciate everything you have done.
- You also need to include a report describing your design decisions.
- The only external library should be RxJS libraries supplied with the starter code.
- **Make sure the code you submit executes properly.**
- **Do not submit the .git folder, node_modules or dist folders.**

The marking process will look something like this:

1. Extract **<studentNo>_<name>.zip**
2. Navigate into the folder named **<studentNo>_<name>**
3. Execute `npm install` and `npm run dev`
4. Open http://localhost:5173 in a browser

Please ensure that you test this process before submitting. Any issues during this process will make your marker unhappy and may result in a deduction in marks.

Late submissions will be penalised at 5% per calendar day, rounded up. Late submissions more than seven days will receive zero marks and no feedback.

Git Instructions

We will be using Git for this assignment; however, this will mostly be self-directed. There are no requirements on how many commits you need to the repo. However, we do recommend following good practices and having frequent commits with meaningful commit messages. If any issues arise with academic integrity or submission, this will be used as evidence if you have completed your own work on time, if you have no commits, this will likely make it harder for you to clear yourself of any possible academic integrity issues, so we **highly recommend** you follow good practices.

The assignment uploaded to Moodle will be used for marking, unless there are exceptional circumstances that prevented you from uploading to Moodle, at which point, we will be marking the last version committed to Git before the due date.

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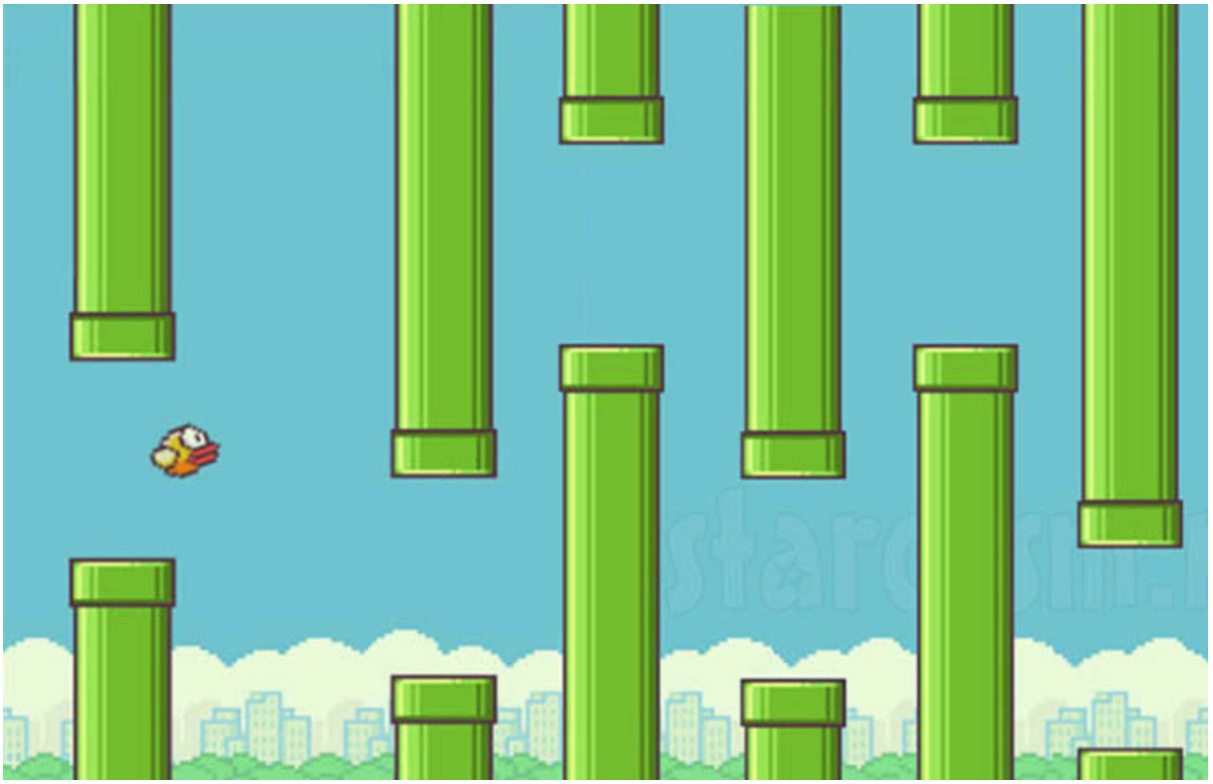

Task description

In this assignment, we will use the RxJS Observable stream explored from Week 3 to create the classic Flappy Bird game in an SVG canvas. You will be provided with a starter code bundle similar to the applied sessions, including instructions on usage.

The image above and the Wikipedia page are meant to give you an idea of the gameplay, but yours needn't look the same or work in precisely the same way, especially with regard to graphics. **Note that only a subset of the features discussed in the link will be part of the requirements.**

You will also need to write a report, as described below.

Requirements

The game must be implemented in a good functional reactive programming style to get marks. A subset of the game's features will be required to get a passing grade. A greater subset of features will be required to get a higher grade. To achieve the maximum marks for this assignment, you will have to use a little creativity and add some non-trivial functionality of your own choice.

Minimum requirements

All of these requirements must be reasonably executed to achieve a passing grade

- A game board with a horizontally scrolling field where the player controls a bird that:
    - Falls continuously due to gravity.
    - Moves upward ("flaps") when a specific key is pressed (e.g., spacebar).
- The game must include pipes (obstacles) that move from right to left across the screen.
    - The pipes have vertical gaps that the bird must fly through.
- The bird has three lives.
    - When the bird hits a pipe or the top or bottom of the screen, a life is lost and the bird bounces off:
        - If the bird hits the top of the screen or the top half of a pipe, the bird should bounce down with a *random* velocity
        - If the bird hits the bottom of the screen or the bottom half of a pipe, the bird should bounce up with a *random* velocity
    - Once all lives are used, the game ends.
- The pipe information is read from a file provided to the main function at startup.
- The game must finish once all the pipes have been successfully navigated or the bird loses all lives.
- Obstacles not relevant to the current play area (e.g., off-screen left) should be removed from the canvas.
- A score must be tracked:
    - Increases when the player successfully passes **through** a pipe.
- A short 1-2 page PDF report detailing your design decisions and use of functional programming techniques discussed in the course notes

Full Game requirements

Meets minimum requirements and has additional features

- When the game ends, the game can be restarted

- At the start of each new game, display a "ghost bird" that replays all previous runs from the current session in real time
    - The ghost should:
        - Follow the exact path the player took in their last game.
        - Move in sync with the current game progression.
        - Be non-interactive (i.e., it does not affect gameplay or collision).
        - Be distinguishable from the player's bird (e.g., different opacity or style).
    - This should be possible to **complete using observable** functionality.
        - You can only get a **maximum of half marks** for this section, if you store all game states in an array
        - **Either** solution will qualify in meeting the full game requirements
- Smooth and usable gameplay.
- See video for an idea of appropriate gameplay.

Additional requirements

See the Additional Information and How to get a High HD sections.

Report

Your report should be 300–600 words in length, plus up to 200 words for each **significant** additional feature, where you should:

- Include basic report formatting headings/paragraphs and diagrams **as necessary**
- **Summarise** the workings of the code and **highlight** the interesting parts (don't just describe what the code does, we can read the source code!)
- Give a high-level overview of your **design decisions** and **justification**
- Explain how the code follows FRP style and interesting usage of Observable
- How state is managed throughout the game while **maintaining purity** and **why**
- Describe the usage of Observable beyond simple input and **why**
- **Important**: Need to explain **why** you did things
- **Do not include screenshots of code unless you have an exceptional reason**
- This should be concise and straightforward. You may use dot points.

Your marker will be instructed to stop reading if your report is too long, and only mark the first 600 (+200 per extra feature) words.

Plagiarism

We will be checking your code against the rest of the class and the internet using a plagiarism checker. Monash applies strict penalties to students who are found to have committed plagiarism. Additionally, we will be conducting an interview, which gives you a chance to explain your code and help us understand your code better. As long as you wrote your own code, there is nothing to worry about during the interview process. See Interview for a rubric on the interview.

AI Statement

As per the AI statement on Moodle, use of generative AI in this unit is unrestricted. However, all code generated with AI **must** be properly **cited** in the form of code comments stating what has been generated and the scope of its use. You must be able to demonstrate understanding of all code submitted as part of your assignment. Inability to explain any submitted code may result in an academic integrity case. You will also **not gain any marks for any features implemented using AI**.

Definition of a Pipe

In *Flappy Birb*, pipes are obstacles that scroll across the screen from right to left. Each pipe has a **gap** that the player-controlled bird must pass through. The position and timing of each pipe are defined in an input CSV file. Each pipe is described using the following columns.

Column Name	Description
gap_y	The vertical centre position of the gap (in a fraction of the canvas height, i.e., 0.5 = centre point)
gap_height	The height of the gap — how much space the bird has to fly through. (in fraction of the canvas height)
time	The time that the pipe should appear on the right hand side, in seconds

Additional Information: Marking Criteria and Suggestions

This section is not essential for completing the assignment, and is provided purely for context and additional information to answer common questions students may have.

Marking (30 marks total)

The goal of this assignment is to assess your understanding of FRP and Functional Programming. The marking has three broad sections:

1. Implementation of game features
2. Usage and understanding of proper functional programming style
3. Usage and understanding of RxJS and Observable

It is important to realise that:

- To receive a **Pass** grade by implementing the **Minimum requirements**, demonstrating application of functional programming ideas from our lectures and applied sessions.
    - You can receive up to a **Distinction** for perfectly implementing the **Minimum requirements** and demonstrating an excellent understanding of how to use Observable to write clean, clear functional UI code.
- To achieve a **High Distinction**, you will need to implement the **Full game requirements**
- To achieve the **maximum possible marks**, you will need to implement the full game requirements plus some aspect of **additional functionality,** as described below.

Note that it is essential to follow the submission instructions, as deductions may be applied for failing to follow the submission instructions.

We will mark 5 sections – Report, Functional Programming style, Code Quality, Observable and RxJS usage, and Game Features (including advanced features) – that are individually weighted.

Code that does not use Observable will **not** get a passing grade; games that use imperative, impure, or mutable code will be heavily penalised.

The rubric and marking guide are provided here.

Report (2 marks)

The report is intended to demonstrate your theoretical understanding of functional reactive programming, highlight design decisions, and help your marker appreciate the work that you have put into this assignment.

Important considerations for the report:

- Design decisions need to be correct
- Need to display understanding of course material
- Reports must demonstrate knowledge of FRP to achieve a passing mark
- **Marks can be awarded for students identifying issues with the code and how they can be addressed**
- Avoid filler in the report, but include enough information to show your marker that you have understood the core concepts

Functional Programming style (8 marks)

This section is about using what we have covered in lectures and tutorials. This involves concepts like:

- Small, granular functions
- Reusable functions and avoiding duplicate code
- Purity / referential transparency
- Manipulation of different complex types and generic types
- HOF and curried functions
- Function composition/chaining

To achieve the maximum available marks, it is important to not only use advanced functional programming concepts, but do so in a useful way – for example, improving the readability of the code or following a declarative programming style. For example, simply currying all your functions will not receive marks unless they are partially applied somewhere and used appropriately.

You may also attempt to use Lambda Calculus concepts in your code; however, be careful as they can often just make things hard to understand – it will be important to explain their usage in your report, so your marker can better appreciate your work.

Deductions will be applied for improper usage of types, including unjustified `any` types.

Code Quality (8 marks)

This section loosely covers anything to do with how readable and understandable your code is. Applying a good functional programming style tends to increase the readability of your code. **It is important that your code can be easily understood to help your marker appreciate your work.**

Some examples of what we look at are

- Appropriate line lengths (≤80 characters)
- Documentation and commenting (should explain why the code is the way it is)
- Logical structuring of functions and variables, including overall flow of program logic
- Appropriate variable naming
- Consistent and understandable formatting

Using a linter and formatter may help greatly with this section. See below for tips and suggestions.

Observable and RxJS usage (8 marks)

This section covers usage of FRP – did you use Observable well?

Some important considerations:

- **Must manage game state in Observable**, and use the **scan** and **merge** operators to get a **passing** mark (please refer to the Asteroids example)
- Must handle creation of a stream of pipes using Observables and an appropriate set of operations
- Usage of Observable as per discussed in the lectures, applied sessions, workshop, and in the Asteroids example, while maintaining purity, is sufficient for a **high** mark in this section if implemented very well and without issues
- **To achieve the maximum marks available, we want to see interesting and creative uses for Observable and RxJS operators (original work)**

Other considerations:

- Side effects should be contained as much as possible
- Using additional RxJS operators that are not covered in class, or using the ones we introduce in interesting and novel ways, will be awarded additional marks (given that they are appropriate and useful)

Game Features (4 marks)

This section is about whether your game fulfils the requirements, and the overall complexity of your game (and thus the implementation).

Adding features should not come at the expense of the other criteria — a well-implemented game with fewer features may and, often will, achieve a higher mark than a less well-implemented game with more features.

Important: You will receive marks for implementing game features, but **this mark will also cap your total mark**.

- The maximum mark possible for implementing **minimum game requirements** is 70 (Distinction)

- The maximum mark possible for implementing **full game requirements** is 90 (HD)
- To achieve the maximum available marks (90+), you must implement **advanced requirements**

Some marking considerations:

- Extra features must follow FRP
- Advanced requirements can be not just gameplay but extra FRP features too
- Tests: for full marks, tests need to be **comprehensive** and not just simple/random test cases — they should guide development
- Bugs and other gameplay-related issues will **not** be deducted from this section and be deducted from the total mark
- The total mark cap will be increased when implementing additional features. It is *possible* to achieve an HD by implementing the minimum game requirements and *some* full game requirements

To achieve the maximum available marks, features should be significant and change how state is managed in interesting ways. Discussed further below.

Bonus marks are available for particularly novel, impressive, or advanced features. Note that marks cannot exceed 100% of the total available marks.

Interview

The interview mark is a scaling factor of your entire grade for this assignment. For example, if you get 23/30 for the assignment and you get a scaling factor of 90%, then your final grade is 20.7/30.

Category Description	**Detailed Description**	**Scaling Factor**
Complete understanding	The student is in full command of every aspect of the code, and demonstrates a deep familiarity of the code and paradigm used. They can answer questions precisely, correctly, and concisely with no prompting.	100%
Prompted understanding	The student is prepared and can consistently provide answers that are fully correct, but requires some prompting.	90%
Somewhat understanding	The student is somewhat prepared, and gives answers that are partially correct, or fully correct in one area, but cannot answer questions about another area correctly.	75%
Partial understanding	The student can answer something partially relevant or correct to a question but they can’t engage in a serious discussion of the work.	50%
Trivial understanding	Offers minimal understanding. Can name some operators or describe small parts of the code, but they clearly can’t engage in any discussion of the work.	30%
No understanding	The student has not prepared, cannot answer even the most basic questions and likely has no understanding of their code.	0%

Rubric

The rubric consists of **Marking bands** that represent the possible grade values for implementing requirements. This will be a **cap** on your final mark.

The **Marking guide** is what TAs will be using to mark your assignment, and what will contribute to your final mark/grade for this assignment.

Marking bands (summary of marking guide)

Code/Report quality	**Implementation**		
	Minimum requirements	*Full game*	*Full game + extension(s)*
Any of the following are not acceptable: Use of imperative code, TypeScript compile errors, `any` types, Not using RxJS, No comments, Missing or unreadable report.	Not passing.	Not passing.	Not passing.
Pure functional code (except in `subscribe` handlers), no compile/runtime errors, basic comments, basic report covering the implemented features. Uses Observable for state management.	P	C	C
Effectively uses Observable for state management, has generic types, and side effects are identified; comments are brief, only describing the implementation. The report demonstrates basic understanding of FRP principles. Functions are used for broad high-level behaviour.	C	D	D
Small pure functions, immutable data and reusable code exploiting parametric polymorphism, side effects are contained; complete comments explaining the rationale and choices made in code. Advanced usage of Observable. Detailed report of implemented features that demonstrates strong understanding of Functional Programming and FRP.	D	HD	HD (90+)

Marking guide

	FP Style	Code Quality	Observable
0–1 marks	Code is written in an imperative style, use of for/while loops and mutable variables (let/var). Modifies mutable data structures that aren't declared as read-only to handle state management. No use of FP.	Code is completely unreadable. Contains very large code blocks with complex nested logic and long lines. Excessive use of single-letter and/or vague function names.	No use of observables. Uses DOM to store state or does not use Observable to store state.
2 marks	Some use of FP but has not demonstrated good understanding. Many functions are impure and modify state.	Code is difficult to read and requires careful analysis to understand intent. Many poor choices for variable names and many examples of complex nested logic with lack of documentation.	Some use of Observables, but does not utilise RxJS operators such as scan to effectively handle state. Observable callbacks contain impure code outside subscribe.
3 marks	Demonstrates some understanding of FP. Code contains some impure code. Use of HOF, but not utilised effectively.	Reader is able to get a general idea of code, but is difficult to read. Contains long lines and large code chunks. Some attempt at using functions and splitting up complex logic.	Uses Observables to handle state management and user interaction. Some Observable methods are not used effectively or not as intended, which demonstrates a lack of understanding.
4 marks	Style and structure is adapted from Asteroids example, but is not adapted to fit Flappy Birb. Code is entirely pure.	Able to get the general idea of code. Contains many complex structures, and large chunks of code that require refactoring. Minimal documentation	Uses observables to handle state management and user interaction. Uses subscribe to handle stream logic; overuse of `subscribe` callback.
5 marks	Similar style to the asteroids example, effectively adapted to new context.	Can tell the purpose of each piece of code. Contains documentation, but	Good use of basic Observables from the unit. Some methods in the

	Code is entirely pure and utilises the state management system introduced in the Asteroids example.	some comments are redundant. Some long lines and large blocks, but generally minimised.	Observable stream are overly complex and can be broken down more appropriately.
6 marks	Improves the Asteroids example considerably for the new game context. Good use of small modular functions and HOF. Shows great understanding of course content.	Code quality is of similar level to the Asteroids example in the notes.	Utilises Observable structure covered in unit content effectively. Good use of using observables for state management.
7 - 8 marks	Applies FP concepts in original ways beyond the Asteroids example. Great use of HOF, modular functions and a custom type system. Demonstrates fantastic understanding of course content in novel and interesting ways.	Code is easy to read, intuitive and flows well. Self-documenting (descriptive variable names, easy to follow code flow). Well documented, and comments are provided when needed. No long lines, and code is broken into readable chunks.	Uses interesting Observable methods not covered in course content.

	0 - 0.5 marks	1 mark	1.5 marks	2 marks
Report	Not written or does not correspond to submission. Provides a summary of the code. Contains some justification, but focuses too much on summarising code. Contains too many screenshots of code.	Provides a summary of code with reference to FRP principles followed. Demonstrates some understanding of FRP and how it was used to manage state. Some justification for design choices with some focus on why.	Clearly written and concise. Provides a good summary of code. Design choices are justified and considers tradeoffs. Relates design choices to FRP and course content. Good understanding of FRP and pure state management.	Clearly written and concise. Highlights only key aspects of the code. Strong understanding of FRP and how it is used to manage state. Design choices are well justified, and considers non-trivial alternatives and tradeoffs.

Features		Marks	Running total	Classification
Pipes are read from the given CSV file		**0.25**	0.25	**Minimum (≤ 70)**
Pipes move across the screen continuously, timing aligns with CSV file, and are removed when off the screen		**0.25**	0.5	
Bird falls down and flaps reasonably		**0.5**	1	
Score		**0.25**	1.25	
Bird has 3 lives and loses a life when it hits a pipe or the top/bottom of screen		**0.25**	1.5	
Bird bounces off pipe or top/bottom of screen with random velocity		**0.25**	1.75	
Game ends when the bird has passed through all the pipes		**0.25**	**2**	
Game can be restarted		**0.5**	2.5	**Full (≤ 90)**
Ghost birds	Ghost birds implemented by storing all game states in an array	**0.5**	3	
	OR Ghost birds implemented using observables	**1**	3.5	
	Advanced feature	**0.5**	**4**	**Advanced (90+)**

How to get an HD or High HD

To achieve a mark in the HD range, you need to implement a complete game with good style. To get in the high HD range, you will also need to implement **advanced features**.

One or more of the following (or something of your own devising with a similar degree of complexity) done well (on top of the basic functionality described above) will earn you a high HD, provided it is implemented using the functional programming ideas we have covered in lectures and classes:

- Create unit tests and create a file **tests/main.test.ts** which are **comprehensive** and **guided the development of the program**
- Ability to pause a game

- Power ups or Multipliers for some pipes, which might e.g. give bonus scores to the user, speed up or slow down the game, destroy pipes, etc.
- *Advanced (not recommended unless you already know how): Make a distributed multiplayer version, wrapping the comms in Observable (you'll have to provide your own server for this).*

In general, **additional features for achieving HD and high HD will have to non-trivially impact your state management and/or overall complexity of the game**. For example, a power-up that changes the speed of the pipes does not require interesting usage of state on its own, but if power-ups decay over time, then that would be more interesting and non-trivial.

Note that adding features will grant you a higher grade **under the condition that it is done in proper Functional and FRP style**. For an example of the proper style, refer to the example Asteroids Game described in the Course Notes.

Tips and suggestions

These are not part of the explicit requirements, but are things we may look at as part of the marking criteria. For example, poor choices of variable names may not have an explicit deduction but may impact your code quality mark as it makes the code hard to read.

Tips for getting started.

- Complete the Week 3-4 RxJS applied & **workshop** exercises and begin studying observables in the course notes.
- Once you have completed the above, work through the example Asteroids Game described in the Course Notes. Follow the same framework to begin adding functionality to **main.ts** as above.

More tips.

- Finish all the JavaScript and TypeScript exercises and the course notes FRP material first. They are designed to give you the skills you need to prepare for this assignment
- Come to the workshops and applied sessions for important tips and assistance.
- **Attend consultations given by the teaching team.** They are often sparse or empty around the time assignments are released, so it can be a great opportunity to get more detailed guidance and feedback
- Any general questions should be directed to the Ed forums when possible. However, try to avoid posting potential solutions. If you cannot make the consultations, you may make a ***private*** post for the assignment with your code.
- Your code should include brief comments to explain logic and design choices where necessary, or to refer to detailed explanations in your report. Please do not add comments that are self-evident from the code, e.g.

```
const x = 1; // variable x is set to 1.
```

- **Start as soon as possible**. Do not leave the assignment until it's too late.

Recommended coding practices

- Structure your program in a consistent and coherent manner (group relevant functions, declarations, and variables together)
- Use block/section comments to clearly lay out each part of your code
- **Use nice indenting and formatting**
    - By default, Prettier is given to you and is integrated with VS Code. This includes format on save by default.
    - Follow the instructions in the README to manually format your code.
    - If you choose to use a different IDE, it will be left up to you to set up the formatter to your own satisfaction.

- Use camelCase for names, UpperCamelCase for types, and UPPER_CASE for constants.

Changelog

- 13 Aug: Clarify that the bird should start with 3 lives.