University of St Andrews

CS4099

SH Project Report

An online card-based game to explore human response to predefined scenarios

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Abstract

There are many situations in which it is desirable to know the opinions of a population. Aside from standard opinion surveys, little to no research has been done into alternative methods of gathering the public opinion.

This project was undertaken in collaboration with the St Andrews Centre for Exoplanet Science[1], in an attempt to develop a software artifact capable of capturing user decisions in a game interface. This project focuses on the framework through which these games may be created, played and visualised, with the end goal of analysing these responses and inferring user's opinions on certain subject matters through their choices. The framework is designed to be highly flexible, allowing all aspects of a game's story and development to be decided by an administrator.

Declaration

I declare that the material submitted for assessment is my own work except where credit is explicitly given to others by citation or acknowledgement. This work was performed during the current academic year except where otherwise stated.

The main text of this project report is

Add word count

NN,NNN* words long, including project specification and plan.

In submitting this project report to the University of St Andrews, I give permission for it to be made available for use in accordance with the regulations of the University Library. I also give permission for the title and abstract to be published and for copies of the report to be made and supplied at cost to any bona fide library or research worker, and to be made available on the World Wide Web. I retain the copyright in this work.

Todo list

Add word count 1
Define phrases: pillar, admin user, player, game definitoin, game instance? 2
Elaborate on requirements 8
Discuss process 9
14
Maybe draw an example as this is a bit confusing 14
Discuss export 18
Game workings 22
Reducers 22
Unit tests 22
'consider adding hidden columns which could affect the game but couldn't be seen by the user' 'only two answers per question?' 'subdecks - response can swap the whole deck eg when finding aliens' -can be done technically but easier 'Add/remove all UI element' 25

Define phrases: pillar, admin user, player, game definitoin, game instance?

Introduction

This project was kickstarted by researchers Anne Smith (Biology) and Christine Helling (Astronomy), with the aim of using the completed system to determine how the population would react to the discovery of alien life. This would be done through use of the system in some experimental context, however the details on what form this would take remain unclear.

2.1 Objectives

As part of my Description, Objectives, Ethics and Resources (DOER) document I described the objectives of this project:

2.1.1 Primary Objectives

- Devise and implement a game that presents the player with scenarios and allows them to choose from potential responses
- Devise and implement a flexible infrastructure to model and constrain scenarios and their impacts
- In collaboration with Anne Smith and Christine Helling, devise a sample set of appropriate scenarios with impacts and populate the game.
- Devise and implement an infrastructure for capturing and recording player responses
- Implement basic visualisation of responses

2.1.2 Secondary Objectives

- Devise and implement an admin centre to allow easy creation of new game content
- Carry out an experiment to assess the effectiveness of the game as a tool to assess people's real world views
- Create more advanced visualisation and analysis tools

2.1.3 Tertiary Objectives

- Perform a wider user experiment

Context Survey

Here I will review the existing software and literature on the different aspects of this project. I will briefly look at the psychological and gamification considerations around this topic to provide context, however the focus will be on the existing technologies.

3.1 Opinion of First Contact?

As this project has been undertaken in collaboration with the Exoplanet Research Society, it is worth briefly reviewing the literature on the target question - how would humans react to the discovery of alien life? There has been some research[2, 3, 4] into this area, but it is certainly not extensive and very little of it is systematic. The topic is vast with many variations:

- How has extra-terrestrial life been discovered?
- What is the nature of the life, is it intelligent?
- Is alien life on our doorstep, or far enough away that it could never reach or harm us?

Anne Smith and Christine Helling believe it could be beneficial to create a game capable of collecting this information, in order to reduce the burden on participants answering such an extensive library of questions and improve engagement. If this was possible it would have the potential to impact the way opinion data is collected across multiple faculties.

3.2 Survey Gamification

An emerging trend in modern business practice, gamification can be defined as 'using game mechanics and game design elements to measure, influence and reward user behaviors.' [5]. There has been research into gamification as a tool to improve the quality of responses from and engagement with surveys. From this I aim to gain an awareness of the necessary considerations when implementing gamification.

As of yet, most experiments into survey gamification have only gone so far as to change the wording of survey questions, show questions alongside imagery or change the answer input mechanics. My project represents a considerable departure from the standard survey format, with the goal being that the player could enjoy the game as a standalone experience. Because of this, there are many psychological considerations as to the validity of the results that can be gathered through this format. While investigating these issues is not my goal, I deemed it important to understand them, in an attempt to minimise any bias that my framework could impose onto players.

A 2011 paper found that while participants' enjoyment of the survey sees a great increase, gamification has three aspects which can affect the 'character of the data' [6]:

1. Effects caused by changes to the question and how it is interpreted
2. Effects caused by changing the attitude and mindset of respondents
3. Effects caused by changes to the design and layout of question

These considerations are targeted towards the low levels of gamification previously discussed, where the questions still have a fairly standard format. I do however believe that they are still applicable to my project.

The design of my game adds context that persists between questions. A 2015 paper[7] states 'Designers may also implement feedback loops, i.e., dynamics wherein user actions affect the overall state of gameplay. Feedback loops may visualize concepts such as a user's progress, status, wealth, health, points, etc.'. This gives me confidence that adding a persistent context to the game is a valid design decision, which I believe relates to the first point above - 'Effects caused by changes to the question and how it is interpreted'. This is because changing the context effectively changes the question, as people may respond differently under different circumstances.

'Effects caused by changes to the design and layout of question' will also appear in my artifact - there must be some UI to interact with, and as such it is possible that this may affect the player's choices. I attempt to minimise this risk - ideally the only bias imposed should be from the game description itself.

Briana Brownell, Jared Cechanowicz, and Carl Gutwin summarise the state of research into survey gamification as follows: 'In most cases, their results show that the addition of these game elements increases the length and quantity of responses, and respondents typically prefer the gamified version to the standard survey version. However, their research does not compare the effectiveness of game elements in gamified surveys. They have also found that that some gamified survey designs can lead to compromised respondent data (Puleston & Sleep, 2011).' [8]. This indicates that there is promise in the notion of gamifying surveys - however, gamification can result in a reduction in the accuracy of the data collected. Depending on the extent to which the survey is abstracted from, precise details, both of the question and response, can be lost. Given this, gamification is likely best suited to situations in which the surveyors do not need precise answers.

3.3 Similar Software

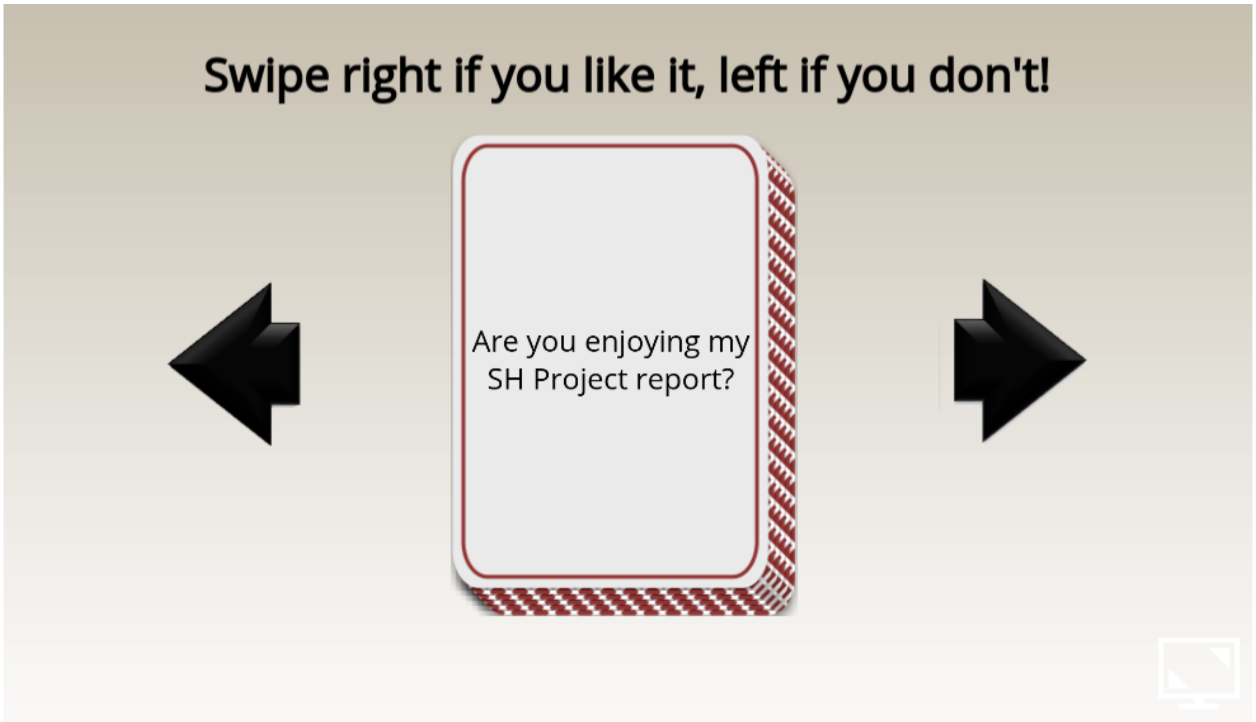
3.3.1 Datagame

Datagame[9] offers services that allow researchers to create and publish gamified surveys. This is done through heavily game-influenced interfaces, such as word searches and decks of cards.

Datagame supplies the tools required to populate one of several template games with custom questions, and export this to an online format that can be played through many channels such as Facebook[10].

There are four game types available to customise. The one most similar to the kind I intend to create is referred to as a 'Swiper' game. In this, the player draws cards from a virtual deck, each of which presents a yes/no question. The user swipes the card left or right, to answer yes or no respectively. Figure 3.1 shows this interface - it is fairly simple, with no standout features other than those added during admin configuration. Customisation allows the user to replace card backgrounds with an images, as well as change the colour of the text. Figure 3.2 shows an example of the game editing view in which the following aspects of the game can be edited:

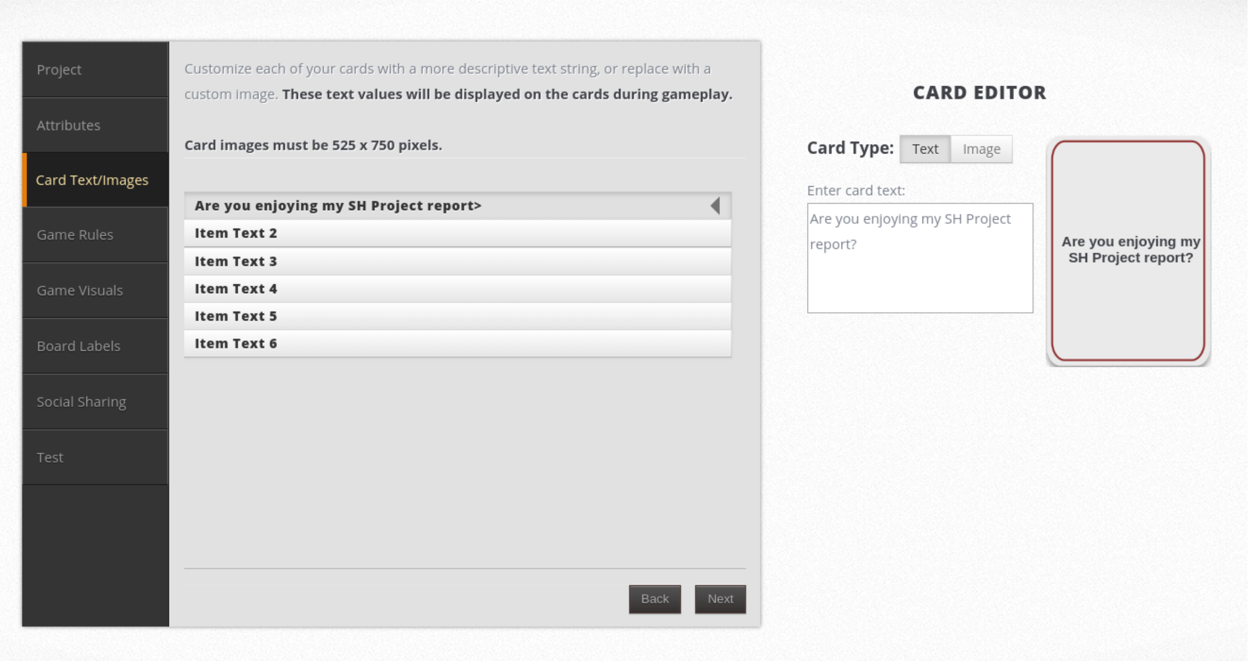
- Project title
- Title question
- List of cards
- Card name
- Card text/images
- Toggle card shuffling
- Game UI labels
- Background image



Swipe right if you like it, left if you don't!

Are you enjoying my SH Project report?

Figure 3.1: Example question in one of the Datagame[9] game types, which involves answering yes or no questions by swiping left or right.



Customize each of your cards with a more descriptive text string, or replace with a custom image. **These text values will be displayed on the cards during gameplay.**

Card images must be 525 x 750 pixels.

- **Are you enjoying my SH Project report>**
- **Item Text 2**
- **Item Text 3**
- **Item Text 4**
- **Item Text 5**
- **Item Text 6**

CARD EDITOR

Card Type: Text Image

Enter card text: Are you enjoying my SH Project report?

Are you enjoying my SH Project report?

Figure 3.2: Process of editing the Datagame[9] game instance shown in figure 3.1.

3.3.2 Qualifio

Qualifio[11] offer a similar service. They provide more varied game formats than Datagame, but the presentation is less game-like.

3.3.3 Reigns

When proposing the format of the artifact, I based my framework on an existing game, Reigns [12]. In Reigns, the player takes the role of a medieval ruler, and makes binary decisions to solve problems their subjects approach them with. These decisions affect further scenarios that may appear, as well as changing how the ruler is perceived by various factions, such as their population, army and church. The player's success is measured by how many decisions they can make without falling out of favour with any of the factions.

As of 2019-03-01, this is a well reviewed game, with a rating of 4.7/5 on the Google Play store [13]. Given this, in addition to the simplicity of recording and analysing the choices, I believe the framework of Reigns could provide a good starting point for gathering player opinions.

Requirements

Elaborate on requirements

Below are the requirements that I specified early on in the project.

4.1 Functional Requirements

- A user can enter a unique id, under which their game data will be recorded
- A user can choose a game to play by entering the game code
- A user can, read and respond to scenarios presented to them
- A user can see the effect that their responses have on the pillars
- A user can lose a game, when the value of one of their pillars reaches zero
- An administrator can add, edit and remove cards from a game definition
- An administrator can add, edit and remove pillars from a game definition
- An administrator can view a summary of the game they are creating, which contains information on any machine detectable oversights and game balance
- An administrator can save a game they are editing and return to it later, or let users play it
- An administrator can save their progress in editing one game and switch to another
- An administrator can select specific cards and obtain visualisations that summarise how players respond to them
- An administrator can filter turns included in visualisations by the state of the game during those turns
- An administrator can export and download all game data to an appropriate data processing format

4.2 Non-Functional Requirements

- All interfaces are clear and intuitive
- The game interface is responsive to input - there should be minimal delay between an input action and the outcome
- The game interface does not influence the user's choice in a way that is not customisable
- User data should be stored securely

Software Engineering Process

As the majority of the work put into this project was in developing the software artifact, I was focused from the beginning on following an effective software engineering process.

5.1 Process

Discuss process

5.2 Tools

With this in mind, one of the first tools I employed was Git[14]. Considering the length of the project, it was reasonable to suspect that there may come a time when I would have to revert my project to a previous point if something was broken. Version control software was the obvious solution, and Git is the one I have the most experience with. To complement this, I set up a master GitHub[15] repository to serve as a backup.

In addition to serving as a backup, GitHub provides a good set of project tracking features. I considered other tools often used to track projects, such as Trello[16], but in the end decided that GitHub's ability to reference aspects of the code (due to them being stored together) made it better suited for my needs. I will outline which features I used here:

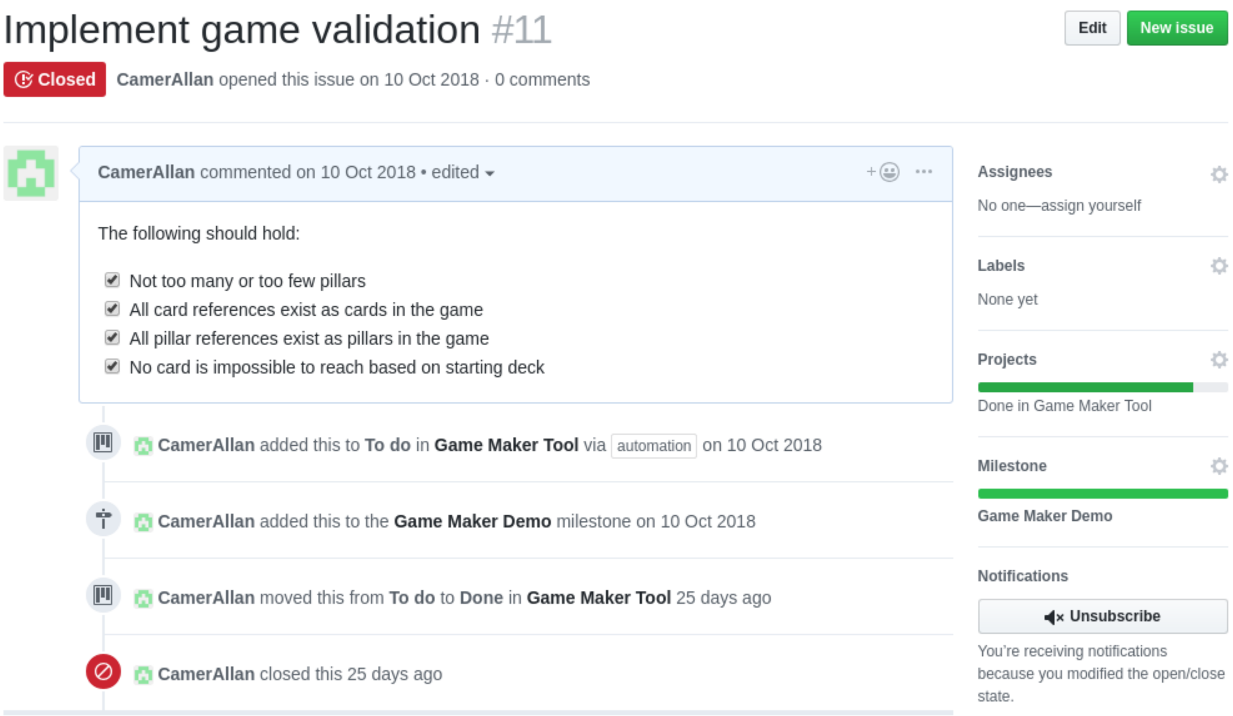
Issues These are the core element of GitHub. Any task that needs completing is documented as an issue. I kept my issues fairly high-level, as I have found previously that too much detail in issues results in spending excessive amounts of time managing them, and outdated aspects become too common. Figure 5.1 shows an example issue.

Projects Issues alone can become unorganised, so I made use of GitHub's projects feature. I split my work into four parts - game, game maker, viusalisation and backend then made a project for each of these. This allowed me to keep issues relating to different parts of the project separate, making it easier to focus on one section at a time.

Each project has its own kanban-style board, used to track its progress. An example can be seen in figure 5.3. Issues assigned to a project start in the `todo` column. When being worked on, I would move them into `In progress`, and finally when closed they are automatically moved to `Done`.

The number of issues in each column defines the project overview, so this can provide a reasonably accurate depiction of the progress of each section.

Milestones The first step I took in tracking my project was to set my Milestones. These are an aspect of a GitHub project that serve as a deadline, to which issues can be added. Completing and closing these issues then automatically provides a visualisation of progress towards a milestone, as can be seen in figures 5.4 and 5.5. These made for a helpful overview, which was useful both for myself, and for sharing my progress with my supervisor.



Implement game validation #11

CamerAllan opened this issue on 10 Oct 2018 · 0 comments

CamerAllan commented on 10 Oct 2018 • edited

The following should hold:

- ☑ Not too many or too few pillars
- ☑ All card references exist as cards in the game
- ☑ All pillar references exist as pillars in the game
- ☑ No card is impossible to reach based on starting deck

CamerAllan added this to **To do** in **Game Maker Tool** via automation on 10 Oct 2018

CamerAllan added this to the **Game Maker Demo** milestone on 10 Oct 2018

CamerAllan moved this from **To do** to **Done** in **Game Maker Tool** 25 days ago

CamerAllan closed this 25 days ago

Assignees
No one—assign yourself

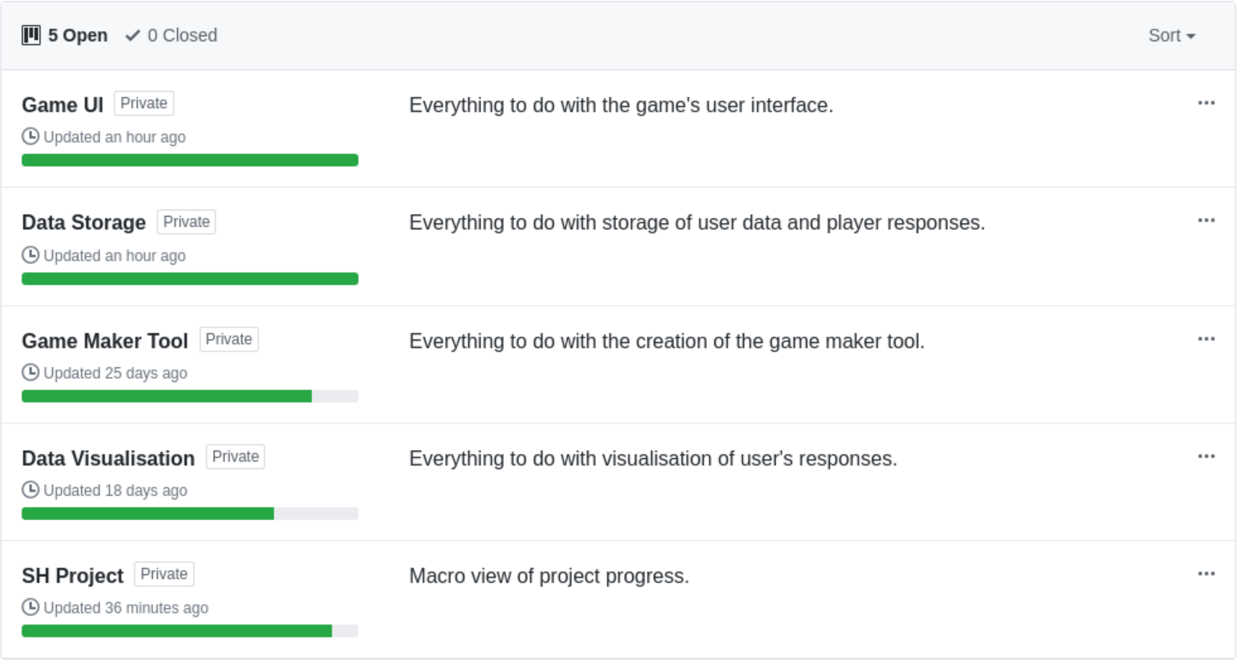
Labels
None yet

Projects
Done in Game Maker Tool

Milestone
Game Maker Demo

Notifications
You're receiving notifications because you modified the open/close state.

Figure 5.1: An example of an issue, note the assigned description, project, and milestone.

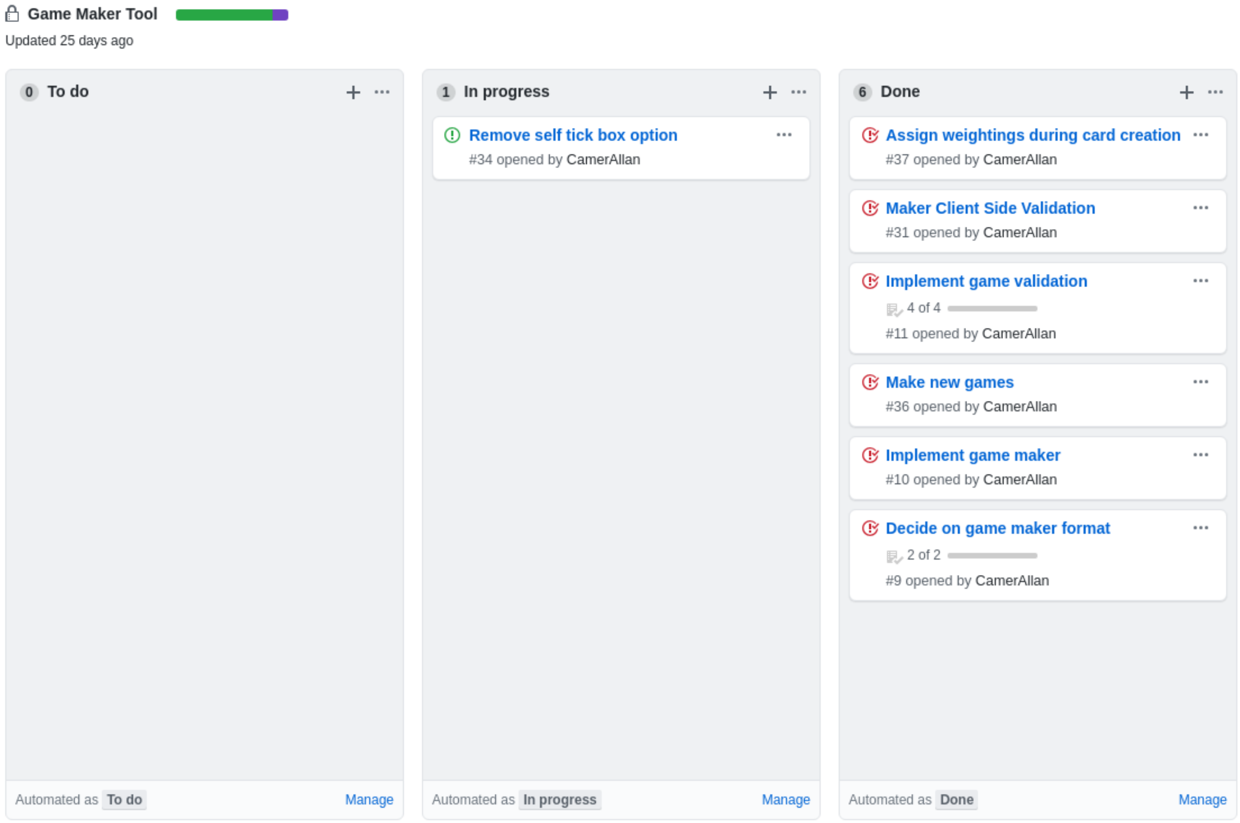


5 Open ✓ 0 Closed

Project	Description
Game UI (Private) Updated an hour ago	Everything to do with the game's user interface.
Data Storage (Private) Updated an hour ago	Everything to do with storage of user data and player responses.
Game Maker Tool (Private) Updated 25 days ago	Everything to do with the creation of the game maker tool.
Data Visualisation (Private) Updated 18 days ago	Everything to do with visualisation of user's responses.
SH Project (Private) Updated 36 minutes ago	Macro view of project progress.

Figure 5.2: Project overview page.

I decided on these milestones early on by estimating the dates by which I could complete core parts of the project. As this was done in advance I was not able to be precise with demo dates, however I completed the vast majority of work for each milestone before the deadline, so I consider this a successful element of my planning.



Game Maker Tool

Updated 25 days ago

0 To do

Automated as **To do** Manage

1 In progress

- **Remove self tick box option**
  #34 opened by CamerAllan

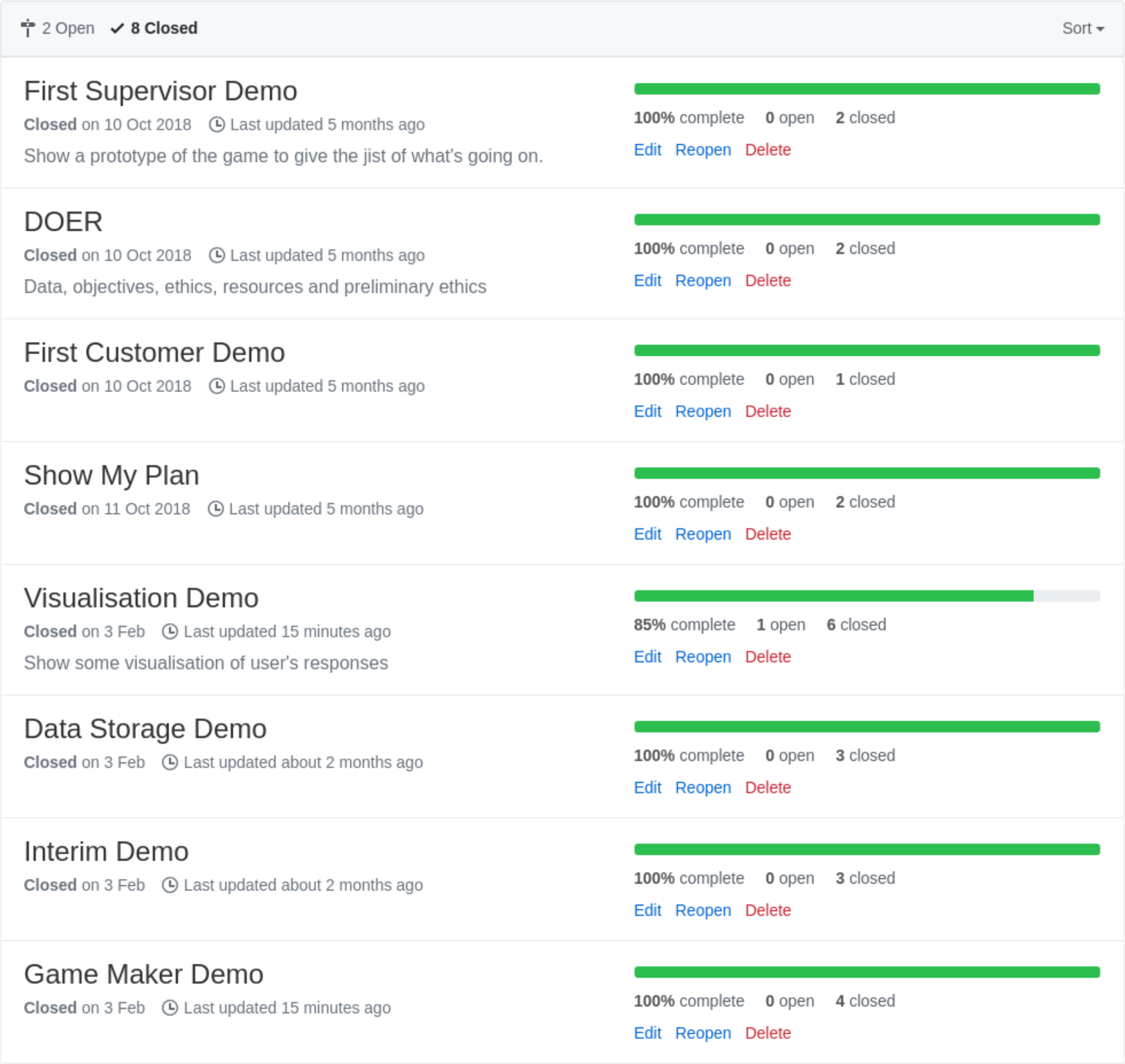
Automated as **In progress** Manage

6 Done

- **Assign weightings during card creation**
  #37 opened by CamerAllan
- **Maker Client Side Validation**
  #31 opened by CamerAllan
- **Implement game validation**
  4 of 4
  #11 opened by CamerAllan
- **Make new games**
  #36 opened by CamerAllan
- **Implement game maker**
  #10 opened by CamerAllan
- **Decide on game maker format**
  2 of 2
  #9 opened by CamerAllan

Automated as **Done** Manage

Figure 5.3: Example project board towards the end of the project.



2 Open ✓ 8 Closed Sort ▾

First Supervisor Demo
Closed on 10 Oct 2018 Last updated 5 months ago
Show a prototype of the game to give the jist of what's going on.
100% complete **0** open **2** closed
Edit Reopen Delete

DOER
Closed on 10 Oct 2018 Last updated 5 months ago
Data, objectives, ethics, resources and preliminary ethics
100% complete **0** open **2** closed
Edit Reopen Delete

First Customer Demo
Closed on 10 Oct 2018 Last updated 5 months ago
100% complete **0** open **1** closed
Edit Reopen Delete

Show My Plan
Closed on 11 Oct 2018 Last updated 5 months ago
100% complete **0** open **2** closed
Edit Reopen Delete

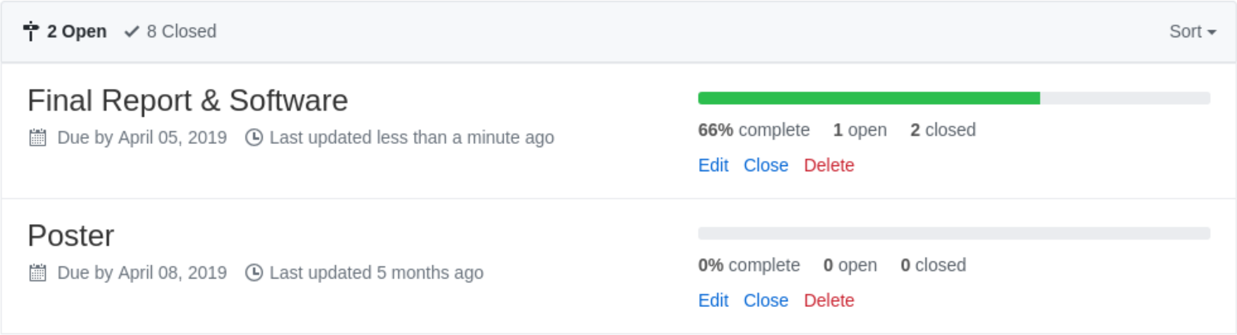
Visualisation Demo
Closed on 3 Feb Last updated 15 minutes ago
Show some visualisation of user's responses
85% complete **1** open **6** closed
Edit Reopen Delete

Data Storage Demo
Closed on 3 Feb Last updated about 2 months ago
100% complete **0** open **3** closed
Edit Reopen Delete

Interim Demo
Closed on 3 Feb Last updated about 2 months ago
100% complete **0** open **3** closed
Edit Reopen Delete

Game Maker Demo
Closed on 3 Feb Last updated 15 minutes ago
100% complete **0** open **4** closed
Edit Reopen Delete

Figure 5.4: Overview of closed (completed) milestones towards the end of the project



2 Open ✓ 8 Closed Sort ▾

Final Report & Software
Due by April 05, 2019 Last updated less than a minute ago
66% complete **1** open **2** closed
Edit Close Delete

Poster
Due by April 08, 2019 Last updated 5 months ago
0% complete **0** open **0** closed
Edit Close Delete

Figure 5.5: Overview of open milestones towards the end of the project

Ethics

All data used for testing and development purposes was fictional. Fictional data was made up by myself, and consists only of user ids. No personal or identifying information was gathered during the user evaluation. Participants' answers were anonymously recorded on paper forms and kept in a secure location. The digitised forms were stored in an encrypted location.

Design

7.1 Gameplay Overview

Maybe draw an example as this is a bit confusing

The game provides a fairly straightforward experience from the user's point of view. Conceptually, it is a card game, so I will describe it as such. The game consists of three decks which I dub 'in play', 'out of play' and 'reserve'. In addition to this, there are n 'pillars' - these are attributes of importance within the game story's context. Each of these has a minimum, maximum and current value. The 'in play' deck has a defined starting set of cards, with the 'reserve deck' containing all others - 'out of play' starts empty. Both decks are shuffled at the start of the game, and each pillar has a predefined starting value.

The player draws and reads a card from the play deck, each one showing the following information:

- Title
- Description
- Choice #1 ('accept')
- Choice #2 ('reject')
- Requirements to draw

Each choice on a card consists of text detailing the response, and the effects of the response. Effects are made up of two parts - pillar changes, and cards added/removed. Pillar changes specify amounts to add or remove from one or more pillars. Cards added/removed defines which cards should be moved between 'out of play' and 'reserve'. Requirements to draw consists of conditions that the current pillar levels must satisfy in order for this card to be drawn.

After each choice made (turn), any cards in 'out of play' the meet the current pillar requirements are moved to 'in play', and any 'in play' that do not are moved to 'out of play'.

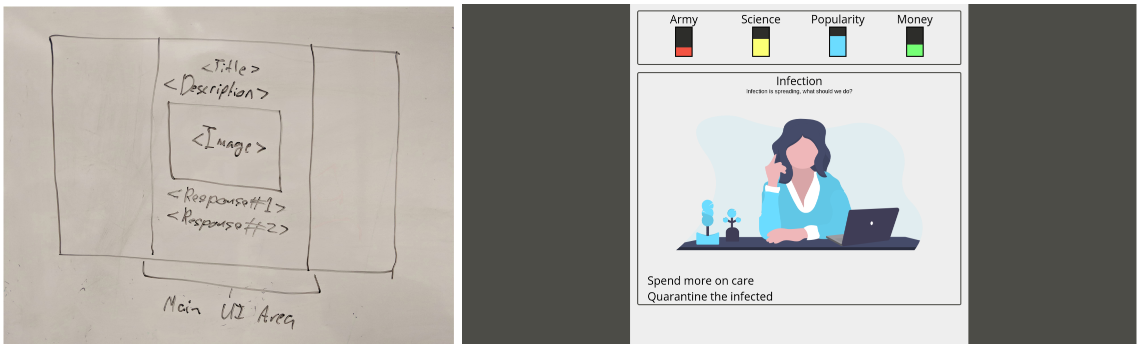
The game ends when any of the pillars fall to their minimum value.

7.2 UI

7.2.1 Game

As described above, the game sounds like a lot of effort on behalf of the player, having to sort and shuffle cards. Fortunately, this effort can be removed completely through work done by the computer. This leaves a simple game from the user perspective; users are presented with a card, make a choice, and get the next card.

This meant that the design for the game UI could also be simple. Figure 7.1 shows my first design for this UI alongside the final product. Initially, I wasn't sure whether the pillars should be visible to the user, however after some testing it was clear that they were needed to provide the player with feedback as they played the game, so they were later added to the top of the screen.



Infection

Infection is spreading, what should we do?

Spend more on care
Quarantine the infected

Figure 7.1: Comparison between initial and final designs for the game UI

Pillars are displayed as vertical bars at the top of the screen, each having their own fill colour (customisable through game definition). I was inspired to add this colour customisation by other survey gamification tools, as a way to make the game more visually engaging, without forcing a colour scheme that could conflict with the desires of admin users. Pillars fill from bottom to top, and represent where the current value lies between the defined min and max.

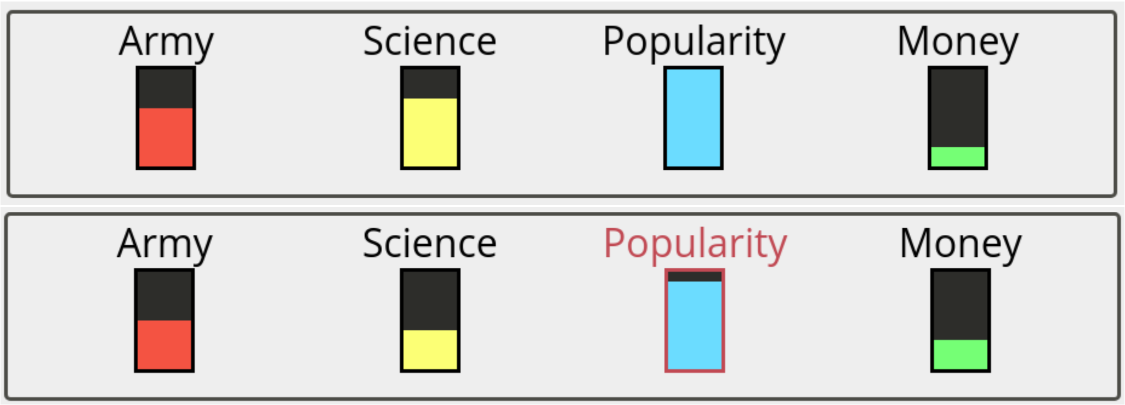
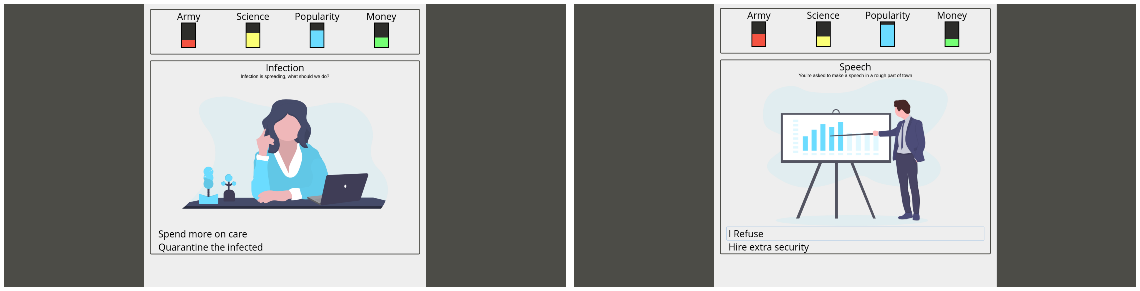


Figure 7.2: Visualisation of a negative outcome; the red outline around `Popularity`

The image shown with a given card is dependent upon the pillars the card influences, as seen in figure 7.3. In this example game, I gave each pillar an 'advisor' image, so that the advisor representing the pillar most affected by a card is shown.



Infection

Infection is spreading, what should we do?

Spend more on care
Quarantine the infected

Speech

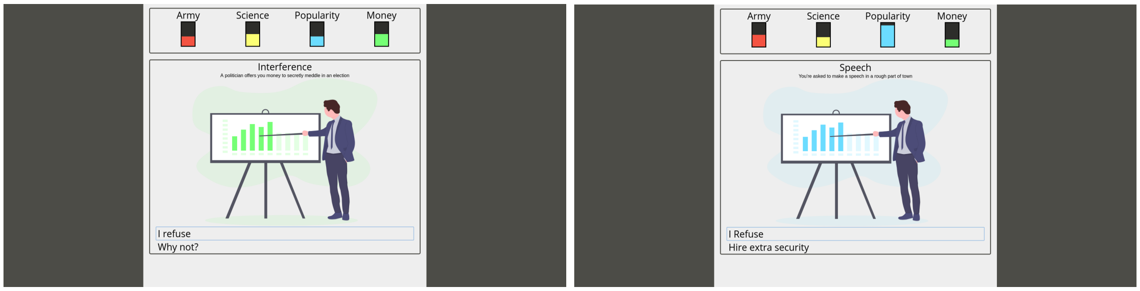
You're asked to make a speech in a rough part of town

I Refuse
Hire extra security

Figure 7.3: These cards primarily affect different pillars, so they have different associated images

As seen in figure 7.4, not only can the image change, but the primary colour of the image may also change.

I decided to include this feature as cards may affect more than one pillar, and this was not being represented when only using different images. With this colour shifting implemented, the image can represent secondary pillar effects.



Interference
A politician offers you money to secretly meddle in an election
I refuse
Why not?

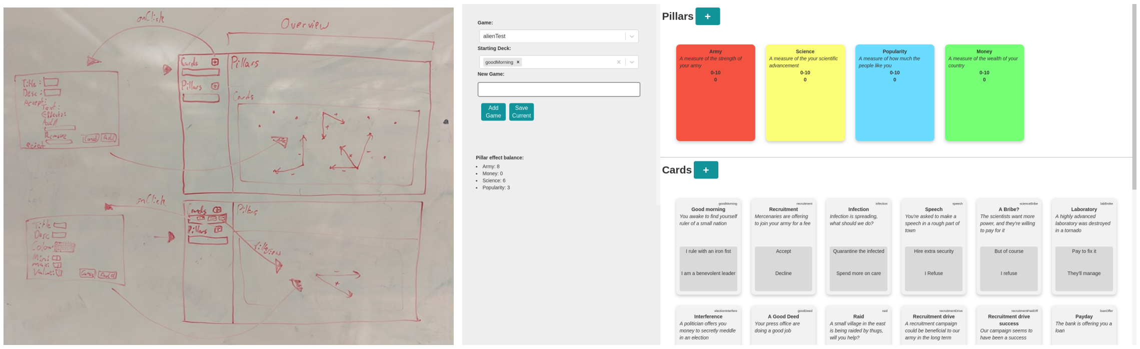
Speech
You're asked to make a speech in a rough part of town
I Refuse
Hire extra security

Figure 7.4: Both of these cards primarily affect the `Money` pillar (they are being presented by the `Money` advisor) however the second also affects `Popularity`, so has a blue primary colour

7.2.2 Admin tools

Game Maker

The game maker interface was the most challenging to design, as I wanted the user to be able to maintain a high-level overview of the game while adding and editing pillars and cards. After thinking this through, I initially settled on the design depicted in figure 7.5. The main theme is that editing is done in the left panel, while the right side continues to show an interactive view of the game, including a visualisation of the relationships between cards. The final design ended up being roughly the same, however the card view is not as complex - connections between cards are not visualised, as after more consideration of the relationships involved, I could not think of a clear way to show this. The cards are instead displayed in a grid in the final design.



Game:
alienTest
Starting Deck:
goodMorning ×
New Game:

Pillar effect balance:

- Army: 8
- Money: 0
- Science: 6
- Popularity: 3

Army
A measure of the strength of your army
0-10
0

Science
A measure of the your scientific advancement
0-10
0

Popularity
A measure of how much the people like you
0-10
0

Money
A measure of the wealth of your country
0-10
0

goodMorning
Good morning
You awake to find yourself ruler of a small nation
I rule with an iron fist
I am a benevolent leader

recruitment
Recruitment
Mercenaries are offering to join your army for a fee
Accept
Decline

infection
Infection
Infection is spreading, what should we do?
Quarantine the infected
Spend more on care

speech
Speech
You're asked to make a speech in a rough part of town
Hire extra security
I Refuse

scienceBribe
A Bribe?
The scientists want more power, and they're willing to pay for it
But of course
I refuse

labBroke
Laboratory
A highly advanced laboratory was destroyed in a tornado
Pay to fix it
They'll manage

electionInterfere
Interference
A politician offers you money to secretly meddle in an election

goodDeed
A Good Deed
Your press office are doing a good job

raid
Raid
A small village in the east is being raided by thugs, will you help?

recruitmentDrive
Recruitment drive
A recruitment campaign could be beneficial to our army in the long term

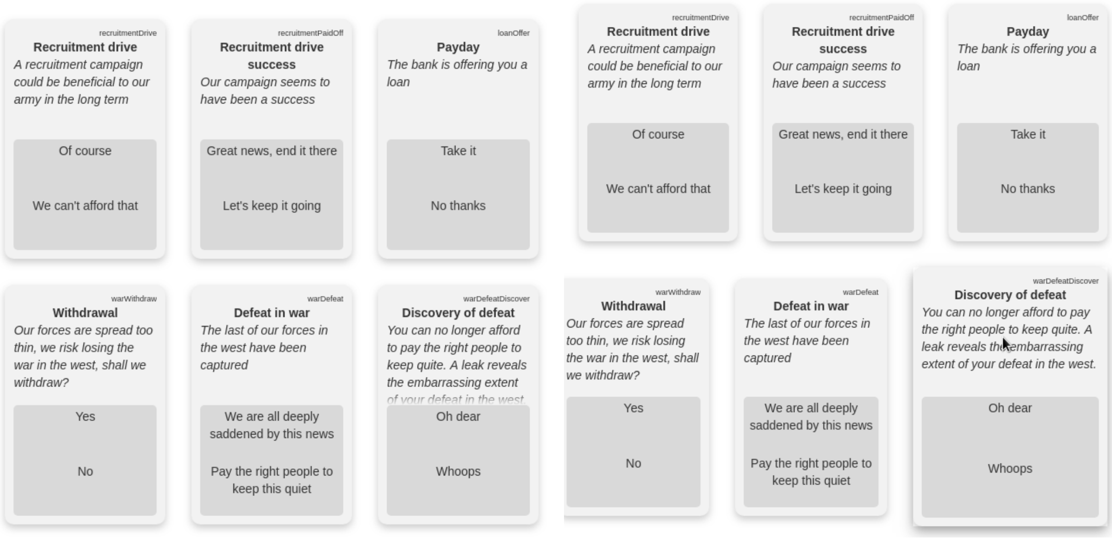
recruitmentPaidOff
Recruitment drive success
Our campaign seems to have been a success

loanOffer
Payday
The bank is offering you a loan

Figure 7.5: Comparison between initial and final designs for the game maker. Shown is the example game I created for demonstration purposes.

In the section on the right, the user can see the game pillars and cards that they have created. This side is scrollable, while the left section remains in view. If the details of a card are too large for the view, the text fades out. The card view can be expanded by hovering over it, as seen in figure 7.6 - when this is done, other cards shrink and move to allow the extra space. New cards and pillars can be added with the large + buttons by the headers, while existing ones can be edited by clicking on them. Both of these options opens the edit view on the left section.

The left section provides contextual menus. When no pillar or card is selected, it provides high-level functionality, such as saving, switching, or creating new game definitions. Also present here is starting deck selection, game balance information and any warnings.



recruitmentDrive
Recruitment drive
A recruitment campaign could be beneficial to our army in the long term
Of course
We can't afford that

recruitmentPaidOff
Recruitment drive success
Our campaign seems to have been a success
Great news, end it there
Let's keep it going

loanOffer
Payday
The bank is offering you a loan
Take it
No thanks

recruitmentDrive
Recruitment drive
A recruitment campaign could be beneficial to our army in the long term
Of course
We can't afford that

recruitmentPaidOff
Recruitment drive success
Our campaign seems to have been a success
Great news, end it there
Let's keep it going

loanOffer
Payday
The bank is offering you a loan
Take it
No thanks

warWithdraw
Withdrawal
Our forces are spread too thin, we risk losing the war in the west, shall we withdraw?
Yes
No

warDefeat
Defeat in war
The last of our forces in the west have been captured
We are all deeply saddened by this news
Pay the right people to keep this quiet

warDefeatDiscover
Discovery of defeat
You can no longer afford to pay the right people to keep quite. A leak reveals the embarrassing extent of your defeat in the west.
Oh dear
Whoops

warWithdraw
Withdrawal
Our forces are spread too thin, we risk losing the war in the west, shall we withdraw?
Yes
No

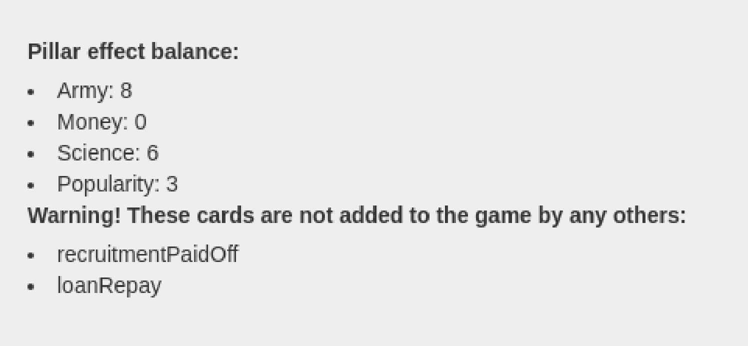
warDefeat
Defeat in war
The last of our forces in the west have been captured
We are all deeply saddened by this news
Pay the right people to keep this quiet

warDefeatDiscover
Discovery of defeat
You can no longer afford to pay the right people to keep quite. A leak reveals the embarrassing extent of your defeat in the west.
Oh dear
Whoops

Figure 7.6: Demonstration of hover expanded view (note that the full text is cut off on the left, readable on the right)

The pillar effect balance provides the admin user with an idea of how balanced their game is in its current state. This is done by summing all of the effects that are applied to each pillar for any given response to all cards. This acts as an indicator of how well a user is likely to do if they randomly pick their responses. The higher the balance values, easier the game.

Warnings appear when a card has no chance of being added to the game. This means that a card has been created, but it is neither in the starting deck, nor is it added by any other card. This is only a shallow check - if card A is added by another card B, which itself is never added, the warning will only appear for card B. I consider this acceptable, as once card B is added or deleted, the situation will be resolved.



Pillar effect balance:

- Army: 8
- Money: 0
- Science: 6
- Popularity: 3

Warning! These cards are not added to the game by any others:

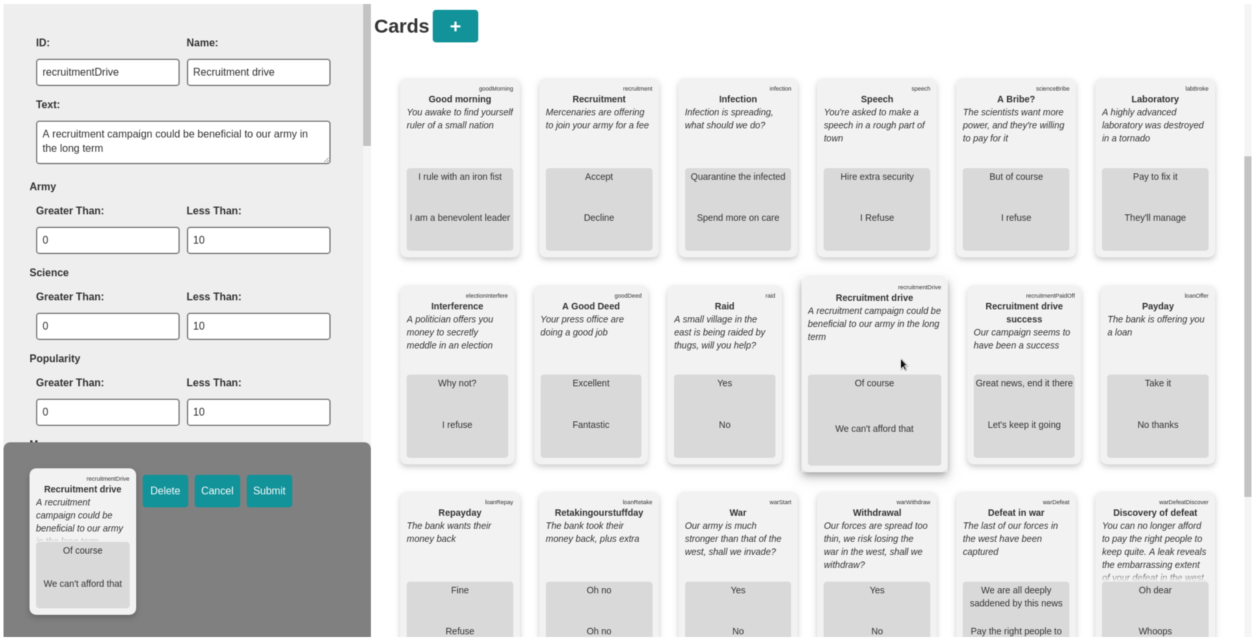
- recruitmentPaidOff
- loanRepay

Figure 7.7: Info on left panel. Note the two warnings, which appeared on removing `recruitmentPaidOff` and `loanRepay` from all 'cards added' lists

When editing a card, a live preview can be seen at the bottom of the panel, along with buttons to cancel changes, delete, or submit the card. When editing the consequences, adding and removing cards is done through a dropdown list, which allows multiple cards to be selected.

Figure 7.10 shows the pillar editing menu, which is very similar to the card editing view. The colour of the pillar can be entered as a hex value, which is immediately reflected in the preview below.

Clicking `Save Current` will save the updated game definition to the database, and it can then be played from the game UI by entering the correct game ID.


ID: recruitmentDrive

Name: Recruitment drive

Text: A recruitment campaign could be beneficial to our army in the long term

Army
Greater Than: 0
Less Than: 10

Science
Greater Than: 0
Less Than: 10

Popularity
Greater Than: 0
Less Than: 10

recruitmentDrive
Recruitment drive
A recruitment campaign could be beneficial to our army in the long term
Of course
We can't afford that

goodMorning
Good morning
You awake to find yourself ruler of a small nation
I rule with an iron fist
I am a benevolent leader

recruitment
Recruitment
Mercenaries are offering to join your army for a fee
Accept
Decline

infection
Infection
Infection is spreading, what should we do?
Quarantine the infected
Spend more on care

speech
Speech
You're asked to make a speech in a rough part of town
Hire extra security
I Refuse

scienceBribe
A Bribe?
The scientists want more power, and they're willing to pay for it
But of course
I refuse

labBroke
Laboratory
A highly advanced laboratory was destroyed in a tornado
Pay to fix it
They'll manage

electionInterfere
Interference
A politician offers you money to secretly meddle in an election
Why not?
I refuse

goodDeed
A Good Deed
Your press office are doing a good job
Excellent
Fantastic

raid
Raid
A small village in the east is being raided by thugs, will you help?
Yes
No

recruitmentDrive
Recruitment drive
A recruitment campaign could be beneficial to our army in the long term
Of course
We can't afford that

recruitmentPaidOff
Recruitment drive success
Our campaign seems to have been a success
Great news, end it there
Let's keep it going

loanOffer
Payday
The bank is offering you a loan
Take it
No thanks

loanRepay
Repayday
The bank wants their money back
Fine
Refuse

loanRetake
Retakingourstuffday
The bank took their money back, plus extra
Oh no
Oh no

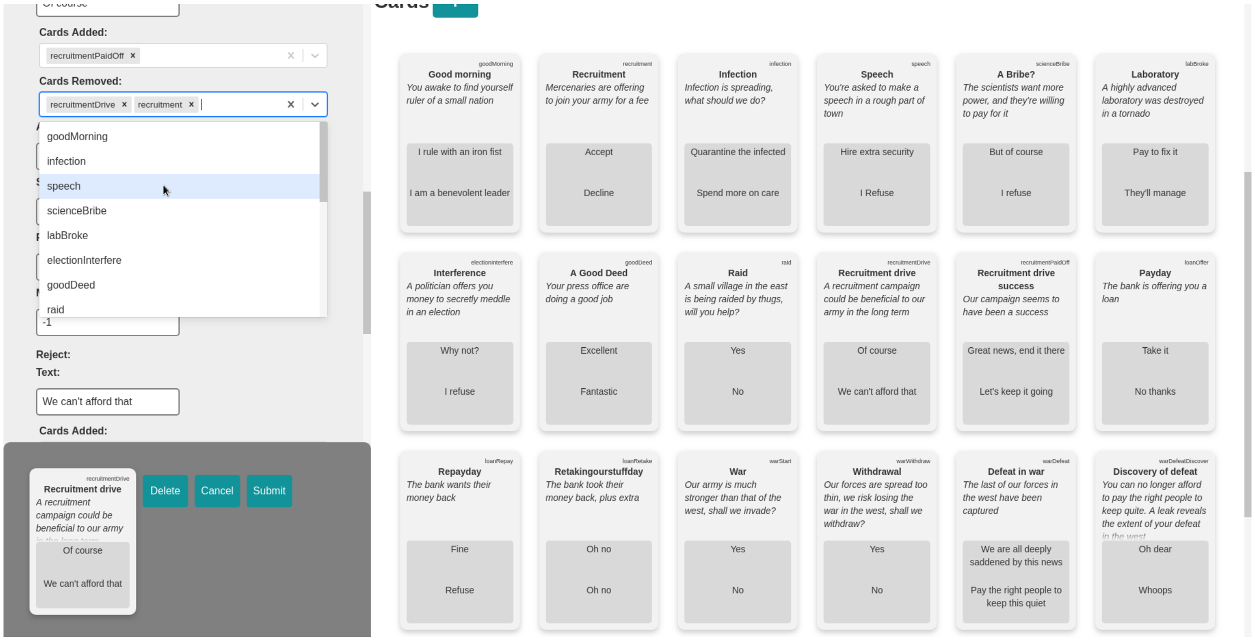
warStart
War
Our army is much stronger than that of the west, shall we invade?
Yes
No

warWithdraw
Withdrawal
Our forces are spread too thin, we risk losing the war in the west, shall we withdraw?
Yes
No

warDefeat
Defeat in war
The last of our forces in the west have been captured
We are all deeply saddened by this news
Pay the right people to

warDefeatDiscover
Discovery of defeat
You can no longer afford to pay the right people to keep quite. A leak reveals the embarrassing extent of your defeat in the west
Oh dear
Whoops

Figure 7.8: Card editing view, reached by selecting a card by clicking it.


Of course

Cards Added: recruitmentPaidOff ×

Cards Removed: recruitmentDrive × recruitment ×

goodMorning
infection
speech
scienceBribe
labBroke
electionInterfere
goodDeed
raid

-1

Reject:
Text: We can't afford that

Cards Added:

recruitmentDrive
Recruitment drive
A recruitment campaign could be beneficial to our army in the long term
Of course
We can't afford that

goodMorning
Good morning
You awake to find yourself ruler of a small nation
I rule with an iron fist
I am a benevolent leader

recruitment
Recruitment
Mercenaries are offering to join your army for a fee
Accept
Decline

infection
Infection
Infection is spreading, what should we do?
Quarantine the infected
Spend more on care

speech
Speech
You're asked to make a speech in a rough part of town
Hire extra security
I Refuse

scienceBribe
A Bribe?
The scientists want more power, and they're willing to pay for it
But of course
I refuse

labBroke
Laboratory
A highly advanced laboratory was destroyed in a tornado
Pay to fix it
They'll manage

electionInterfere
Interference
A politician offers you money to secretly meddle in an election
Why not?
I refuse

goodDeed
A Good Deed
Your press office are doing a good job
Excellent
Fantastic

raid
Raid
A small village in the east is being raided by thugs, will you help?
Yes
No

recruitmentDrive
Recruitment drive
A recruitment campaign could be beneficial to our army in the long term
Of course
We can't afford that

recruitmentPaidOff
Recruitment drive success
Our campaign seems to have been a success
Great news, end it there
Let's keep it going

loanOffer
Payday
The bank is offering you a loan
Take it
No thanks

loanRepay
Repayday
The bank wants their money back
Fine
Refuse

loanRetake
Retakingourstuffday
The bank took their money back, plus extra
Oh no
Oh no

warStart
War
Our army is much stronger than that of the west, shall we invade?
Yes
No

warWithdraw
Withdrawal
Our forces are spread too thin, we risk losing the war in the west, shall we withdraw?
Yes
No

warDefeat
Defeat in war
The last of our forces in the west have been captured
We are all deeply saddened by this news
Pay the right people to keep this quiet

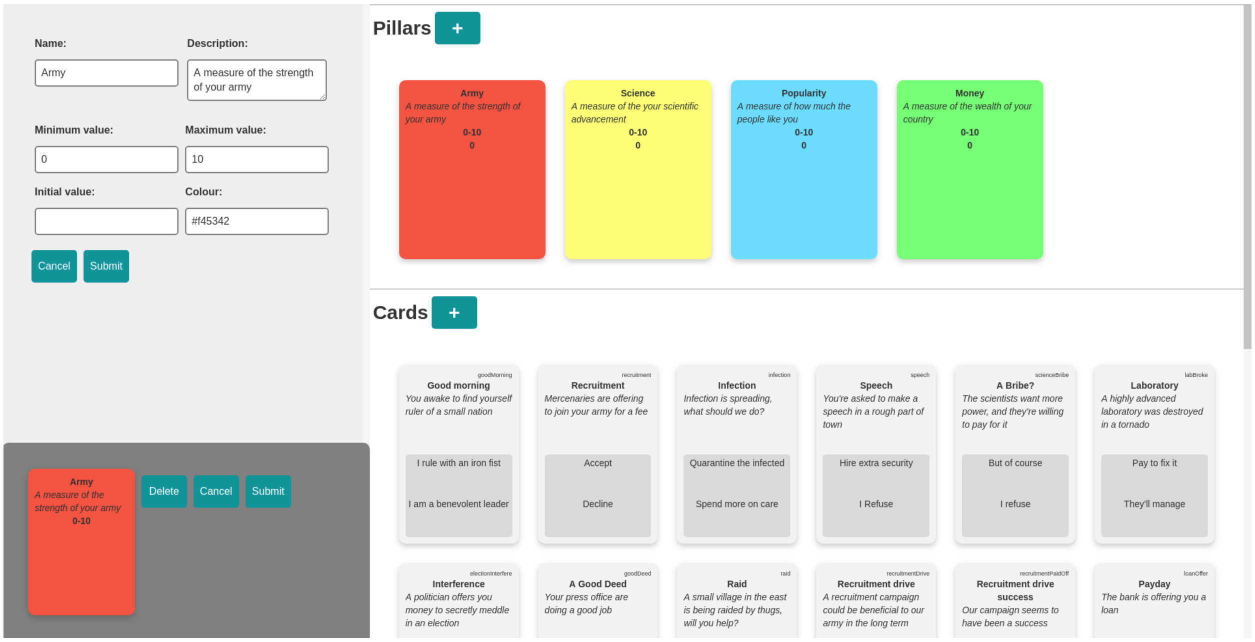
warDefeatDiscover
Discovery of defeat
You can no longer afford to pay the right people to keep quite. A leak reveals the extent of your defeat in the west
Oh dear
Whoops

Figure 7.9: Dropdown showing all other cards that can be added or removed

Visualisation

Discuss export

The visualisation screen took a similar shape to the game maker, with data selection and filtering happening in a left panel while the visualisations are updated on the right. It is possible to filter results to be visualised by pillar values. This limits the data shown only to cards that appeared while pillar values match the specified criteria The visualisations I chose to show are as follows:



Name: Army

Description: A measure of the strength of your army

Minimum value: 0

Maximum value: 10

Initial value:

Colour: #f45342

Cancel Submit

Army
A measure of the strength of your army
0-10

Delete Cancel Submit

Pillars +

Army
A measure of the strength of your army
0-10
0

Science
A measure of the your scientific advancement
0-10
0

Popularity
A measure of how much the people like you
0-10
0

Money
A measure of the wealth of your country
0-10
0

Cards +

goodMorning
Good morning
You awake to find yourself ruler of a small nation
I rule with an iron fist
I am a benevolent leader

recruitment
Recruitment
Mercenaries are offering to join your army for a fee
Accept
Decline

infection
Infection
Infection is spreading, what should we do?
Quarantine the infected
Spend more on care

speech
Speech
You're asked to make a speech in a rough part of town
Hire extra security
I Refuse

scienceBribe
A Bribe?
The scientists want more power, and they're willing to pay for it
But of course
I refuse

labBroke
Laboratory
A highly advanced laboratory was destroyed in a tornado
Pay to fix it
They'll manage

electionInterfere
Interference
A politician offers you money to secretly meddle in an election

goodDeed
A Good Deed
Your press office are doing a good job

raid
Raid
A small village in the east is being raided by thugs, will you help?

recruitmentDrive
Recruitment drive
A recruitment campaign could be beneficial to our army in the long term

recruitmentPaidOff
Recruitment drive success
Our campaign seems to have been a success

loanOffer
Payday
The bank is offering you a loan

Figure 7.10: Pillar editing view

- Accept/Reject balance

  This is a horizontal bar chart showing the proportion of players that choose one option over the other for a given set of cards. Each card has a value between -1 and 1, where -1 indicates that players choose the reject option every time, while 1 indicates accept is chosen every time.

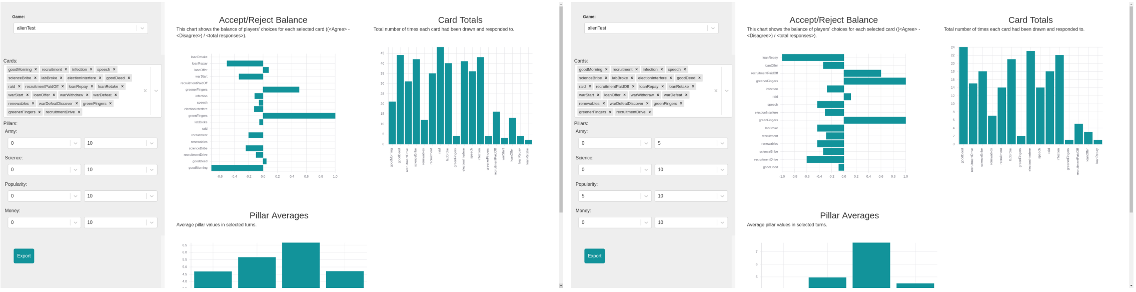
- Total times drawn

  This is a vertical bar chart showing the total number of times each card has been drawn and responded to.

- Pillar average

  This shows the average pillar levels over all turns.

The intention of these visualisations is to allow a user to 'play' with the data. The live updating charts allow the user to rapidly identify relationships, for example between pillar levels and accept/reject balance.



Game: alienTest

Cards: goodMorning × recruitment × infection × speech × scienceBribe × labBroke × electionInterfere × goodDeed × raid × recruitmentPaidOff × loanRepay × loanRetake × warStart × loanOffer × warWithdraw × warDefeat × renewables × warDefeatDiscover × greenFingers × greenerFingers × recruitmentDrive ×

Pillars:

Army: 0 10

Science: 0 10

Popularity: 0 10

Money: 0 10

Export

Accept/Reject Balance

This chart shows the balance of players' choices for each selected card ((<Agree> - <Disagree>) / <total responses>).

Card Totals

Total number of times each card had been drawn and responded to.

Pillar Averages

Average pillar values in selected turns.

Game: alienTest

Pillars:

Army: 0 5

Science: 0 10

Popularity: 5 10

Money: 0 10

Export

Figure 7.11: Visualisation screen effects of filtering data by cards and pillar values. This example filters responses to cards during turns where the player's `Army` was between 0 and 5, and their `Popularity` was between 5 and 10.

The other function this page offers is the ability to export data to CSV. This effectively repackages the database as a csv file, where each row represents the turn of a user. Individual games are uniquely identified by sets of rows with the same user id and game id.

7.3 Frontend

When using Redux, one of the first design decisions that must be made is the structure of the Redux store. This is the JavaScript object that holds the page's state. Figures 7.12 and 7.13 show a visual representation of the store for the game site. The game logic runs client-side, so to enable this, the entire game definition is requested from the database server once the player requests to play it. Depending on the use case, this could be considered a downside as technically a player could 'cheat' the game through using console commands. This choice did however greatly simplify the API between the client and sever, as once the game has begun, the client only needs to send the outcome of each turn.

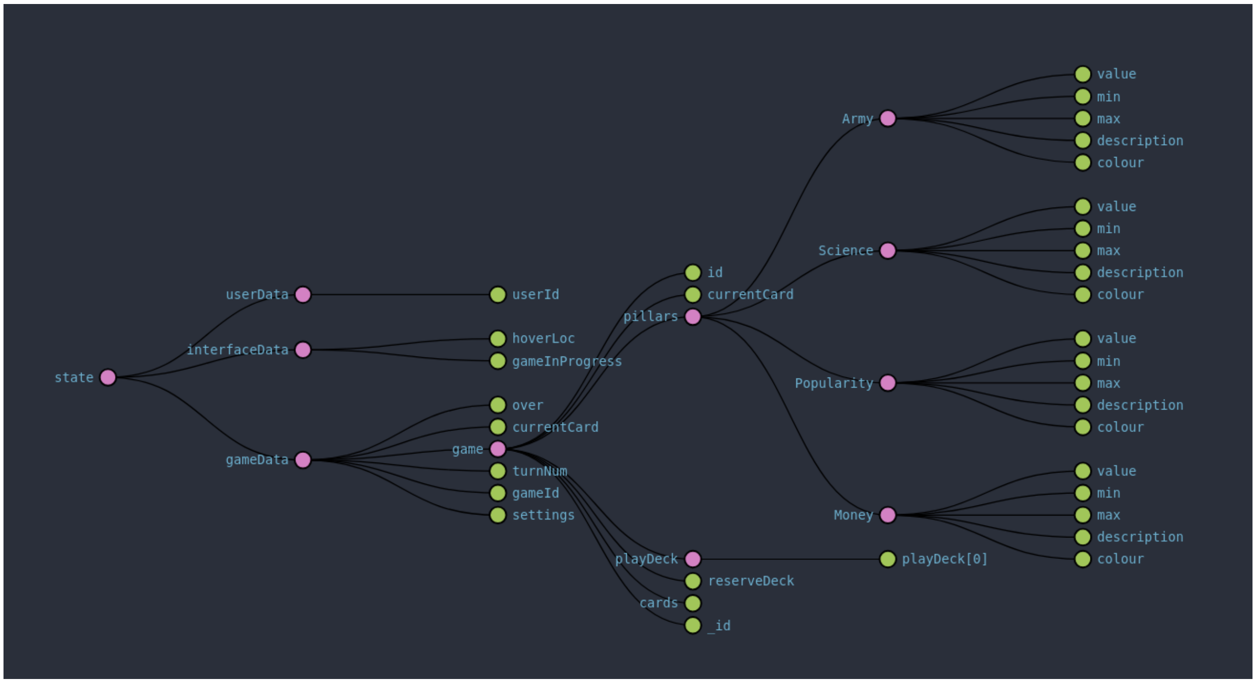


Figure 7.12: Redux store object structure. Note that the pillars (Army, Science, Popularity, Money) are game definition dependent. Cards object is omitted due to large size.

7.4 Backend

Access to the database is provided through a backend server

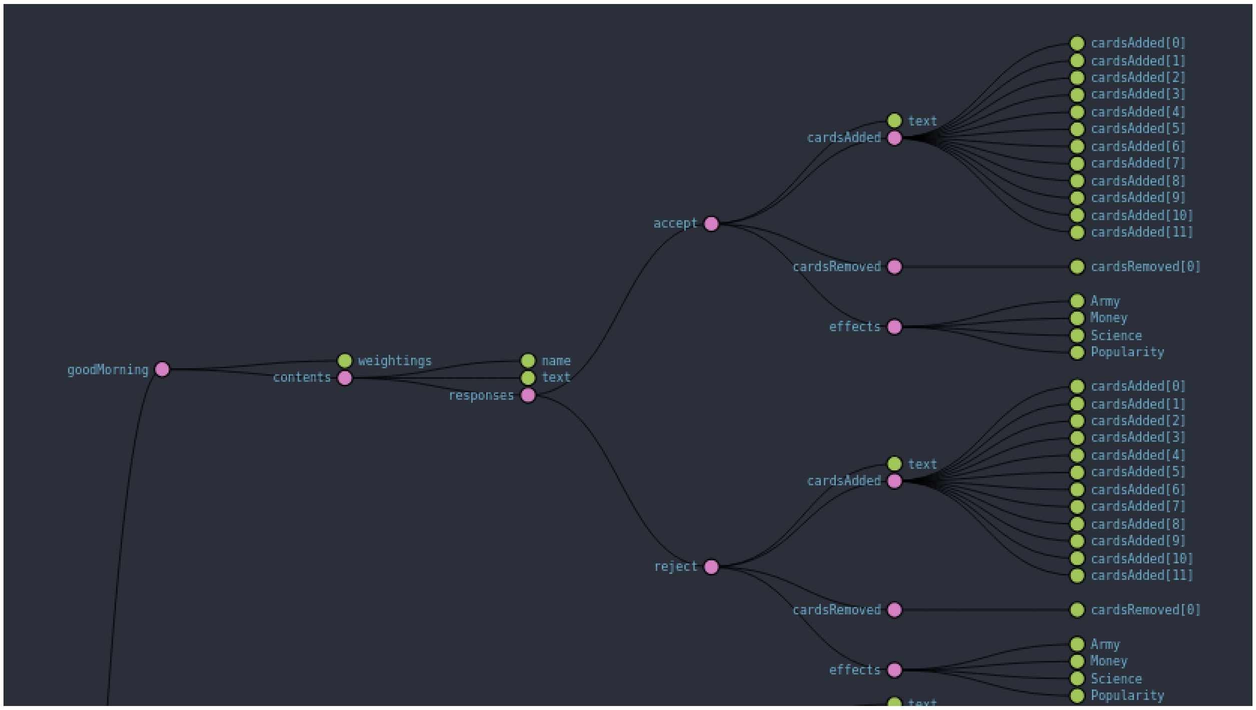


Figure 7.13: Example of a card object in the store. This is a starting card that adds many other cards to the game no matter which option is chosen.

Implementation

Game workings

Reducers

Unit tests

8.1 Tools & Technologies

8.1.1 Node.js

I decided early on that this application should be easily accessible on a range of devices, particularly the game interface. For this reason I built the system as a responsive web-application, running on a node server. Node[17] is an excellent framework for getting sizeable projects up and running very quickly, which I was able to do with this project. This is in part due to NPM[18], which provides access to countless packages which I was able to use, ranging from Victory[19] for visualisations, to Thunk[20] for managing asynchronous side effects.

8.1.2 TypeScript

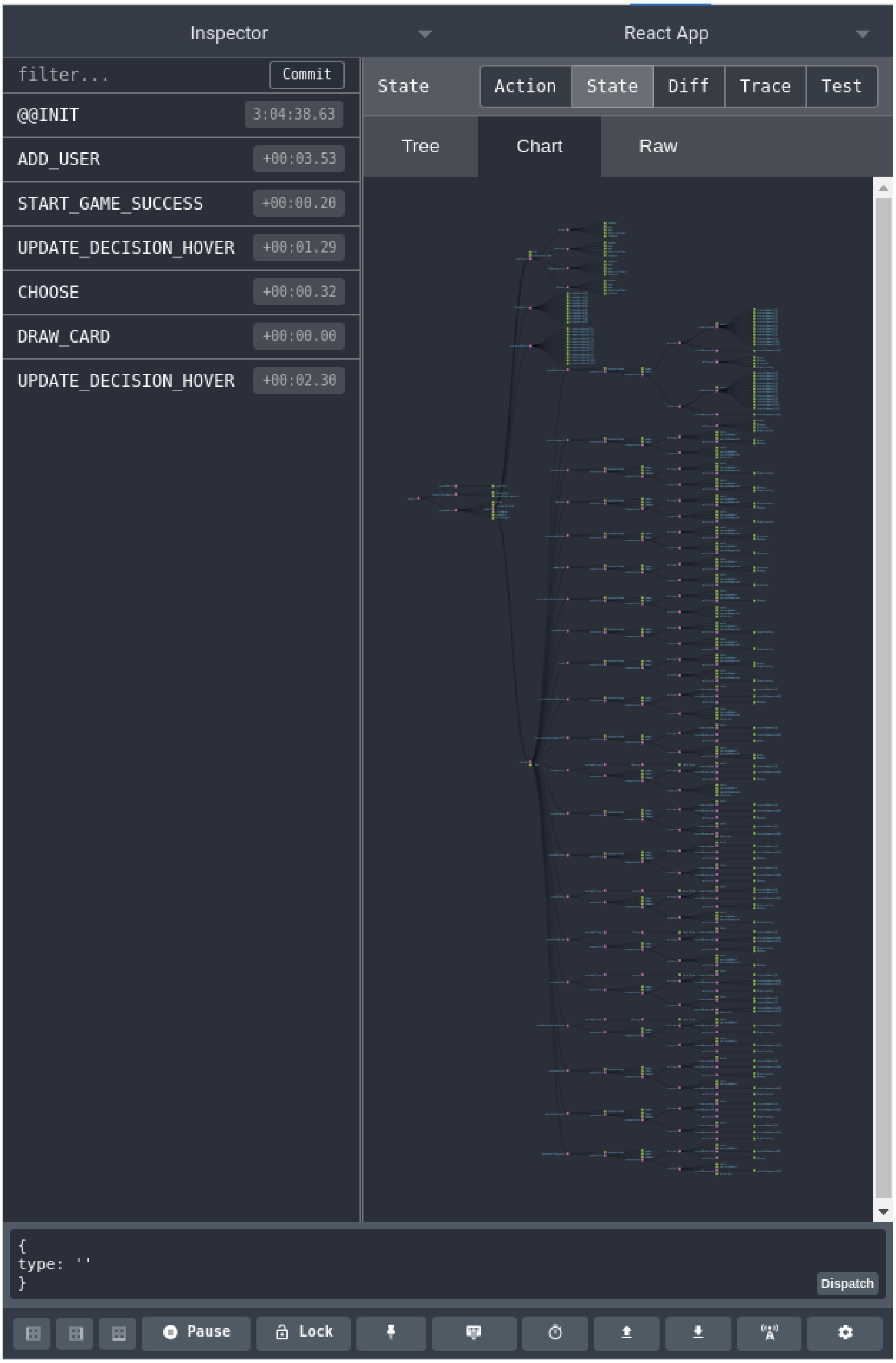
According to Microsoft who maintain it, ‘TypeScript is a typed superset of JavaScript that compiles to plain JavaScript’[21]. I decided to use TypeScript (TS) to combat some of the problems that can occur when working on a large JavaScript codebase. Being statically typed, TS prevents type errors and instantly makes code more navigable and readable. This helps both during development and maintenance, which is particularly important if others continue to work on this project.

React

React[22] is a UI library that simplifies the creation of responsive interface components. I knew that I wanted my application to be highly responsive, with each section effectively being split into a single page application. React made this fairly trivial once the structure of the page was settled, as information flows down through components and they are automatically updated.

Redux

Redux[23] complements React nicely, by helping to manage state. When using pure React, each component stores it’s own state. This can make things confusing as components that should be reflecting information can fall out of sync. Redux encourages moving the state of the whole application into one top-level serializable JS object. This then acts aas a ‘single source of truth’, which takes care of several considerations. Another benefit that I found redux to have is the debugging tools, which take the form of a chrome extension[24]. When Redux is correctly used, this tool makes it possible to view and manipulate the application state, and even ‘time travel’ the page to a previous state, such as before a button was clicked. This made debugging very straightforward, particularly for the game logic.



```
@@INIT                  3:04:38.63
ADD_USER                +00:03.53
START_GAME_SUCCESS      +00:00.20
UPDATE_DECISION_HOVER   +00:01.29
CHOOSE                  +00:00.32
DRAW_CARD               +00:00.00
UPDATE_DECISION_HOVER   +00:02.30
```

```
{
type: ''
}
```

Figure 8.1: Redux DevTool[24] opened in game view. This shows what actions have occurred while the page has been open, as well as visualising the application state.

8.1.3 NeDB

To store both the game definitions and the gameplay data, I needed a form of server-side persistance. I had to decide here between designing and maintaining a rigid relational database, or opting for a NoSQL[25] solution. After consideration, I chose to go with a document-based database. The main factor in this decision was that I was unsure of what data would be desired by users of the final product. While a relational database requires strict definitions of data and their types, document-based databases are much more free form, meaning values can be added and removed with no alterations to the database server required.

Specifically, I chose to use NeDB[26]. NeDB is a lightweight JS database library that was quick and easy to set up and use. The API it provides is a subset of that of MongoDB[27], and was therefore well documented despite this being a smaller, more lightweight tool. Game definitions and user data are stored in two separate instances.

This database implementation does have some downsides in terms of long term maintenance - ideally further along in the project's life cycle this would probably be converted to a relational database, once the data requirements were more strictly defined. Also, regrettably NeDB does not expose encryption as part of its API. This was something I only became aware of towards the end of the project, I might have chosen a different library if this had been immediately obvious. It would still be possible to encrypt fields individually It did however suit the needs of the project, and I believe I made the right choice in getting started with NoSQL.

8.2 Frontend

8.2.1 Game

Logic

Most of the game logic happens in the redux reducers. This is the part of the code where actions arrive and the payload gets processed, resulting in some change to the game state which is then propagated through the page.

Reducers should technically be pure functions, as this makes them reliably testable and allows the time travel aspect of the debug tools to work correctly. I have followed this convention for all of my reducers, except for `CHOOSE`, which is called when the player makes a choice. This is because of the shuffle function that gets called, which has a random element.

The shuffle function I used is an implementation of the Fisher-Yates Shuffle[28]. I needed this to ensure that the game remained unpredictable across replays, improving replayability.

Images

The colouring of images was one of the more technically involved parts of the project. In order to avoid heavily pixel processing I knew I would have to use SVGs, which can be edited with comparably insignificant computation (also having the advantage of being infinitely scalable). I then had to acquire some example images to use for my game definition. To maintain a similar art style I sourced them all from the same artist, Katerina Limpitsouni, on her site unDraw[29]. These images are open-source and usable for free and without attribution. The website has the advantage of allowing the main colour of each image downloaded to be set through a colour picker. After failing to find a solution to edit specific colours of an SVG in JavaScript, I resorted to wrapping each image in a React component, which passes through and injects the desired colour. This was not a favourable solution, as it's not possible to do this through the game maker tool. Considering this a prototypical feature (and not part of requirements), I believe the implementation is satisfactory.

Alternatively to this solution, another, less technically challenging but more time consuming possibility would be to fill the image URL property of each card, which could then be downloaded and rendered client-side.

Hover

When the user hovers over an answer with the mouse, the pillars affected by that response are outlined with a border, the colour of which depends on whether the effect is positive or negative. There were multiple ways in which this could have been implemented; I decided to use an enum property in the global state. Doing so makes it extensible - other effects or other hovering elements could be added easily.

Evaluation

'consider adding hidden columns which could affect the game but couldn't be seen by the user' 'only two answers per question?' 'subdecks - response can swap the whole deck eg when finding aliens' -can be done technically but easier 'Add/remove all UI element'

Conclusion

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