HTML5 game inside Facebook

Honour Project

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Abstract

This project involves the research and creation of a HTML5 Facebook game. A Facebook game is a software application inside the social network Facebook, that means you only can play this games if your logged in Facebook. In this report I will explain what is required to create a game on Facebook, to be more precise I explain how I take two HTML5 games and I put them on Facebook. This games are a single-player game (Snake) and two-players games (Connect4).

Acknowledgement

I would like to thanks my project supervisor, Dr. Bruce Scharlau for his assistance and advice during the development of this project, and would also like to thank my family and friends for supporting me during the development of this project and for helping in the testing phase.

Declaration

I declare that this document and the accompanying code has been composed by myself,and describes my own work, unless otherwise acknowledged in the text. It has not been accepted in any previous application for a degree. All verbatim extracts have been distinguished by quotation marks, and all sources of information have been specifically acknowledged.

Signed:..

Roberto Martínez Querol **Date:** …..............................

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1. Introduction

1.1. Overview

In this days many people have Facebook and many of them play Facebook games. The point is the development of these games, each of them is composed of several parts, such as the server, database, etc.. and is not so easy to communicate the different parts and neither is easy do them.

This project want to explain the bases to create each of the parts and the connections between them in order to explain how create a simple game where two people with a Facebook account can play the game against each other.

1.2. Primary goals

The primary goals of the project are as follows:

- Know how work a HTML5 game for facebook.
- Manage the server to send, receive and store information.
- Manage the communication with Facebook to play with friends and store the games.
- Manage the data base to save all the data (sql and nosql).

1.3. Secondary goals

The secondary goals of the project are as follows:

- Make the connections in a complex multiplayer game like a MMORPG (massive multiplayer role playing game) or something like that but it can be hard.

1.4. Steps

The steps to follow are the next:

- Single-player Facebook game, this game store the maximum score.
- Simple two-player Facebook game, storing the state of the game, the times each player win a game and the data necessary for the turns management.
- Multiplayer game for Facebook. (optional)

2. Background

2.1. Games in Social networks

Social networks have become important in our days, and along with them the games offered integrated in them. Facebook is one of the most important social networks and have a lot of games.

Social games now are a real alternative of electronic entertainment. More and more companies knowing the opportunities offered by this new variant of games and use their best efforts to the creation of social networking entertainment. It is logical if we consider the existing demand within these pages, the amount of user they have, the time spent within them and is not a big problem integrated in Facebook.

In August 2012 over 235 million people play games on Facebook, ¼ of Facebook users.[3]

2.2. HTML5 games

HTML5 (***H****yper****T****ext* ***M****arkup* ***L****anguage*) is a markup language for structuring and presenting content for the World Wide Web and a core technology of the Internet. It is one way to develop games for Facebook. At the beginning Flash was used for the development of games for Facebook but now HTML5 can be a better choice.

More Facebook games are in 2D. Now the power for 2D animation is the same thing with HTML5 and Flash, the advantage HTML5 can run in more mobile devices, Flash will not have upgrades, and a lot of big companies are in HTML5 side and are leaving out Flash including Google, Chrome, Firefox, safari and Adobe. The disadvantage is that HTML5 does not work in older browsers.

3. Methodology

At the beginning it is essential to search information about video games in html5 for Facebook so we can investigate the possible technologies that can be used for development of the project. When we have the information is moment to choose the most appropriate technologies in each case.

Once this is done we need to find a hosting to store our game made in HTML5 and when the simple game is working we can go to the next step.

The next step will be to put this game on Facebook using the information provide by Facebook about the person who wants to play, we will store the score of each player. This first game will be one simple, we only store the maximum user score.

After we finish this we should search for a simple multiplayer game, in our case a typical board game where a person play against other person in turns. Will have to adapt the game to keep the information in a database and communicate to each player the game state at each instant of time. For this we must study the best way to do this, once this is done we will put the game in Facebook. In Facebook two friends will can play with each other.

The next logical step is put a MMOG in Facebook. This could become more complicated because this kind of game have more complexity, for this reason this part is optional.

The final part is finish the documentation of the project.

4. What has been done until now on Facebook

Until now most of browser games have been done in Flash. 70% of web-based games are build using Flash, including 24 of the top 25 Facebook games.[4]

But now some people are doing the games in HTML5 for Facebook. The reason is maybe Flash announced they will no longer adapt Flash Player for mobile devices to new browser, OS version or device configurations and this is a problem for the developers because the mobile devices are very important in these days and if they don't adapt Flash for the new browser Flash will die early.[5]

Also Flash doesn't work in Iphone/Ipad.

For this reason I will implement the game in HTML5, it works in mobile and a lot of browsers and it will continue to be updated then I think is a good idea to work on Facebook.

5. Technologies

5.1. Hosting

The hosting is required for host our game. This host must have a good data-storage and a SSL security because Facebook needs it.

5.1.1. x10hosting

X10hosting is a free hosting site. They have been hosting the masses since 2004. It have a free hosting includes PHP5, MySQL, auto install script such as Joomla, wordpress, phpBB and SMF. [1]

This one is used in the first part of the project, do a simple online game but it is impossible to use it later because this hosting does not have SSL on the free version and Facebook needs it.

5.1.2. Heroku

Heroku is a free hosting site in cooperation with Facebook. Heroku (pronounced her-OH-koo) is a cloud application platform, a new way of building and deploying web apps. Their service lets app developers spend 100% of their time on their application code, not managing servers, deployment, ongoing operations, or scaling. Heroku provides a platform for building, deploying and running cloud apps in many programming languages. They have a lot of add-ons system for extending the capabilities of their platform. [2]

This one is the most important hosting in the project because it provides a SSL service for free and have a lot capabilities and making easier the game creation.

5.1.3. Others

There are many others hosting sites in internet to host web pages, games, information, etc. I will explain some of them below:

- 000webhost.com: Free hosting with uptime guarantee. He has PHP with MySQL Database support. The free version without SSL.[6]
- freehosting.com: Free hosting site, they provide a lot of serviced like:

  cPanel, E-Mail and WebMail hosting with IMAP, POP3 and SMTP, FTP, CGI, PHP5, MySQL, PYTHON, ROR, CRON and File Manage. Don't have SSL.[12]

5.2. Javascript

Javascript is a programming language that runs on a web browser was first implemented in version 2 of the browser. Javascript is not a subset of Java, infact, the two languages share little in common. It runs on the browser, it 's a client-side scripting language.[7]

The HTML5 canvas is a region code inside HTML code with height and width. With javascript you can draw on the canvas and this is the way to do a game with HTML5. First we define inside a HTML one canvas element and then we can use the javascript code for modified the canvas element and draw something inside. With this we can do a game inside a HTML webpage. Javascript is the standard for do that.

5.2.1. Facebook SDK for javascript

The Facebook SDK for JavaScript provides a client-side functionality for the management of the applications on Facebook. This functionalities are:

•Enables you to use the Like Button and other Social Plugins on your site.
•Enables you to use Facebook Login to lower the barrier for people to sign up on your site.
•Makes it easy to call into Facebook's primary API, called the Graph API.
•Launch Dialogs that let people perform various actions like sharing stories.
•Facilitates communication when you're building a game or an app tab on Facebook.[11]

5.2.2. jQuery

jQuery is a fast, small, and feature-rich JavaScript library. It makes things like HTML document traversal and manipulation, event handling, animation, and Ajax much simpler with an easy-to-use API that works across a multitude of browsers. With a combination of versatility and extensibility, jQuery has changed the way that millions of people write JavaScript. [8]

jQuery is used in the application to call PHP pages from javaScript code. These calls are for the communication with the database to set, get, delete or add information in our data base.

To make the call we use this code structure:

```
$.ajax({ url:'(url where I have the php)',
                        data: {(name of the variable):(variable content)},
                        type: 'post',
                        success: function(output) {
                           (code to do after the call)
                        }
                    });
```

I always do the post method and the variable “output” has the value of the response returned by the PHP.

With this the php can do the queries as normal.

```
mysql_query(“(query)”);
```

To know more about this exists more information here: http://php.net/.

5.3. HTML5

HTML5 is the new standard HTML (*HyperText Markup Language*) language for structuring and presenting content on the web. The HTML5 intention is to include all web technologies in a single standard.

HTML + CSS + JavaScript APIs = HTML5

The differences between the old HTML and HTML5 are:

-New elements for a specific content: header, nav, footer, article...

-New functionalities through a standardized interface.

-Audio and video elements for a multimedia reproduction.

-New element called canvas to draw on it.

-New inputs like calendar, date, email...

-Born a lot of APIs based in javaScript: canvas, webstorage, web sockets, XMLHttpRequest2.... [9]

5.3.1. Alternative: Adobe Flash Player

The alternative for do games on Facebook is Adobe Flash Player. Flash is a multimedia and software platform used for authoring of vector graphics, animation, games and Rich internet applications which can be viewed, played and executed in Adobe Flash Player. The problems is they announced they will no longer adapt Flash Player for mobile devices to new browser, OS version or device configurations.[10]

Taking this into account, the best option in the development of video games for facebook I think is HTML5.

5.4. CSS

CSS (Cascading Style Sheet) is a style sheet language used for describing the presentation semantics of a document written in a markup languages, in our case HTML5. Is used in our game for do the main page of the game which contains the game information, user information, etc.

5.5. Data storage

For the game we need a good data storage with a good management. If the game have a lot people playing if it is not good the database can have problems. Exists a lot of databases for do that, the most common are SQL database but exists others. In Heroku you can find add-ons for data storage for the applications you are storing there.

5.5.1. ClearBD mySQL

ClearDB creates multi-master and multi-master with multi-replica MySQL configurations in regions that are important to you to provide your applications with a fully redundant solution that can survive outages, network failures and even natural disasters. You choose how much computing power and storage you need, then they set it all up for you so that you have a secure, powerful and reliable MySQL database that best serves your needs.

Under the hood, ClearDB uses a combination of advanced replication techniques, advanced cluster technology, and layered web services to provide you with a MySQL database that is "smarter" than usual. We also use things like mixed binary replication logging and auto-increment offset seeding so that you can continue using MySQL's nondetermanistic and time-based functions such as UUID(), NOW() as well as auto-increment keys in your tables.[13]

I choose this data base because is a SQL database and I am familiar with this kind of databases and SQL is a very common good way for store and access the data. In Heroku you can find SQL add-ons for data storage (like Heroku postgres) but ClearBD is a good choice for his simplicity and utility. The connections with ClearDB in our applications I made with PHP code.

5.5.2. Redis cloud (nosql)

Redis is an open source, advanced key-value store. It works out-of-the-box with Express and many other Node.js apps and modules. The database instances are on a fast local network connection and offer superior speed compared to other hosted solutions.[14]

This solution is faster than the SQL solution, this is visible in the tests.

It has a PHP library, we use this library for do the connections with our redis, the reason is for easy comparison with the SQL option (ClearBD).

5.5.3. Others

Heroku has a lot of add-ons for data storage like:

-Mongo lab: Mongo (from the word "hu**mongo**us") is a open-source database noSQL. MongoDB stores structured data as JSON-like documents with dynamic schemas (MongoDB calls the format BSON). Mongo lab is a fully-managed cloud database service featuting highly-aviable MongoDB database, automated backuos, web-based tools, 24/7 monitoring, and a expert support.[16]

-MongoHQ: Is another MongoDB. They provide more or less the same than Mongo lab.

-RedisGreen: Is like Redis cloud with diferent management.

-Heroku Postgres: Is a SQL database like ClearBD. PstgreSQL is a data-management system. Open-source objetc-relational database. Works with: Java, Perl, Python, Ruby, Tlc, C/C++ and its own PL/pgSQL.

5.6. PHP

PHP (*Hypertext Preprocessor*) is a widely-used general-purpose scripting language that is especially suited for Web development and can be embedded into HTML. The PHP code is executed on the server, generating HTML which is then sent to the client. The client would receive the results of running that script, but would not know what the underlying code was. The user can't know the PHP code, only the result.[15]

PHP is used in our application for the main page (index.php) for several purposes and is used also for the communication with the BD (ClearBD and redis).

To collect the value sent by post method in the PHP script we need this code:

```
$_POST["(name of the variable)"];
```

5.6.1. Facebook SDK for PHP

The Facebook SDK for PHP provides a rich set of server-side functionality for accessing Facebook's server-side API calls. Is used to perform operations as an app administrator.[16]

In the application we use this for take the user information, like his name, friends, friends playing, etc.

5.6.2. predis

Predis is a flexible and feature-complete PHP client library for the Redis key-value store. Is used for the communication with the Redis cloud BD.

5.6.3. Alternative to PHP

A part of PHP we can use other programming languages to connect to our databases.

-ClearBD: Ruby and Python/Django. I chose PHP in this case because I did something in php before and is a programming language commonly known.

-Redis cloud: Ruby, Java, Python and Node.js. I did the Clear BD in PHP and I did not think to change the programming language.

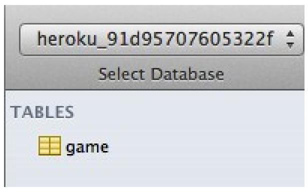
5.6.4. Sequel pro

Is a management tool for Mac OS X. This tool is for the management of the SQL data bases and is very easy to use it. [18]

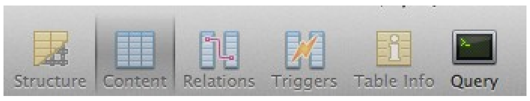
To do the connection you only need:

- Host adress
- username no acces
- password of the user
- database name
- port

You can chose the option to connect using SSL. Sequel pro has a very intuitive interface. You can choose the DB in the top-right corner and then you can see the tables on it.



When you choose the table you can change the structure, see and change the content, make relations, add triggers, see the table info and make Query for management.



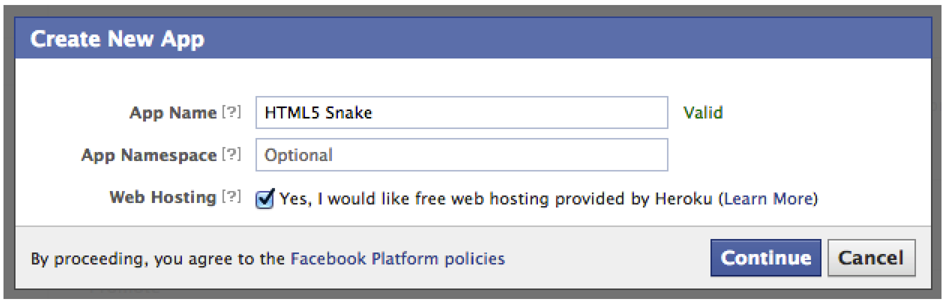
6. Development and Implementation

The most important things in this project are the connections with Facebook and the data store. All games have been found online and changed later to put them on facebook.

6.1. Start with the app on Facebook.

6.1.1. Create app

To develop a game on Facebook the first thing is to have a Facebook account. For it only has to go to the official website https://www.facebook.com[21] and register on it. Once in our account, we should go to the Facebook developers site https://developers.facebook.com/apps[19] and create new app.



Create New App

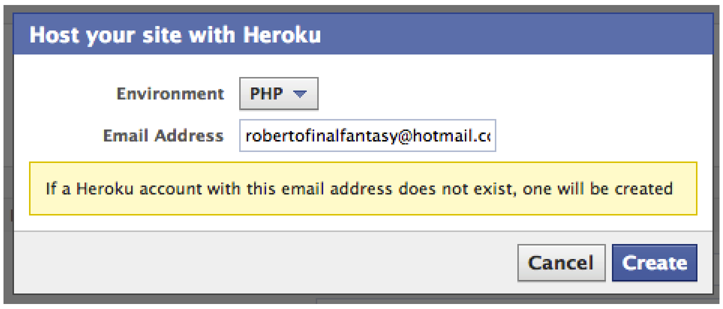
App Name [?] HTML5 Snake Valid

App Namespace [?] Optional

Web Hosting [?] ✓ Yes, I would like free web hosting provided by Heroku (Learn More)

By proceeding, you agree to the Facebook Platform policies

If you have another hosting different to Heroku do not check the last option. If you don't have a Heroku account you can create one in this step.



Host your site with Heroku

Environment PHP

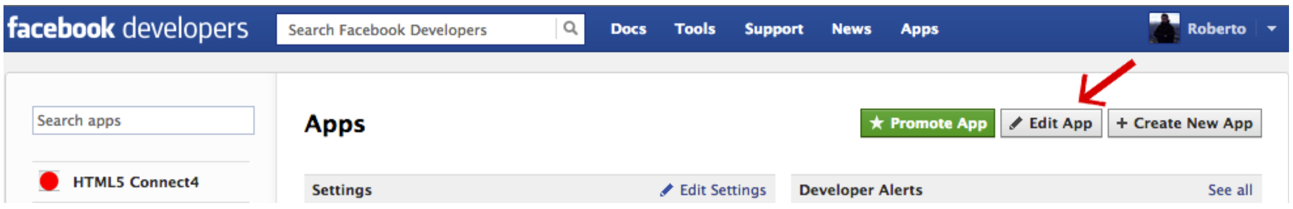
Email Address robertofinalfantasy@hotmail.c

If a Heroku account with this email address does not exist, one will be created

Now you can edit the information of you app in the next page. You can edit a lot of things like the name, App domains, hosting URL, developer Roles, payments, etc.

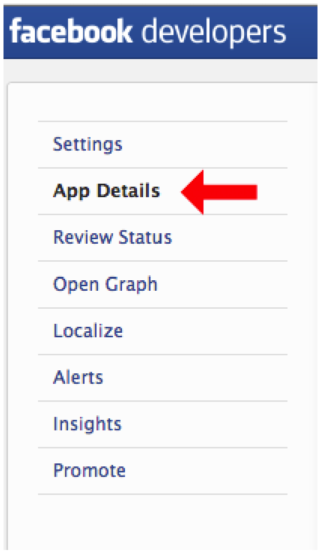
6.1.2. Submit app

Once you have finished the game you still needs to do the last step to being able to have the game in the app centrer: submit the app. To do that you need to go to Facebook developers app page (https://developers.facebook.com/apps[19]) and select the app you want to submit and click “edit app”.



In basic settings you can change the name of the app and choose the app domain. If you have been chosen Heroku when you created the app some information has been completed: site URL, canvas URL, appDomain, etc.Also you can add a mobile web site, Native iOS App and Native Android App.

To submit the app you should go to App details.



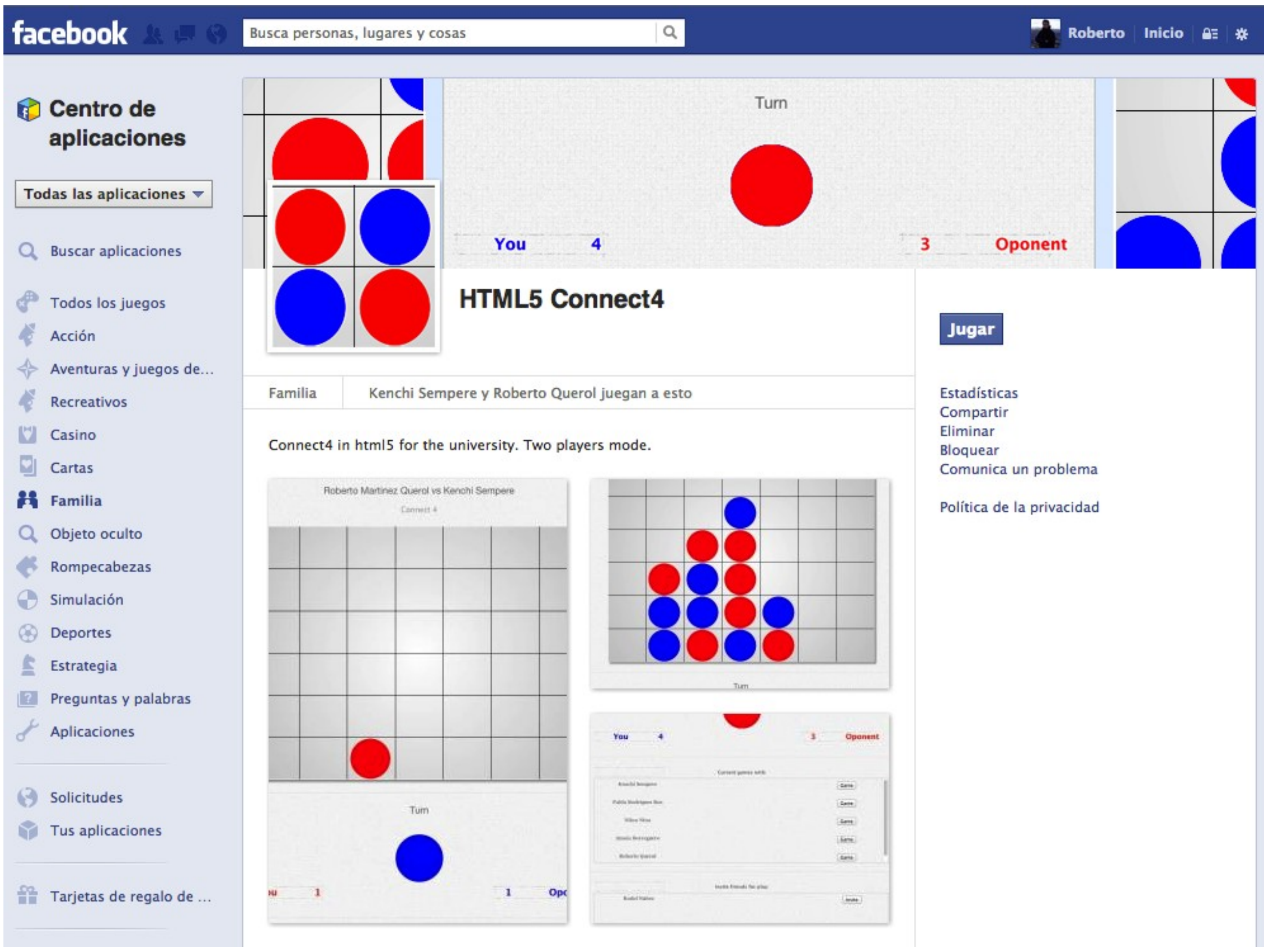
In the app details you need to complete some sections for submit the app:

- Primary Language: The main language of your app.
- Display name: The app name.
- Description: Short description of your app.
- Detailed description: A good description of your app.

- Privacy Policy URL: You need a privacy policy. When you have a page with it you should put the URL here.
- Icons: You need some icons for your app page.
- Screenshots: Some screenshots of your app.

When you complete this page you can submit your app and automatically creates a page for your application on Facebook.

Example with the connect4:



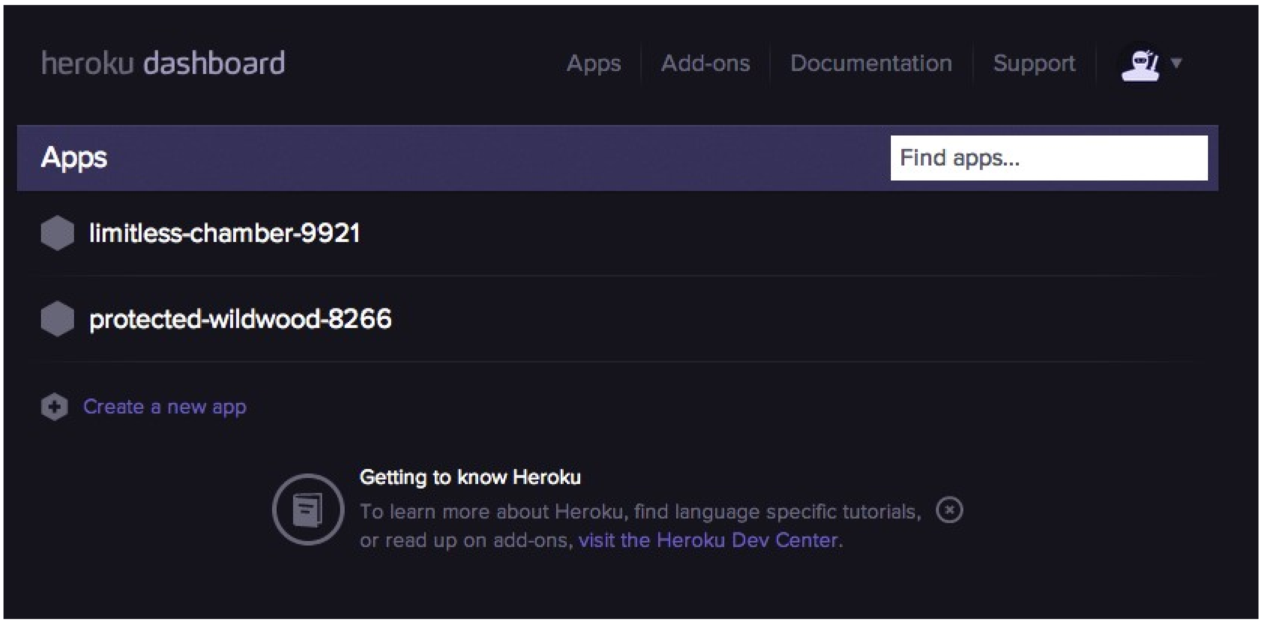
HTML5 Connect4

Connect4 in html5 for the university. Two players mode.

6.1.3. Heroku

When you create your app on Facebook a template app, in this case written in PHP, has been copied and deployed.

If you go to your Heroku account, in the section apps you will find something like that:



limitless-chamber-9921

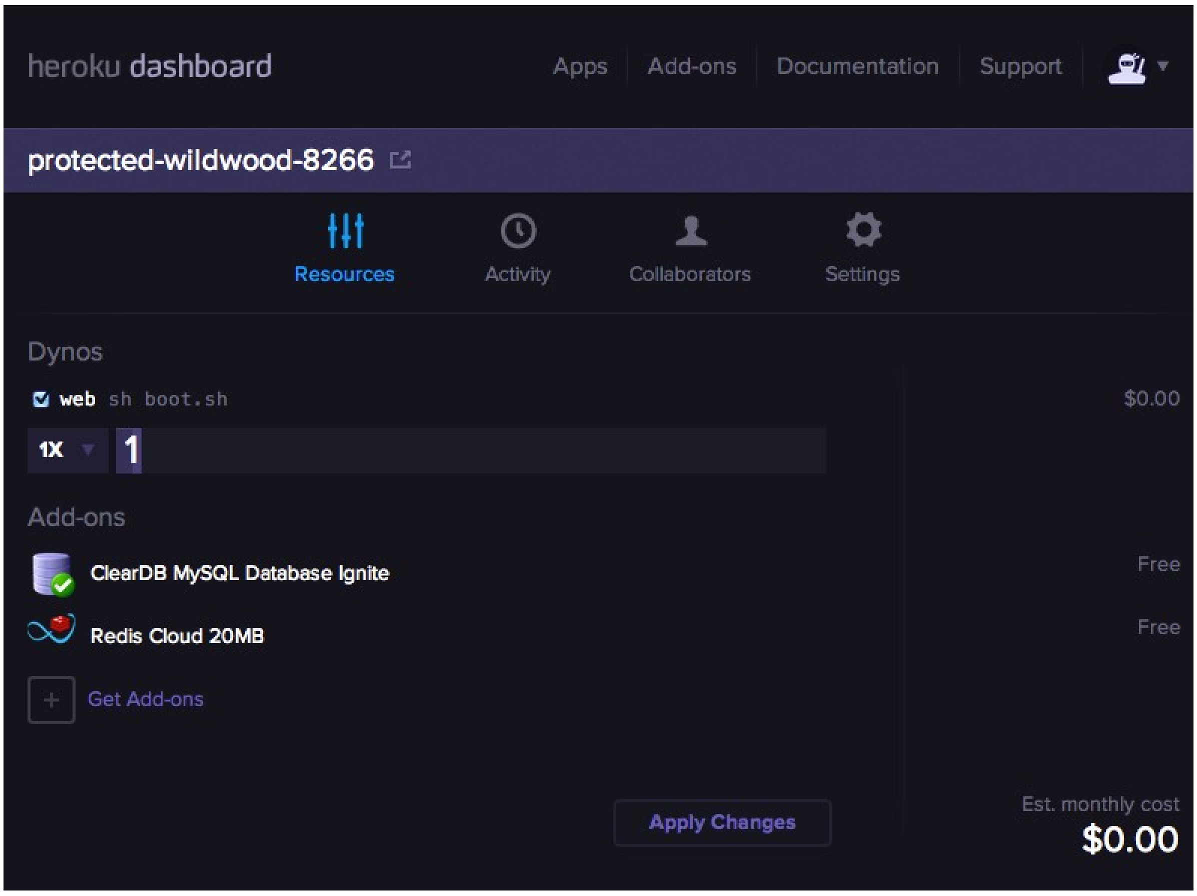
protected-wildwood-8266

Getting to know Heroku

To learn more about Heroku, find language specific tutorials, or read up on add-ons, visit the Heroku Dev Center.

Heroku is a good hosting with addons, good documentation, good support and easy management. Is easy create a new app and add more things in it.

If you chose one of your apps you can see the latest activities, add collaborators to your app, change some settings or add new add-ons or see the add-ons you already have.


heroku dashboard

Apps | Add-ons | Documentation | Support

protected-wildwood-8266

Resources | Activity | Collaborators | Settings

Dynos

web sh boot.sh — $0.00

1X 1

Add-ons

ClearDB MySQL Database Ignite — Free

Redis Cloud 20MB — Free

Get Add-ons

Apply Changes

Est. monthly cost $0.00

This is an example of Connect4 game. This one have two free add-ons: ClearBD and Redis cloud.

Heroku has a lot of add-ons for a lot of things:

-Data store	-Mobile
-Search	-Logging
-Email and SMS	-Workers and queueing
-Analytics	-Caching
-Monitoring	-Media
-Utilities	-Payments

Here is a tutorial explaining how to start an application on heroku: https://devcenter.heroku.com/articles/facebook[22]

6.2. Snake

I found a tutorial for create a snake game in HTML5 here: http://juegoscanvas.blogspot.co.uk/[23]. I have changed the code to use the Facebook account to store the maximum score.

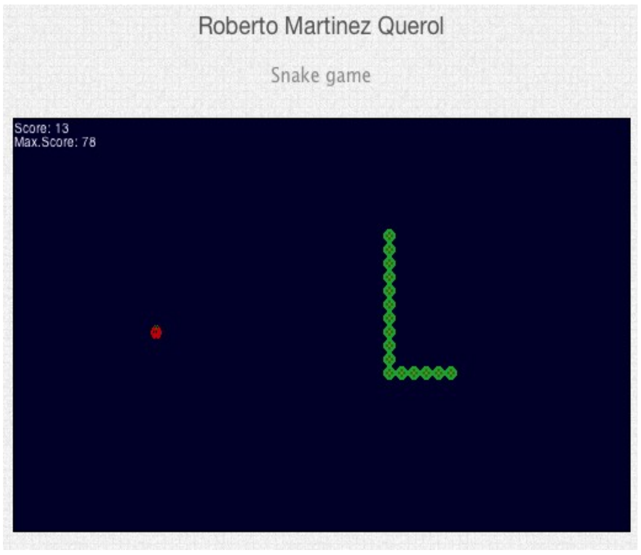
You can find the game here:

- Facebook page: https://www.facebook.com/appcenter/264925106974559?preview=1&locale=es_ES
- Game on Facebook: https://apps.facebook.com/264925106974559/?fb_source=appcenter&fb_appcenter=1

6.2.1. What is Snake?

Snake is a casual video game that originated during the late 1970s in arcades becoming something of a classic. In 1998 the game appear on Nokia mobile phones and Snake found a massive audience.

In the game, the player controls a thin creature which roams around a plane picking up food (in this case and apple), trying to avoid hitting its own tail. When the snake eats a apple, its tail grows longer, making the game increasingly difficult. The user can change the direction of the snake's head (up, down, left or right). When the snake hit its own tail the game finish. The score is the number of apples the snake can eat before hit its own tail. The player pause the game with the key enter.



Now I will explain the changes and the architecture of the game.

6.2.2. index.php

This is the main page of the project. Facebook give you a index template for your apps and you only should modified it for your needs.

In this case we need to put a canvas object inside the index with width 500 and height 300 and make, call the necessary javaScripts (jquery-1.7.1.min.js and game.js) and put invisible input with the userId who is playing, this last thinks is because we need the userId for store the maximum score inside the javascript code. This id is a Facebook id.

Jquery-1.7.1.min.js is the jquery library.

6.2.3. game.js

This script contains everything related to the game, in this case the snake game.

At the beginning the script take the user from the index.php with the code:

```
user=document.getElementById("nombre").value;
```

The most important function is the function run(). This function have the main loop of the game, the first thing the function does is calculate the state of the game from the inputs and then the function paint the new state.

- This new state depends on two things: the last state and the input.

  -If the key enter is active we have two possibilities:

    -If it is running the game is paused

    -If it is paused the pause is removed.

  -If the direction of the snake is the right or the left and the input is the arrow up or arrow down the snake changes its direction towards this input.

  -If the direction of the snake is up or down and the input is the arrow left or arrow right is the snake changes its direction towards this input.

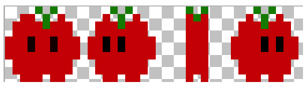
When the program finish this part then it move the snake to it direction:

  -If in this direction found a apple a new part of the snake is added in the head.

  -If in this direction found a other part of his body the game end and the state is reset.

-If in this direction does not find anything a new part is added in the head and a part is deleted in the tail.

In this script (game.js) I did the functions to call PHP scripts, I add the animation of the apple and the max score in the paint function.


Apple animation

- Paint the max score:

```
ctx.fillText('Max.Score: '+maxScore,0,20);
```

-'Max.Score' is a String

-MaxScore is a variable with the max score

-0 and 20 are the position x,y in the canvas.

- Paint the apple animation:

```
ctx.drawImage(iFood,timer%4*10, 0, 10, 10, food.x,food.y, 10, 10);
```

-iFood is the image.

-timer%4*20 is the position x. The timer is a variable to know the correct frame.

-0 the position y.

- 10,10 is the size (width, height)

- The PHP calls are for:

-Register the user in the DB if not exist at the beginning.

-Get the max score of the user at the beginning.

-Set the new max score of the user if the last score is better when the user lose the game.

6.2.4. Data base

The connections with the DB had made with PHP script. All the PHP include the file in.inc, this file contain the information of the DB. This information is:

-Server address (variable *$db_server).*

-Data base user (variable *$db_user).*

-User password (variable *$db_pass).*

-DB name (variable *$db_dbase).*

With this code the php start the connection with the DB:

```
mysql_connect($db_server, $db_user, $db_pass);

mysql_select_db($db_dbase);
```

In the data base for the snake I only need one table: User.

In this table I only need two columns: user_id and score. user_id is the ID of the user in Facebook and score is the maximum score obtained for this user.

PHP script:

- regis.php: Input variable: id, this id is the Facebook id of the user. Inserts the user passed as a parameter if it does not exist in the DB, the maximum score is 0.
- score.php: Input variable: id, this id is the Facebook id of the user. Returns the user punctuation passed as a parameter.
- setScore.php: Input variable: id and msScore. id is the Facebook id of the user and msScore is the new maximum score of the user. Sets the maximum score received as parameter with the specified user.

6.3. Connect 4

The code of the connect 4 is in: https://github.com/unixpickle/Connect4[24]. This game is only to play in one computer. I have changed the code and now two friends on Facebook can play together with his Facebook account.

I do two version with different DBs:

- ClearBD SQL
  - you can find the game here: https://protected-wildwood-8266.herokuapp.com/
  - Facebook page: https://www.facebook.com/appcenter/443501612396104?preview=1&locale=es_ES
  - Facebook game: https://apps.facebook.com/443501612396104/?fb_source=appcenter&fb_appcenter=1
- Redis cloud (noSQL)
  - yo can find the game here: https://protected-wildwood-8266.herokuapp.com/indexnosql.php

6.3.1 What is connect4?

This game have a lot of different names: Captain's Mistress, Four Up, Plot Four, Find Four, Fourplay, Four in a row and Four in a line. It is a two-player game, each player have a colour and then they drop a coloured disc from the top and the disc fall straight down occupying the next available space within the column. The objective of the game is to connect four of own discs next to each other vertically, horizontally or diagonally before your opponent. The are a many variation of the board size, in my case the size is 7x6.

When the user create a connect4 game, he is the red player and his friend is the blue player. The user who create the game starts and he can click one column, putting a disc in the lowest Y position of this columns. When the user puts a piece on the board, he have to wait for the other person to place a piece.

Now I will explain the changes and the architecture of the game.

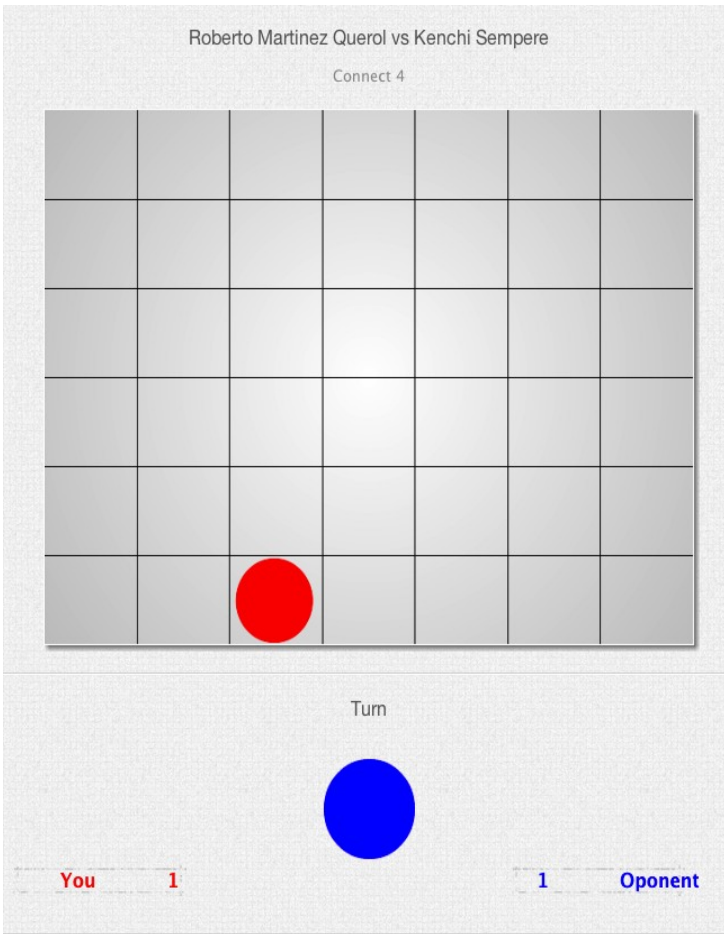
6.3.2. index.php

This is the main page of the project. Facebook give you a index template for your apps and you only should modified it for your needs.

In this case we need to change a lot of thinks:

-First the php gets the parameter “a” passed with the method get (in the URL). This parameter only exists if the user start a game with a friend. The parameter “a” is the ID of a friend to play with him.

-If the variable “a” exists then the canvas is added and the user can play with the friend who's id is “a”. We have two canvas: the canvas for play and the canvas which shows the turn (red or blue).



When the game is created all the javascript are called and start to run. We need five parameters for the game:

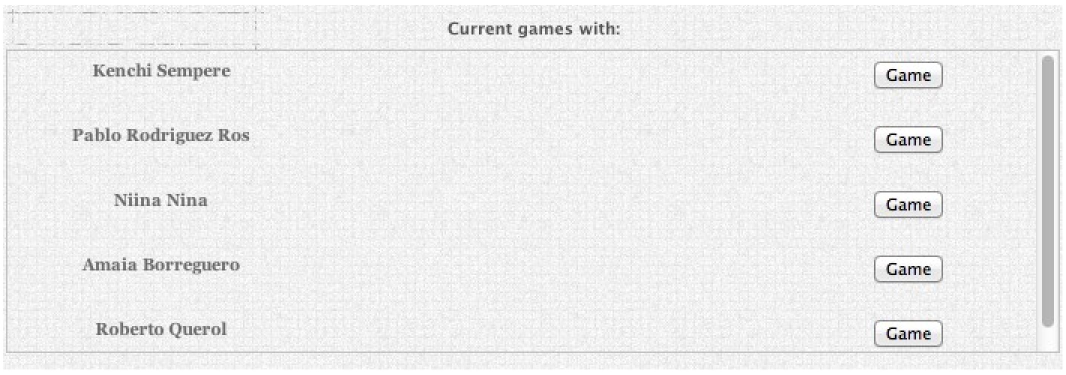
- state: the state of the game.
- id1: user id.
- id2: friend id.
- turn: current turn (red or blue).
- jt: turn of the user (red or blue).

This parameters are a input hidden in the php, is the easy way to take a parameter from the javascript.

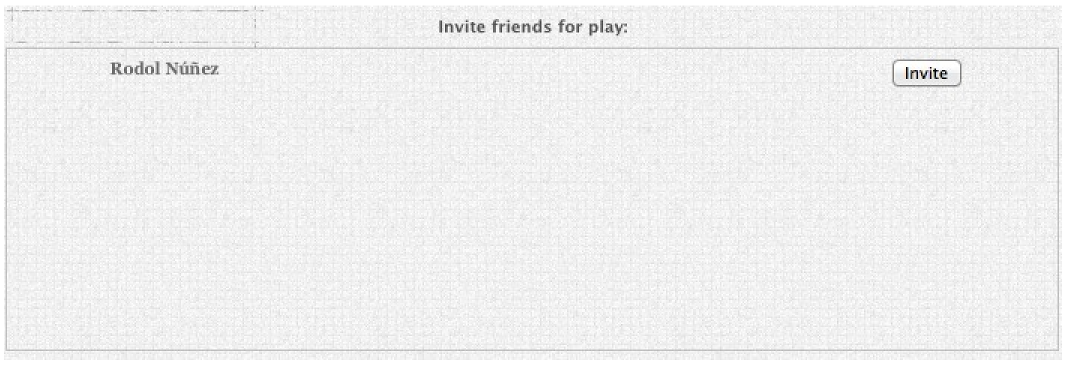
Example:

> Inside the php the program have a input with id “turn” and the attribute “hidden” with the same value as $turn: *<input type="hidden" id="turn" value=<?= $turn ?> />*
>
> This value can be got in the javascript with: *document.getElementById("turn").value;*

-The php add a section to continue de game with a friend pressing the button “Game”. The games shown below are the games in the DB with the user friends. When the user press the button, this button call a javascript function to recharge the page with the parameter “a”, this parameter is the userID of the friend the user want to play.



-The php add a section to create a game with the user friends who are playing this game but the user don't have a game with them. To do that the user can press the button “invite”. This button add a game in the DB between the user and his friend. When the user press the button, this button call a javascript function to prepare the call to the PHP to create a new row in the DB.



6.3.3. GameEngine.js

This script contains the global variables and is the first script called when all is loaded.

The main functionalities are:

-configure the canvas.

-create the game board.

-paints for the first time the board.

Here I add the call to get the second canvas. This canvas is for paint the player turn on it.

6.3.4. GameBoard.js

This script have three functions:

- Constructor function. When the program create a GameBoard this script initialize the variables and create the GameState, this game state needs the size of the board, in this case 7x6.
- When the user click in the canvas the function MouseDown is called.

  If it is not the player turn this function does nothing but if is the player turn and the variable “winner” is equal to 0 (nobody wins) this function put the new piece in the board and update the state in the DB. When you click in a column the piece fall at the less position Y it can, if the column is full the movement is invalid.

If the variable “winner” is different to 0 this means one player won the game. Then this function increment the wins of the player who won the game.

- When the player make a movement and the state change we need to paint again the canvas. In this script we have the function draw which is responsible for managing the painting. This function paint the background, the separators between squares and have the loop to paint the pieces. If the variable winner is different to 0 the winner dialog is painted. If is not the turn of this player and nobody won the game the function “checkTurn” is called for wait him turn.

6.3.5. GameState.js

This script contains the state of the game. When the program do a new GameState this take some variables from the php, this variables are:

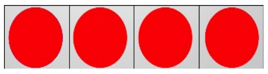
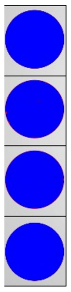
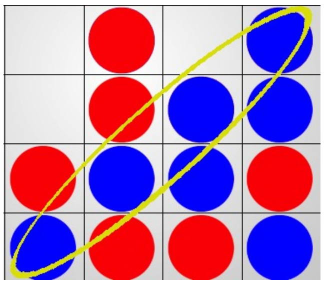
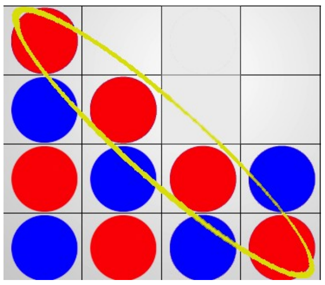
- state: the state of the game.
- id1: user id.
- id2: friend id.
- turn: current turn (1 if it is the red player or 2 if it is the blue player).
- jt: turn of the user (1 if it is the red player or 2 if it is the blue player).

Also initialize some variables for the game.

Here we have the polling to the DB to know if is the player turn or not in the function “checkTurn”. This polling is 300 milliseconds+ResponseTime. To know if is the player turn we only need to compare if the turn stored in the DB is the same number as the player. When the program know is the player turn its get the state from the DB to actualize the state.

We have also functions in this script to call the php to save the game. We have two functions for one reason: in one of them the script change the turn but we do not need that if we want to store the initial state because we already have the correct turn. To save the game we need to pass the array to a string, I do this with a loop to pass the entire array to a string.

Here we have the function to add a new piece in the board and a function to check if one player won the game in the last movement or not. To do that the script check if some one have four pieces in a row, there are four possibilities:

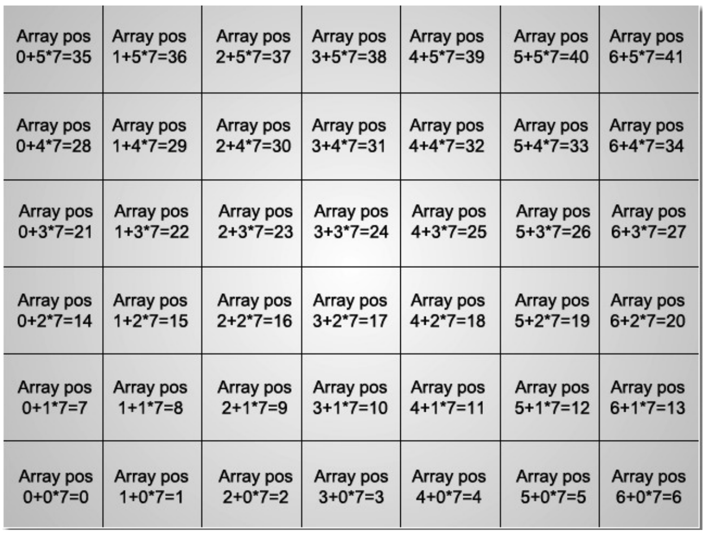





6.3.6. Game State

The game state have two things:

- Board
- Turn

In the program the board is a array called piecesG, this array contains integers. The size of this array is 7x6, the same as the board size. The position of the board in the array is x+y*7.



Array pos 0+5*7=35	Array pos 1+5*7=36	Array pos 2+5*7=37	Array pos 3+5*7=38	Array pos 4+5*7=39	Array pos 5+5*7=40	Array pos 6+5*7=41
Array pos 0+4*7=28	Array pos 1+4*7=29	Array pos 2+4*7=30	Array pos 3+4*7=31	Array pos 4+4*7=32	Array pos 5+4*7=33	Array pos 6+4*7=34
Array pos 0+3*7=21	Array pos 1+3*7=22	Array pos 2+3*7=23	Array pos 3+3*7=24	Array pos 4+3*7=25	Array pos 5+3*7=26	Array pos 6+3*7=27
Array pos 0+2*7=14	Array pos 1+2*7=15	Array pos 2+2*7=16	Array pos 3+2*7=17	Array pos 4+2*7=18	Array pos 5+2*7=19	Array pos 6+2*7=20
Array pos 0+1*7=7	Array pos 1+1*7=8	Array pos 2+1*7=9	Array pos 3+1*7=10	Array pos 4+1*7=11	Array pos 5+1*7=12	Array pos 6+1*7=13
Array pos 0+0*7=0	Array pos 1+0*7=1	Array pos 2+0*7=2	Array pos 3+0*7=3	Array pos 4+0*7=4	Array pos 5+0*7=5	Array pos 6+0*7=6

The integers inside the array can be:

- 0 : the position is empty.
- 1 : the position have a red piece from the player 1.
- 2 : the position have a blue piece from the player 2.

The variable turn is an integer, the integer only can be two values:

- 1 : is the turn of the player red.
- 2: is the turn of the player blue.

6.3.7. Data base

The connections with the DB had made with PHP. In this game I implemented two DBs, the first DB use SQL (ClearBD) and the second one do not use SQL (Redis cloud).

The information in the DB is the same in both cases:

- **id1:** Facebook id of the player red.
- **id2:** Facebook id of the player blue.
- **state:** Board state. This is the string with the information of the array state mentioned before. This string contains 0,1 and 2 like the board matrix.
- **turn:** This is the current turn. 1 if it is red turn and 2 if it is blue turn.
- **p1:** How many wins have the red player.
- **p2:** How many wins have the blue player.
- **aux:** When someone win a game the two players try to increment the number of win of the winner, to prevent a double increment I have this variable. When this variable is equal to 0 this PHP increment the number of wins of the winner and this variable becomes 1. If this variable is equal to 1 this PHP do not increment the winnings and becomes 0.

The primary key of this DB is Id1+Id2 and Id1+Id2 is the same than Id2+Id1, that means in my BD can't exists two games between the same two players. Both of them use the same PHP.

- **existGame.php:** Input variables: Id1 and Id2. Id1 is the Facebook id of the user who is calling the PHP and Id2 is the Facebook id of the friend. This PHP return 1 in case exists a game between the two Ids passed as parameters. Returns 0 otherwise.
- **getState.php:** Input variables: Id1 and Id2. Id1 is the Facebook id of the user who is calling the PHP and Id2 is the Facebook if of the friend. This PHP return the state of the game between id1 and id2.
- **getTurn.php:** Input variables: Id1 and Id2. Id1 is the Facebook id of the user who is calling the PHP and Id2 is the Facebook id of the friend. This PHP return the turn of the game between id1 and id2.

- **newGame.php:** Input variables: Id1 and Id2. Id1 is the Facebook id of the user who is calling the PHP and Id2 is the Facebook id of the friend. This PHP create a new game in the data base. And initialize the information of the game:

  state = '000000000000000000000000000000000000000000'. Empty board.

  turn = 1. The player red always is the first.

  p1 = 0. The player red have 0 wins at the beginning.

  p2 = 0. The player blue have 0 wins at the beginning.

  aux = 0. This must be 0 because we can increment the winner count.
- **saveSinc.php:** Input variables: w, Id1 and Id2. w is the variable for determinate who won the game, if this variable is 1 the winner is the red player, if it is 2 the winner is the blue player. If aux = 0 this php change aux to 1 and increment the winner count of the winner, if the w is equal to 1 the php increment p1, if w is equal to 2 this script increment p2. If aux = 1 this php only change aux to 0. Id1 is the Facebook id of the user who is calling the PHP and Id2 is the Facebook id of the friend.
- **saveState.php:** Input variables: Id1, Id2, s and t. Id1 is the Facebook id of the user who is calling the PHP and Id2 is the Facebook id of the friend. s is the state of the game and t the current turn. This php store the state and the turn between the player id1 and the player id2.

6.3.8. ClearBD SQL

All the PHPto connect with ClearBD SQL include the file in1.inc, this file contain the information of the DB like in the snake with the same structure to access to the DB:

-Server address (variable *$db_server).*

-Data base user (variable *$db_user).*

-User password (variable *$db_pass).*

-DB name (variable *$db_dbase).*

With this code the php start the connection with the DB:

```
mysql_connect($db_server, $db_user, $db_pass);

mysql_select_db($db_dbase);
```

With this the php can do the queries as normal.

```
mysql_query("(query)");
```

To know more about this more information here: http://php.net/[25].

6.3.9. Redis cloud (noSQL)

Redis works different than a SQL DB, its needs a key to store the information and with this key you can access the information related wit this key. To store the information I used the hash data type, in this case the key is id1+id2, where id1 is the id of the user who makes the game and id2 is the id of the friend. To not have two games between the same player we need to check id1+id2 and id2+id1 because the game between id1 and id2 is the same as have a game between id2+id1. With PHP and the key we can get the game information (state, turn, p1, p2 and aux).

All the php have this code:

```
require 'predis-0.8/autoload.php';

  Predis\Autoloader::register();

  $redis = new Predis\Client(array(

        'host' => parse_url($_ENV['REDISCLOUD_URL'], PHP_URL_HOST),

        'port' => parse_url($_ENV['REDISCLOUD_URL'], PHP_URL_PORT),

        'password' => parse_url($_ENV['REDISCLOUD_URL'], PHP_URL_PASS),

  ));
```

With this code you can access to the redis cloud stored in the Heroku app. We need to add the first line to load the php code to work with redis in php.

To know more about how to use redis in php: http://phpmaster.com/an-introduction-to-redis-in-php-using-predis/ [20].

6.4. MMOG (Massive Multiplayer Online Game)

I have a single-player game and two-player game, then the next logical step is a MMO game for Facebook. I did not implement this one because I haven't enough time to do it. This king of game have a lot of classes inside and store a lot information, that makes it difficult and needs more time to be implemented.

At the moment, the single player did not need communication between players because they play alone, in the two-player game, in this case the connect4 I do the connection with a polling in the DB, I can do that because is a turn-base game and it is asynchronous. Players take their time, contemplating the possibilities and they can do the movement when they want. In the browser is more difficult to do a real time game than a turn-based game.

To do a MMOG we need to do a real time connection and HTTPs is not enough to do that alone because the real time game require messages send and received sometimes in the region of 33-66 times per second. Luckily, in modern browsers we can take one step higher, and have a real time connection between a server and clients. The purpose of this discussion is to present one overview of how multiplayer games are made.[26]

I found a MMOG with a open-source code in internet, its name is Cobalt Calibu, you can found it in https://www.openshift.com/blogs/hosting-and-developing-the-html5-game-cobalt-calibur-free-on-openshift[27].

The main idea was take a MMOG like that and make changes to put it on Facebook. The way to do that is remove the registration and the login and put a Facebook login to save the game status. With that kind of game is a good idea make a market for the player and sell some game items to earn money like a lot Facebook games.

7. Testing

To see some bugs inside the games and test the performance I tested the games with some friends.

7.1. Snake

This game is very simple and only access to the DB when the game is over and the user do a better score than he did before.

I tested this game with nine people playing at the same time and it works correctly. Is not a lot of people but I this it is ok with this free version of the ClearDB SQL.

In this game I din't find any bug.

7.2. Connect 4

Twelve friend play that game to test it and I found some bugs while we were testing it.

- When a player win a game, his victory count is incremented by 2. This bug happens because when a player win a game the two players increment the count. Is easy to fix this bug using a aux variable, when it is 0 the user increment the count and put this variable = 1, when this variable is 1 the user don't increment the count and put this variable = 0.
- If one player open two windows and make a movement in one of them the state is stored and the game continues normally but when makes a movement in the other windows this state is stored too, cancelling the others movements. This bug is easy to solve with a checksum in the php which save the game. Before store the new state it check this: number of pieces in the old state+1 = number of pieces in the new state, if this is true the php store the new state.
    - With this the php don't store a new game because always n+1 > 0 where n is a positive integer. For solve this the php check if the number of pieces in the new states is equal to 0.
- When a player win a game if the two players close the windows and open it again the dialog with a winner don't appear and the player can do a movement. This is because at the beginning the game don't check if someone won the game. To solve this the program only should check if someone won the game when the game is loaded.

I implemented two DBs for this game. One of them with SQL (ClearBD) and other one without SQL (redis cloud).I do tests in different conditions. The time is in milliseconds, collected by the javascript function Date.now(), I capture the time when a player send the state and when the other player receive that state.

Always the polling is taking in to account the response time.

7.2.1. SQL tests

- Nine games at the same time (polling = 300 milliseconds+response):

Player 1 (chrome)	Player 2 (safari)	Results
Receive :	Send:	
1367599506881	1367599506416	465
Send:	Receive :	
1367599527146	1367599527571	425
Receive :	Send:	
1367599528965	1367599528462	503
Send:	Receive :	
1367599529853	1367599530502	649
Receive :	Send:	
1367599532005	1367599531681	324
Send:	Receive :	
1367599532745	1367599533502	757
Receive :	Send:	
1367599534709	1367599534191	518
Send:	Receive :	
1367599535668	1367599535941	273
Receive :	Send:	
1367599537772	1367599537075	697
Send:	Receive :	
1367599538728	1367599538913	185
Receive :	Send:	
1367599540516	1367599539807	709
Send:	Receive :	
1367599541524	1367599542046	522
Receive :	Send:	
1367599542758	1367599542500	258
Send:	Receive :	
1367599544498	1367599544854	356
Receive :	Send:	
1367599548350	1367599547818	532
Send:	Receive :	
1367599549340	1367599549707	367

Receive :	Send:	
1367599553711	1367599552982	729
Send:	Receive :	
1367599554424	1367599554880	456
Receive :	Send:	
1367599556608	1367599556110	498
Send:	Receive :	
1367599557993	1367599558328	335
Receive :	Send:	
1367599559784	1367599559221	563

Average: 440.04 milliseconds

- Only one game running (polling = 300 milliseconds+response):

Player 1 (chrome)	Player 2 (safari)	Results
Receive:	Send:	
1367582799496	1367582799144	352
Send:	Receive:	
1367582800240	1367582800478	238
Receive:	Send:	
1367582801974	1367582801726	248
Send:	Receive:	
1367582802694	1367582803063	369
Receive:	Send:	
1367582804467	1367582804235	232
Send:	Receive:	
1367582805576	1367582805890	314
Receive:	Send:	
1367582808442	1367582806890	1552
Send:	Receive:	
1367582810151	1367582810843	692
Receive:	Send:	
1367582812000	1367582811547	453
Send:	Receive:	
1367582813214	1367582813719	505
Receive:	Send:	
1367582815387	1367582814945	442
Send:	Receive:	
1367582829900	1367582830667	767
Receive:	Send:	
1367582831576	1367582831225	351
Send:	Receive:	
1367582832293	1367582832541	248
Receive:	Send:	
1367582833937	1367582833636	301

Send:	Receive:	
1367582835697	1367582835895	198
Receive:	Send:	
1367582837569	1367582837393	176
Send:	Receive:	
1367582838287	1367582838893	606
Receive:	Send:	
1367582840229	1367582839670	559
Send:	Receive:	
1367582841063	1367582841611	548
Receive:	Send:	
1367582842545	1367582842369	176
Send:	Receive:	
1367582844130	1367582844650	520

Average: 447.59 milliseconds

- Nine games at the same time (polling = 0 milliseconds+response):

Player 1 (chrome)	Player 2 (safari)	Results
Receive:	Send:	
1367584441696	1367584440988	708
Send:	Receive:	
1367584443168	1367584443512	344
Receive:	Send:	
1367584446096	1367584445829	267
Send:	Receive:	
1367584447485	1367584447759	274
Receive:	Send:	
1367584449922	1367584449139	783
Send:	Receive:	
1367584451255	1367584451575	320
Receive:	Send:	
1367584453535	1367584452943	592
Send:	Receive:	
1367584457690	1367584458002	312
Receive:	Send:	
1367584459047	1367584458748	299
Send:	Receive:	
1367584460795	1367584461312	517
Receive:	Send:	
1367584497836	1367584497335	501
Send:	Receive:	
1367584498902	1367584499317	415
Receive:	Send:	
1367584500801	1367584500538	263
Send:	Receive:	
1367584501762	1367584502132	370
Receive:	Send:	
1367584503796	1367584503441	355

Send:	Receive:	
1367584504836	1367584505138	302
Receive:	Send:	
1367584506756	1367584506417	339
Send:	Receive:	
1367584508106	1367584508289	183
Receive:	Send:	
1367584510556	1367584510304	252
Receive:	Receive:	
1367584512024	1367584512653	629
Send:	Send:	
1367584512284	1367584513104	820

Average: 421.19 milliseconds

- Only one game running (polling = 0 milliseconds+response):

Player 1 (chrome)	Player 2 (safari)	Results
Receive:	Send:	
1367585010544	1367585010293	251
Send:	Receive:	
1367585012660	1367585012889	229
Receive:	Send:	
1367585014617	1367585014466	151
Send:	Receive:	
1367585015740	1367585015977	237
Receive:	Send:	
1367585017520	1367585017234	286
Send:	Receive:	
1367585018500	1367585018702	202
Receive:	Send:	
1367585024326	1367585023846	480
Send:	Receive:	
1367585025263	1367585025439	176
Receive:	Send:	
1367585026892	1367585026900	8
Send:	Receive:	
1367585028026	1367585028563	537
Receive:	Send:	
1367585029693	1367585029490	203
Send:	Receive:	
1367585030946	1367585031481	535
Receive:	Send:	
1367585032877	1367585032686	191
Send:	Receive:	
1367585034014	1367585034436	422
Receive:	Send:	
1367585035634	1367585035268	366

Send:	Receive:	
1367585036550	1367585036875	325
Receive:	Send:	
1367585038817	1367585037949	868
Send:	Receive:	
1367585039808	1367585040288	480
Receive:	Send:	
1367585041252	1367585041052	200
Send:	Receive:	
1367585046261	1367585046701	440
Receive:	Send:	
1367585051934	1367585051768	166
Send:	Receive:	
1367585053950	1367585054123	173

Average: 314.82 milliseconds

7.2.2. noSQL tests

- Nine games at the same time (polling = 300 milliseconds+response):

Player 1 (chrome)	Player 2 (safari)	Results
Send:	Receive :	
1367596174857	1367596175293	436
Receive :	Send:	
1367596176920	1367596176571	349
Send:	Receive :	
1367596178070	1367596178593	523
Receive :	Send:	
1367596190700	1367596190508	192
Send:	Receive :	
1367596192427	1367596192663	236
Receive :	Send:	
1367596194134	1367596193733	401
Send:	Receive :	
1367596194830	1367596194984	154
Receive :	Send:	
1367596196373	1367596195787	586
Send:	Receive :	
1367596197537	1367596198007	470
Receive :	Send:	
1367596200196	1367596200014	182
Send:	Receive :	
1367596201998	1367596202335	337
Receive :	Send:	
1367596203905	1367596203351	554
Send:	Receive :	
1367596204779	1367596205028	249
Receive :	Send:	
1367596211940	1367596211615	325
Send:	Receive :	
1367596214471	1367596214943	472
Receive :	Send:	
1367596216219	1367596215738	481
Send:	Receive :	
1367596217225	1367596217499	274
Receive :	Send:	
1367596219546	1367596218683	863
Send:	Receive :	
1367596220472	1367596220756	284
Receive :	Send:	
1367596222233	1367596221946	287
Send:	Receive :	
1367596233915	1367596234058	143
Receive :	Send:	
1367596235660	1367596235431	229
Send:	Receive :	
1367596237129	1367596237573	444

Average: 368.3 milliseconds

- Only one game running (polling = 300 milliseconds+response):

Player 1 (chrome)	Player 2 (safari)	Results
Send:	Receive :	
1367594950069	1367594950951	882
Receive :	Send:	
1367595500164	1367595499942	222
Send:	Receive :	
1367595501165	1367595501611	446
Receive :	Send:	
1367595503598	1367595503431	167
Send:	Receive :	
1367595505246	1367595505423	177
Receive :	Send:	
1367595508605	1367595508182	423
Send:	Receive :	
1367595509965	1367595510230	265
Receive :	Send:	
1367595512261	1367595511688	573
Send:	Receive :	
1367595513318	1367595513804	486
Receive :	Send:	
1367595516786	1367595516355	431
Send:	Receive :	
1367595517999	1367595518340	341
Receive :	Send:	
1367595520236	1367595520062	174
Send:	Receive :	
1367595521465	1367595521670	205
Receive :	Send:	
1367595523478	1367595522944	534
Send:	Receive :	
1367595524383	1367595524688	305
Receive :	Send:	
1367595526617	1367595526389	228
Send:	Receive :	
1367595527809	1367595528133	324
Receive :	Send:	
1367595529706	1367595529498	208
Send:	Receive :	
1367595531158	1367595531483	325
Receive :	Send:	
1367595533284	1367595533153	131
Send:	Receive :	
1367595534070	1367595534207	137
Receive :	Send:	
1367595536859	1367595536710	149
Send:	Receive :	
1367595538129	1367595538724	595
Receive :	Send:	
1367595540309	1367595539836	473

Average: 341.7 milliseconds

- Nine games at the same time (polling = 0 milliseconds+response):

Player 1 (chrome)	Player 2 (safari)	Results
Send:	Receive :	
1367597399322	1367597399472	150
Receive :	Send:	
1367597403591	1367597403386	205
Send:	Receive :	
1367597404576	1367597404791	215
Receive :	Send:	
1367597405974	1367597405792	182
Send:	Receive :	
1367597406712	1367597406936	224
Receive :	Send:	
1367597407944	1367597407693	251
Send:	Receive :	
1367597408885	1367597409117	232
Receive :	Send:	
1367597409977	1367597409717	260
Send:	Receive :	
1367597410726	1367597410909	183
Receive :	Send:	
1367597411756	1367597411523	233
Send:	Receive :	
1367597412336	1367597412483	147
Receive :	Send:	
1367597413659	1367597413428	231
Send:	Receive :	
1367597414666	1367597414889	223
Receive :	Send:	
1367597418285	1367597418138	147
Send:	Receive :	
1367597419286	1367597419501	215
Receive :	Send:	
1367597420091	1367597419928	163
Send:	Receive :	
1367597421066	1367597421262	196
Receive :	Send:	
1367597426021	1367597425749	272
Send:	Receive :	
1367597427138	1367597427342	204
Receive :	Send:	
1367597431216	1367597430917	299
Send:	Receive :	
1367597433675	1367597433841	166

Average: 209,43 milliseconds

- Only one game running (polling = 0 milliseconds+response):

Player 1 (chrome)	Player 2 (safari)	Results
Receive :	Send:	
1367596948613	1367596948416	197
Send:	Receive :	
1367596955469	1367596955646	177
Receive :	Send:	
1367596956878	1367596956636	242
Send:	Receive :	
1367596957897	1367596958113	216
Receive :	Send:	
1367596959382	1367596959181	201
Send:	Receive :	
1367596960458	1367596960686	228
Receive :	Send:	
1367596962223	1367596962007	216
Send:	Receive :	
1367596963669	1367596963815	146
Receive :	Send:	
1367596964988	1367596964858	130
Send:	Receive :	
1367596966032	1367596966195	163
Receive :	Send:	
1367596970310	1367596970140	170
Send:	Receive :	
1367596971219	1367596971436	217
Receive :	Send:	
1367596972541	1367596972379	162
Send:	Receive :	
1367596973505	1367596973738	233
Receive :	Send:	
1367596974760	1367596974610	150
Send:	Receive :	
1367596975892	1367596976031	139
Receive :	Send:	
1367596977501	1367596977273	228
Send:	Receive :	
1367596980361	1367596980512	151
Receive :	Send:	
1367596981704	1367596981485	219
Send:	Receive :	
1367596982950	1367596983165	215
Receive :	Send:	
1367596984157	1367596984008	149
Send:	Receive :	
1367596985140	1367596985307	167

Average: 187.1 milliseconds

7.2.3 Final conclusion

Test	Average (milliseconds)
SQL nine games with 300 milliseconds	440.04
SQL one game with 300 milliseconds	447.59
SQL nine games with 0 milliseconds	421.19
SQL one game with 0 milliseconds	314.82
noSQL nine games with 300 milliseconds	368.3
noSQL one game with 300 milliseconds	341.7
noSQL nine games with 0 milliseconds	209.43
noSQL one game with 0 milliseconds	187.1

In this table is easy to see which option is better for do the connection with the DB (between redis cloud and ClearBD) in the game connect4: noSQL (redis cloud).

All the averages are better in the noSQL DB. The differences between one game or nine at the same time is only significative in SQL with polling of 0 milliseconds+response time, this can be because the number of person playing at the same time doing polling constantly difficult the connection with the server.

In the case of the noSQL, have nine games at the same time or only one is not significative but is important the time of polling, the differences between 300 and 0 milliseconds is about the double of time and this is a lot of time.

In conclusion, the best implementation for the connect four is noSQL (redis cloud) without polling (0 milliseconds).

- Unusual case: The average time in SQL nine games with 300 milliseconds is better than the SQL one game with 300 milliseconds, that is possible because the difference is very little and we have a small test.

8. Future work

To improve the games and get more people to play them we need to improve the interface and add some things. For example in the snake game is a good idea add a section in the index to see the maximum score of the user friends. In the connect4 the graphics are only lines and circles, to improve this, we can change the board and the pieces for a goods draws.

The next game to implement is a multiplayer game. In this case I talked about MMOG, this kind of game is a really challenge because normally this kind of game are very complex and needs to store a lot information. I talked about it in “6.4. MMOG (Massive Multiplayer Online Game)”.

Appendix A: Privacy policy

Link: https://protected-wildwood-8266.herokuapp.com/privacy_Policy.html

```
<!DOCTYPE html>

<html lang="es">

<body>

<h1>Privacy policy</h1>

<p>This Privacy Policy was last revised on February 28th, 2013.</p>

<p>Privacy Policy explains what information of yours will be collected by html5 Snake
and how the information will be used. I will not use or share your information with anyone
except as described in this Privacy Policy.</p>

<p>The game is served on the Facebook Platform, so your activity on the game may
sometimes be ruled by Facebook Privacy Policy and not ours.I, as developer, also
respect Facebook Principle and Policies.

You can read them on <a
href="http://developers.facebook.com/policy/">http://developers.facebook.com/policy/</a
>.</p>

<h2>Information I collect</h2>

<p>When you access the Game through Facebook, I may receive your UserID and the
user IDs of the user's friends who have also connected with your application, I only need
this for store your maximun score in the data base.</p>

<h2>How I use the collected data</h2>

<p>Just to save the maximum score.</p>

<h2>Additional Questions</h2>

<p>If you have any question, feel free to contact me at: <a
href="roberto.martinez.q@gmail.com">roberto.martinez.q@gmail.com</a>.</p>

</body>

</html>
```

Appendix B: Maintenance Manual

B.1: Directory Structure

B.1.1: Snake

→ Images: folder with the images needed for the application.

→ index.php: main page of the application.

→ javascript: folder with the javascripts.

  → game.js: main class of the game.

  → jquery-1.7.1.min.js: jquery library.

→ PHP: folder with the PHPs.

  → in.inc: file with the DB information.

  → regis.php: file which registers a new user using the user ID.

  → score.php: file to get the score of the user using his ID.

  → setScore.php: file to set the new score to the user with the ID received.

→ privacy_Policy.html: file with the information about my policy and privacy.

→ sdk: folder with the SDK of Facebook.

→ sound: folder with the sounds of the game.

→ styleSheets: folder with the css files for the application.

→ utils.php: file with functions to get some variables.

B.1.2: Connect4

→ Images: folder with the images needed for the application.

→ index.php: main page of the application.

→ indexnosql.php: main page of the application using the noSQL DB (redis cloud).

→ javascript: folder with the javascripts.

  → BoardCanvas.js: file which adds the listeners of the game.

  → GameBoard.js: file which draw the board and manage the board listeners.

  → GamePiece.js: file which draw the pieces.

→ GameState.js: file wich manage the game state.

→ GameEngine.js: file which configurate the game and contain the global variables.

→ WinnerDialog.js: file wich draw the winner dialog.

→ jquery-1.7.1.min.js: jquery library.

→ PHP: folder with the PHPs.

→ in1.inc: file with the DB information.

→ getState.php: file to get the state of the game between the two users received.

→ getTurn.php: file to get the turn of the game between the two users received.

→ existGame.php: file to know if exists game between the two users received.

→ newGame.php: file to create a game between the two users received.

→ saveSinc.php: file to increase the number of winning of the user.

→ saveState.php: file to save the new state in the game between the two users received.

→ predis-0.8: Folder with the Redis library to use Redis in PHP.

→ privacy_Policy.html: file with the information about my policy and privacy.

→ styleSheets: folder with the css files for the application.

→ utils.php: file with functions to get some variables.

→ nosql: this folder contain the images, javascripts and PHPs with the noSQL DB.

B.2 Make it work

To make it work we just need to upload it to a host and run it using the host domain. This host should provide a SSL because Facebook require it. The best way to upload this application is go to the Facebook developers page, create a new application using Heroku and upload the application in Heroku.

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Glossary

Term	Definition
SSL	Secure Sockets Layer, that provide communication security over the internet.
MMOG	Massive Multiplayer Online Game. The online games who a lot of people plays at the same time are MMOG.
Script	Command file.
DB	Data base. This store the information.
Hash	A map of string keys and string values.
app	Application.