An history of fundamental game algorithms with C++

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Goals

What we will do

☑ Learn fundamental algorithms used in ANY virtual scene (games or cinema)
☑ Getting used to C++
☑ Apply good C++ habits (Efficient C++ / Efficient Modern C++, Scott Meyers)

What we won't do

□ Design patterns. You can use them, but no focus on it : those games are simples. Keep complexity low. (But use OOP, please...)
□ Optimization : "premature optimization is the root of all evil". Keep technicality low.
□ Tutorials. You are programmers. You choose your implementation.

Resources

Tools

- SDL2 with sdl_image, sdl_mixer, sdl_ttf
- Either Visual Studio (C++ support)
- Or any light text editor with a Makefile and some batch. Like Visual Code.

SDL2 : https://www.libsdl.org/download-2.0.php

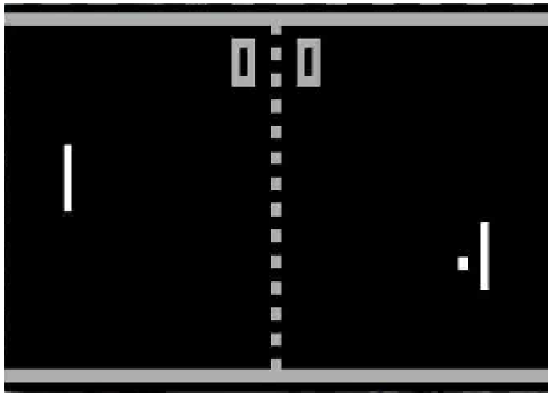
SDL2 image, mixer, ttf : https://www.libsdl.org/projects/

Quick start

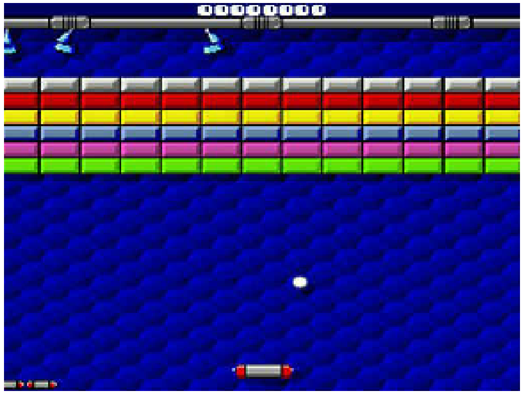
- A basic SDL2 project for Visual Code : https://github.com/Gaetz/sdl-Basic
- ...And some insight about config files (note it is meant to be compiled with g++, for an OpenGL project) : https://github.com/Gaetz/cpp-Tetris
- How to import sdl libs in big VS : http://lazyfoo.net/tutorials/SDL/

Menu

- Pong



- Brick Breaker



- Top-down Racer

- Tile Dungeon

- Space Shooter

- 2D RTS

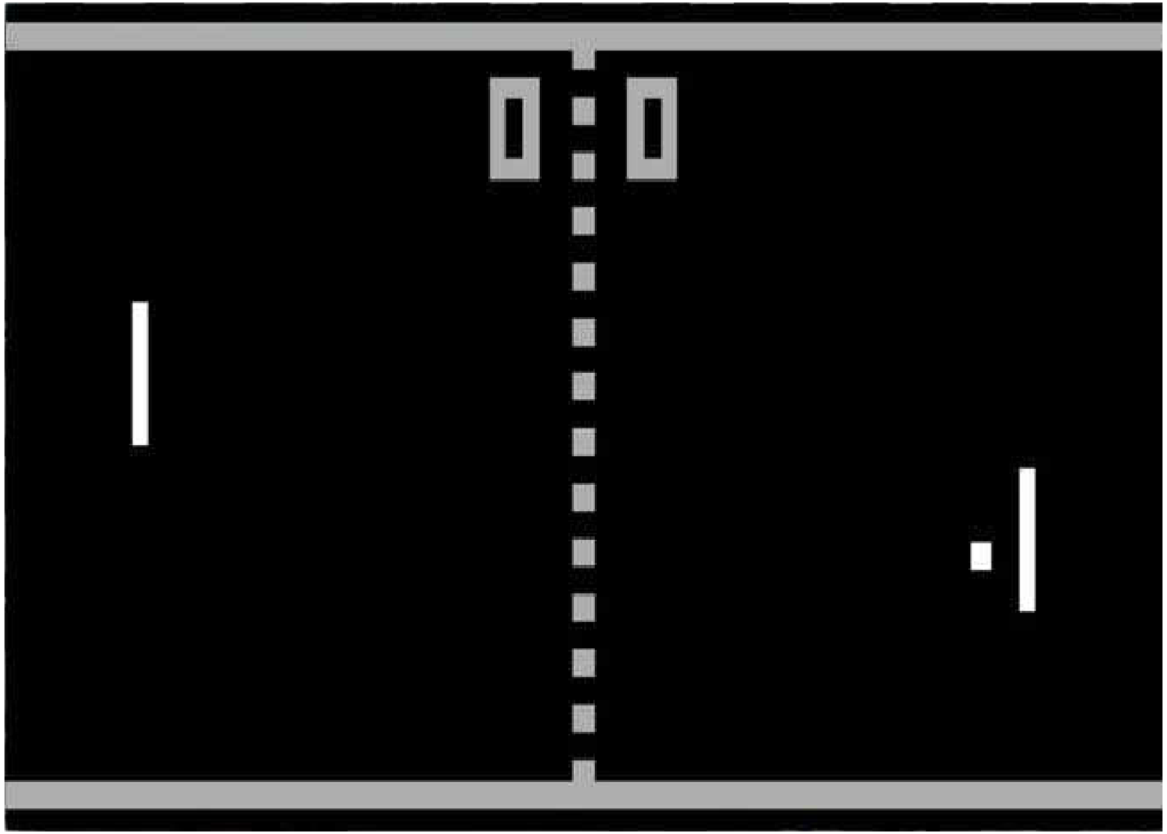
NOT ENOUGH FOOD...BUILD MORE FARMS

Two part for each project :

- First : programming classic algorithms
- Second : extend games to use more complex algorithms

First part - Classic algorithms

Pong



Window

- Create a 800 * 600 black window
- Create a classic empty game loop

Ball

- Draw a white ball
- (http://fvirtman.free.fr/recueil/02_03_04_formes.c.php)

- Don't spend time on optimization!

Ball move

- Make the ball move. To do so, update its coordinates with a speed.

The delta time is the delay since last frame display.

- Process the delta time
- Limit frame per seconds to 60 FPS
- Update the ball speed so it is multiplied by delta time

Ball bounce

- Make the ball bounce. Just inverse its speed when it reaches an edge of the screen.

Paddle

- Draw a paddle on the left edge of the screen.

Move Paddle

- Move paddle with the mouse. The paddle should be centered on the mouse.

Reset ball & Paddle bounce

- If the ball get out of screen on the left, reset its position
- Make the ball bounce on the left paddle

Opponent Paddle

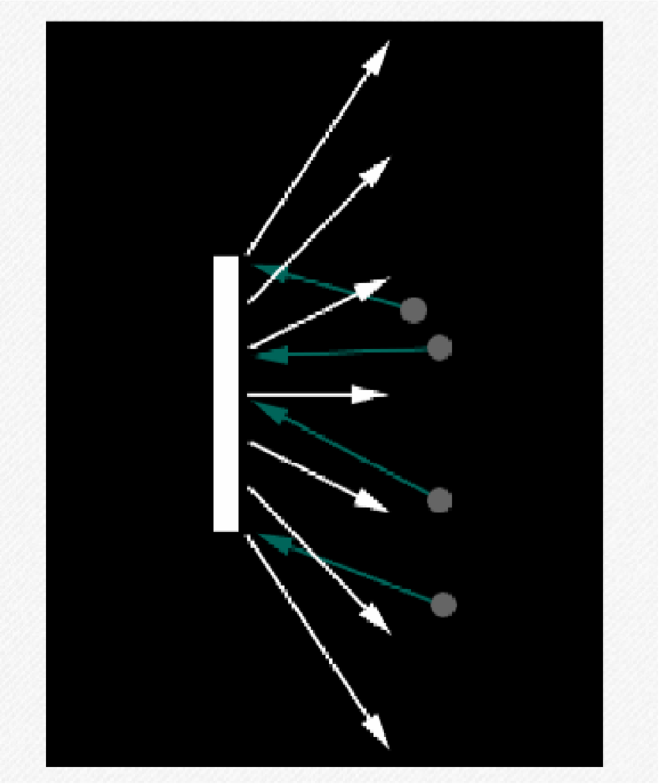
- Draw the right paddle
- Reset the ball when it reaches right edge
- Make the ball bounce on the right paddle

Scores

- Add one text on the upper left screen, one text on the upper right screen
- Register each "player" score, and display it in the texts

Bounce control

- Now, when the ball bounces on the paddle, we want its vertical speed to vary in function of the distance to center :



Opponent control

- Make the opponent paddle move up when the ball is above it, to move down when the ball is below it
- Set a maximum speed to the opponent paddle, so it can miss the ball
- In your code, this speed parameter should be easily accessible

Fix opponent shaking

- Create a deadzone on the paddle, so it moves only if the ball is outside this zone
- This will fix paddle shaking
- In your code, this deadzone length parameter should be easily accessible

Victory score

- Set a maximum score parameter to win the game
- Pause the game after victory to announce the winner
- Reset the game after an interaction (e.g.: mouse click). Indicate the needed interaction.

Polish

- Draw a dashed line in the middle of the screen

Brick Breaker

A good start

- Create a black window with a ball bouncing on the edges inside

Paddle

- Reset the game if the ball cross the bottom edge

- Create a mouse-movable paddle that would make the ball bounce if it collides it

- Bouncing angle shall vary with the position of the ball on the paddle (the further on the paddle, the bigger the angle)

- Set the paddle vertical position 10% away from the bottom of the screen

Paddle fix

- When the ball hit the paddle from the side, it may have a strange behaviour

- Increase the paddle thickness to highlight this behaviour (only for tests)

- Fix it by making the paddle affect the ball only if the ball go downward

Another brick in the wall

- Create bricks on the top of the screen

- 14 rows, 10 cols of bricks, which dimensions are 80 (width) * 20 (height)

- Make a visual gap of 2 pixels on the right side and on the bottom of the bricks

- Storebricks in a unidimensional array (or std::vector)

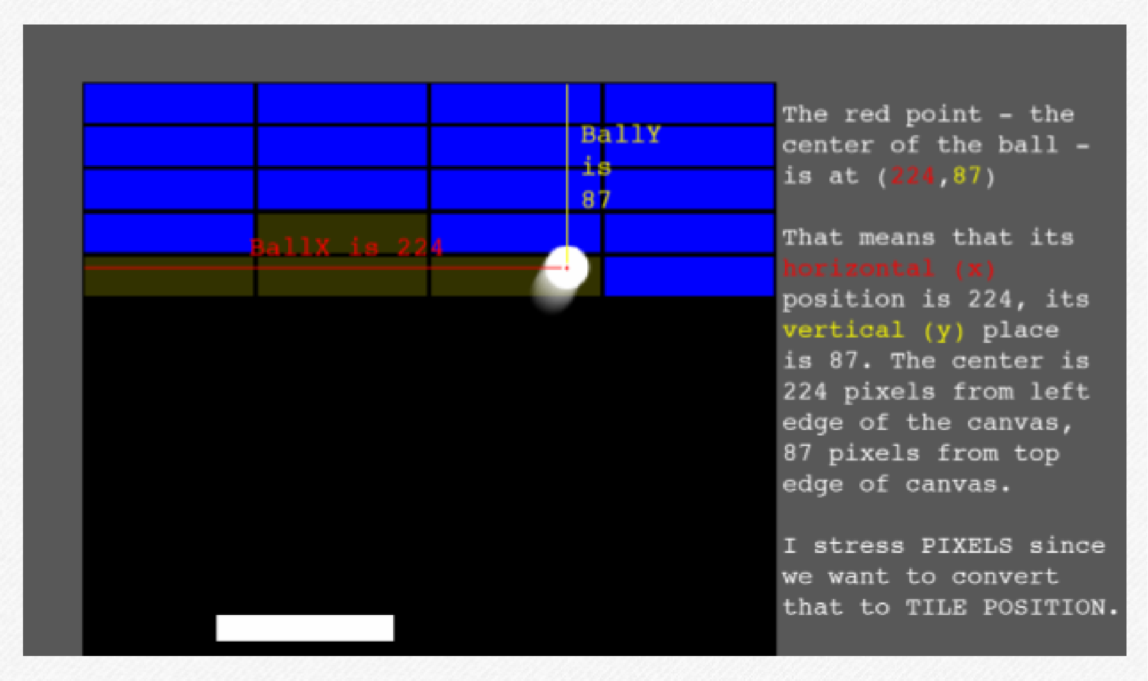
- Then you can use (brickCol + BRICK_COLS_NUMBER*brickRow) to convert from bidimensional to unidimensional coordinate

- Bonus: compare arrays and std::vector as datastructures in c++

Brick collision

- We could check if the ball were inside the brick, or not outside the brick. But it would be a lot of tests each frame.

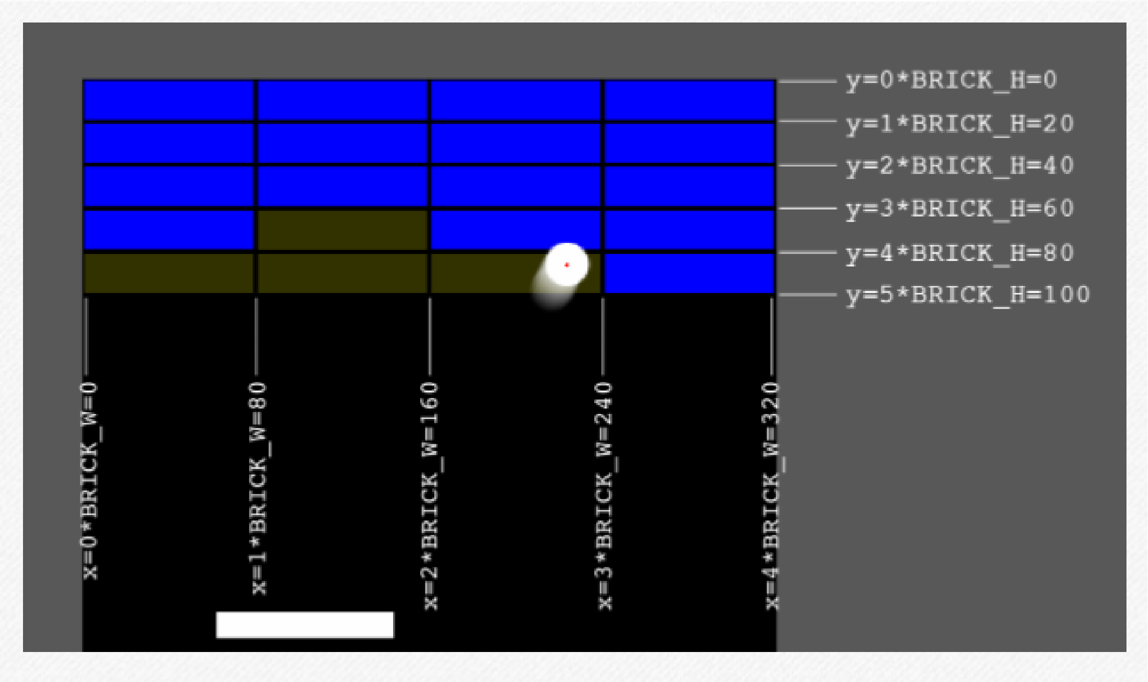
- We rather use a method to know where a point (the ball's center) is on a grid (the grid of bricks).



The red point - the center of the ball - is at (224,87)

That means that its horizontal (x) position is 224, its vertical (y) place is 87. The center is 224 pixels from left edge of the canvas, 87 pixels from top edge of canvas.

I stress PIXELS since we want to convert that to TILE POSITION.



- Dividing the ball coordinates by the bricks' width / height will give you its position on the grid

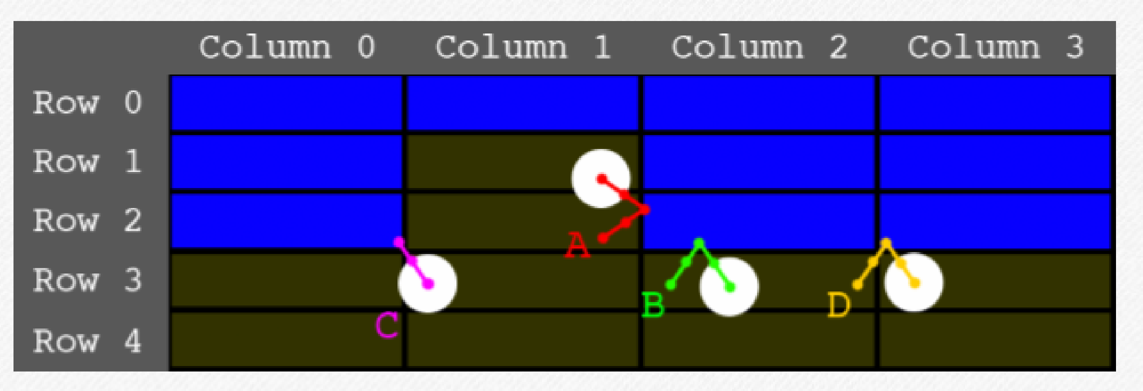
- Erase bricks that "are touched" by the ball, without making the ball bounce

- This method is REALLY important, keep it in mind for similar problems

Ball bounces on bricks

- Inverse the ball's vertical speed when a brick is hit

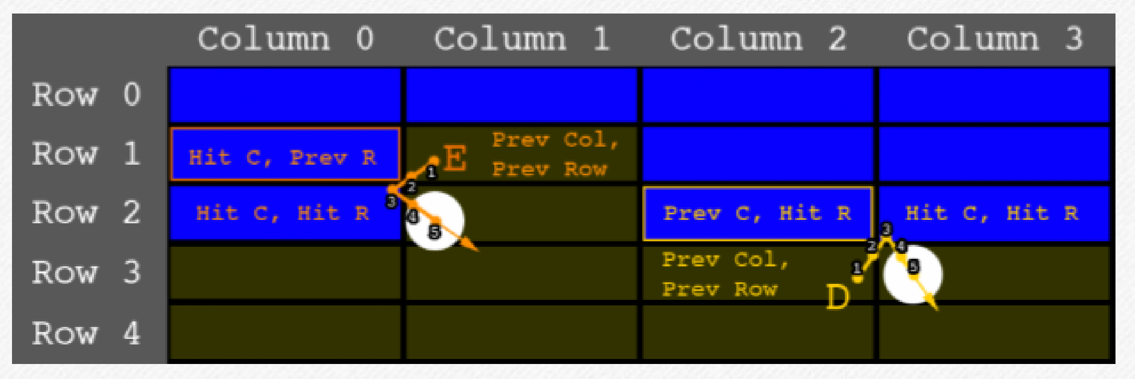
- But we would like different bounces directions if the ball hit an other side of a brick



- The key to solve the problem is to check on which part of the grid the ball was on the frame before (using the ball's speed)

- Did it change column (A) ? Did it change row (B) ? Both (C) ?

- D is a special case. There is also case E, D's vertical counterpart :



- We don't want the C scenario to happen in this case. The difference with C is we cross a diagonal (because of speed) before the collision

- We handle this case by logging the column or row of the previous frame

- There is a last case, where both adjacent sides are blocked by bricks. It only happens in corners, and we should reverse direction like with C

- Debug by adding a code to move the ball to the mouse position with left click, and change vertical/horizontal speed with right click

End game

- Reset bricks when the last one is gone

- Efficiency : keep a counter of the "living" brick number, instead of checking all the array each frame

- Remove the first three rows, and the debug code