Game Overview

The objective of Chain Reaction is to take control of the board by **eliminating your opponents' atoms.**

Players take it in turns to place their atoms in boxes. Once a box has reached critical mass the box explodes into the surrounding boxes
adding an extra atom and claiming the box for the player.
A player may only place their atoms in a blank box or a box that contains atoms of their own colour.
As soon as a player looses all their atoms they are out of the **game.**

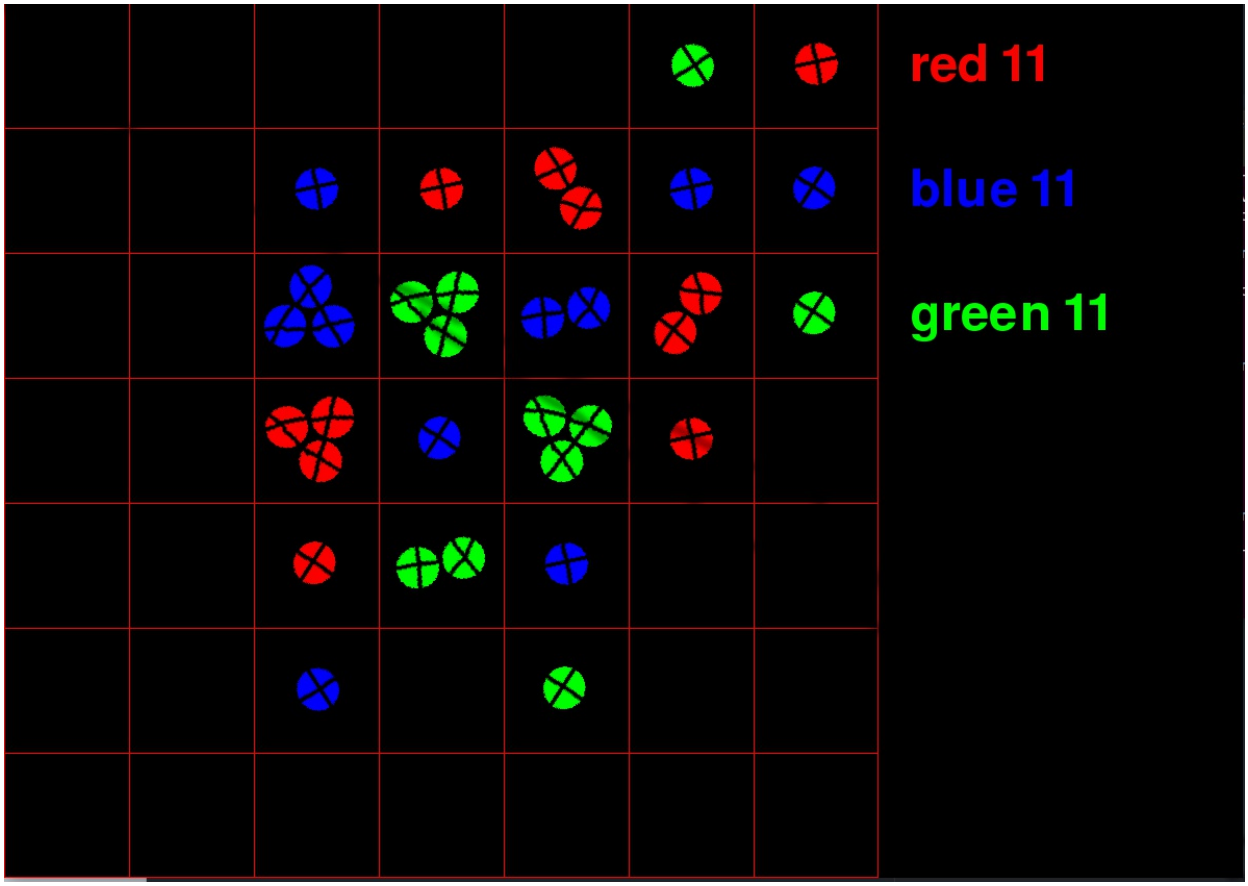
How it Works

there are three important classes
`board` `box` and `animation`

the board contains all boxes
user clicks on a box and adds a atom
then the turns cycle and a user can a place a maximum number of atoms in each type of box
`corner boxes` max of 1 *atom*
`edge boxes` max of 2 *atoms*
`others` max of 3 *atoms*

when a box reaches a maximum it sends its *atoms* to surrounding boxes
and this continues until a certain someone is the only one with atoms

a example of the game is shown



where there are three players `red` `green` `blue`

Implementation

there are a total of **8 source files**

`board.py` *does all the work of handling the game state itself*
`animation.py` *handles all the rendering of box to box movement*
`box.py` *useful encapsulation of a box and its methods*
`player.py` *contains methods related to the player*
`text_render.py` *has functions for text rendering needed across many files*
`end_game.py` *holds all methods to render the winning screen*
`chainreaction.py` *the whole chain of classes begins from here*
`conf.py` *user needs to specify their Configuration in this file*

game assets are stored in assets folder
contains the `atom images` and the `icon`

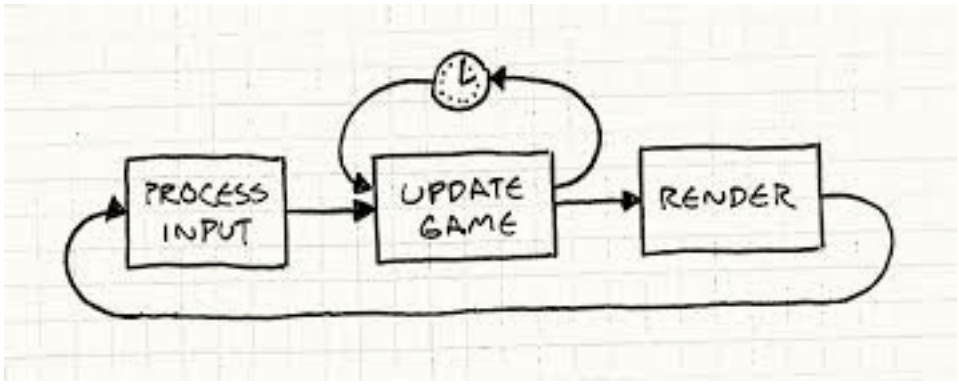
all of this is explained in detail in the following pages

Chain Reaction .py

pygame is initialized here
`board` is constructed from the *conf file*

used functions
`pygame.time.Clock.tick(frames)` *useful timer to vary frames per second of the game* the `frames` specifies thge number of frames to render per second
for example if frames is *60* then this function pauses for 1/60 seconds
`pygame.display.flip` *flips the old screen of the game with the new one*

Game Loop



this is a typical game loop and all games start from here
Process Input
the game state is updated everytime a new event occurs can be `keyboard` `mouse` `voice` etc
when the user clicks a box a click event is sent to board class and stores the event

Update
Now after a event has occured or any other internal change is updated in this *function*
for example in this game the game is updated when the `animation` moves further
or `box atom` rotates

Render
finally after all updates the new *game screen* is shown to the user

Classes

Board

Data Variables:

data: *holds all the data about the game* has duplicates for easy access namely
`self.rows:`
`self.cols`
`self.speed`
`self.multiplier`
`self.img_loc`
`self.rotation_speed`

derived from data
`self.total_box_width` *area of grid*
`self.total_box_height`
`self.total_width` *area of full window*
`self.total_height`

pygame side
`self.w1` *window initialized by pygame*
`self.icon` *icon for the game*

`self.img` *holds all the atom images type list*
has 4 surfaces namely one, two, three atom and animation atom

`self.grid` *holds the grid image -> type surface*

Dynamic containers:

`self.animations` *holds all animations-> set type*
`self.remove_cycle` *holds all animations to be removed -> set type*
`self.box_list` *holds all the boxes -> type list*
`self.players` *holds all the players -> type list*
`self.alive_players` *holds all the alive players -> type list*

Control Variables:

`self.running` *whether any animation is running -> type bool*
`self.main_running` *whether the main game is running -> type bool*
`self.check_end` *when user event has occured and chance has to cycle -> type bool*

`self.animation_owners` *holds owners under animation -> type list*
required because a owner might not be in any boxes and game should not declare it not alive

`self.state` *state of game --*
1 for playing game
2 for in the end screen

`self.count` *hold current total no of turns -> type bool*
`self.end_setup` *if end_game has been setup -> type bool*

Other variables

`self.end_game` *holds all methods for end screen -> type class*
`self.current` *the turn of which player -> type class*

Functions

Init functions

self.initwindow *function to initialize pygame window*

additional info

`pygame.display.set_mode(tuple)` *sets width and height of window*
`pygame.display.set_icon(surface)` *sets the icon as the surface*
`pygame.display.set_caption(str)` *sets the title of the window*

self.make_image *loads atom images*

additional info

`pygame.image.load(str)` *loads the image onto a surface*
the str is the filepath where the atom image is located

`pygame.surface.subsurface(x,y,w,h)` *makes a new surface with parameters*
since the atom images has four images in one subsurface is required

`pygame.transform.scale(surface,(w,h))` *scales the image to the w,h*
this is required to scale the big image to fit inside the box dimensions

the surfaces are then converted to hold alpha value since the background of atom is not needed

self.make_boxes *initialize all boxes*

additional info

to initialize all boxes first the row,col of box is setup
then the box decides what type it is based on row and col
and assumes the location of its surrounding boxes

once all boxes are setup each pos of the surrounding box
is converted into the class object at that position

player setup in board init *initialize all players from data*

additional info
setup all players based on position on the list

self.make_grid *initialize grid surface*

additional info

`pygame.Surface(tuple,flags)` *initialize a surface of w,h*
flag used is pygame.SRCALPHA for holding alpha value too

`pygame.draw.line(surface,color,pos,pos)` *draw of line with required parameters*
this is done in a loop with fixed step to draw lines
this is called again in the end to draw the last line one pos behind
so that it is inside the window

Game Functions

self.user_event(pos) *function which is called when box is clicked*

additional info

if *self.state* is 1
check if click happened inside box dimensions
then generate id for the box based on position
and then only call add_atom when no animation is running
and then set *check_end* to `True` to call cycle

if *self.state* is 2
this is the end_game screen
call `end_game.update` defined in `class end_game`

self.check_change *function to cycle to next player*

additional info

this function first checks `check_end` is `True` or not
if *yes* then check `self.running` if `True` then

call `self.cycle` and set *check_end* to `False`
otherwise do nothing

self.cycle *function to cycle to next player*

additional info

first increment `count`
then cycle to next player with modulus operator on total no of players
`self.count%len(self.players)` *this automatically handles the case of the list reaching the end*

if the next player is not alive then cycle to next player in a while loop

self.run *main game logic function*

additional info

first clear the screen

if `self.state` is 1
this is the main game state
call `self.update` then `self.render`
then update the running state and update alive players
if there is only one alive then move to end_game by setting `self.state` to 2

then render the player atom count and the sidebar
then call check_change to check if turn has to be cycles

if `self.update_disp` is `True`
this happens when player atom count changes so that the display count can be updated on the next run

if `self.state` is 2
first check if `self.end_setup` has been done this is needed as the winner surface has to be made after `self.state` has been changed to 2 by the main game state
but this doesnt have to be called every run

then call `end_game.render` to handle the end_game logic

self.reset_all *function to reset the game if reset is called in end_game*

self.render *function to render the grid and atoms*

additional info

first to blit the *grid*
if animation is running then render a white grid
else render the grid with color of the current player

then call `box.render` to render the atoms
then call `animation.render` to render all animations

self.update *function to update game state*

additional info
if `board.remove_cycle` has animations then *remove them*
called when remove_cycle length is not zero

then call `box.update` to update all boxes
then running is set to `True`

then update all *animations*

self.remove_animation(animation) *this function adds animation to remove_cycle*

additional info
this function is used by animation class to add itself to remove_cycle
then the animation has completed

self.remove_all *this function removes all animations in remove_cycle*

self.add_atom(index) *this function adds an atom to the box*

additional info

first checks if the box specified has a owner
if yes then check if it matches with the current player
if not set ret to False

if box has no owner then add owner as the current player to the box

then add atom if passed condition

Animation

Data Variables

`self.main_board` *pointer to baord object*
`self.direction` *direction of the animation up, left, down, right -> type dict (x,y)*
`self.speed` *speed of atom -> type int*
`self.dest` *holds the destination location of atom -> type dict(x,y)*
`self.box_from` *the box who exploded*
`self.box_to` *the box where exploded atom reaches*
`self.owner` *holds the owner of the box who made this animation ->*

this is needed as *box_from* owner will become `None` after animation is made

Dynamic Variables

`self.curr_loc` *holds the current location of atom -> type dict (x,y)*
updated every frame

Init Functions

self.init(box_from,box_to,speed)

additional info

direction is created by using `self.create_vector`
then this player is added to `animation_owners` of *main_board*
so that the player is is still alive when none of it is on the box

Logic Functions

self.render *displays the atom on the screen*

used functions `pygame.surface.blit(surface,loc)` *copies the surface on the surface instance called from*

additional info
`self.owner.img[3]` is the *image* of the animation *atom*

self.update *updates the position of the atom*

additional info
`self.curr_loc` is first incremented by *direction x speed*
then `self.check_completion` is called to check if atom has reached `box_to`

self.check_completion *checks if atom reached destination*

additional info
dot product along direction is compared between `self.curr_loc` and `self.dest` to check if atom has reached destination

self.completion_event *performs everything needed to end animation*

additional info
first this `animation` is removed from `main_board.animations`

then this `animation` is added to `box_to` events
this *animation* is removed from `main_board.animation_owners` by `box_to` after it updates

Mathematical Functions

animation.create_vector(box_from,box_to) *creates direction from from to to*

animation.dot(vec1,vec2) *performs dot product of vec1 and vec2*

Box

Data Variables

`self.main_board` *the board class pointer*
`self.surrounding` *the surrounding boxes*
`self.holding` *the number of atoms currently held*
`self.max` *the maximum number of atoms it can hold*
`self.rotate_dir` *the direction of rotation*
`self.speed` *the rotation speed of the atom* `self.row` *the row of box* `self.col` *the column where the box is*

`self.pos` *the location of box on the screen -> type list*
calculated by multiplying `self.col` and `mainboard.multiplier`

Dynamic Variables

`self.angle` *the current angle of the atom (from 0 to 360)*
`self.events` *holds all events to be taken -> type list*

Init functions

self.init(main_board) *creates a new instance*

self.setup(row,col) *calculates surrounding box position*

additional info

first appends to `self.surrounding` , the positions of its surrounding
based on its position
then `main_board` will replace `self.surrounding` with the box object at that position

Logic Functions

self.update *process events*

additional info

if there is a event - *that is a* `animation` is in the `self.events` then
take color from it
if current owner is not `None`
then remove current owner `means` *the new owner* has remoced the old one
then add the new `self.owner`
the add method on owner side sets `self.owner` by itself while adding this box to its list
then add atom
then remove the new owner from `main_board.animation_owners` since it has come back to the box
finally remove *animation* from the game by popping it from the list
then update rotation angle of the atom

self.render *renders the atom inside the box*

used functions
`pygame.transform.rotate(surface,angle)` *rotate the image by angle*
`pygame.surface.blit(surface,loc)` *copies the surface on the surface instance called from*

additional info
when rotating the image the image gets padded with extra space since a pygame surface is always a rectangle pixel data
so need to render by center so that the atom doesnt move down
so some extra math to determine the position

self.add_atom *adds atom to box and explodes if needed*

self.expode *add animation to surrounding*

additional info

first make animations from this `box` to the `surrounding`
next remove `self.owner` and `self.owner`
and then set holding to zero

Player

Data Variables

`self.main_board` *the pointer to board*
`self.name` *name of player*
`self.name_surface` *text rendered name*
`self.img` *the surfaces of atoms,grid in its color*
`self.grid` *the grid surface in its color*
`self.color` *the color of player*
`self.pos` *the postiion od player in the game sidebar*
`self.holding_pos` *the position of atom count surface on sidebar*

Dynamic Variables

`self.alive` *well you are right*
`self.boxes` *the boxes it owns*
`self.holding_text` *the holding number surface*

Init functions

self.init(main_board,data,pos)

functions used
additional info
first color of the white surfaces are changed to its color
then creates surfaces for name and updates it on the screen

player.change_color(surface,color) *changes color of the surface*

used functions `pygame.surfarray.pixels3d(surface)` *returns a pixels structure [row[col[red,green,blue]]]*
`pygame.surface.copy` *copies the surface*

additional info
the pixel3d function returns a pixel list which directly refers to the surface pixels
now change the rgb component of each pixel to the `self.color`
the alpha component is untouched

Logic functions

self.add_box(box) *adds box to* `self.boxes`

additional info
first box is added to list
now player is alive since he will always have atleat one box after adding 1 box the

`main_board.update_disp` is `True` since the sidebar needs to be updated

self.rem_box(box) *removed box from* `self.boxes`

additional info
first box is removed to list
now player can or can not have no boxes so `self.alive` is from len of `self.boxes` the `main_board.update_disp` is `True` since the sidebar needs to be updated

self.render *renders to game sidebar*

used functions
`pygame.surface.blit(surface,loc)` *copies the surface on the surface instance called from*

self.update_holding *updates* `self.holding` *of the player*

additional info
the holding of each box is added up and a new surface with that number is created

End Game

Data variables

`pygame.Rect` *a structure holding w,h,x,y of a rectangle ,used to render the buttons*
`self.main_board` *pointer to main_board*
`self.again` *surface for play again button*
`self.again_rect` *rectangle for the surface*
`self.end` *surface for end game button*
`self.end_rect` *rectangle for the surface*

Init Functions

self.init(main_board)

used functions
`text render class` *used to render text*

additional info
text is rendered and positioned based on the `dimesions` of the game `window`

self.setup *creates the winner text surface*

additional info

this function is called when a *player* wins and
a surface containing their name is made

self.update(pos) *function to take click event*

used functions
`pygame.rect.collidepoint(pos)` *checks if the point defined by pos is inside the rectangle*

additional info
the *buttons* `again` and `end` are defined by rectangles
so when the use clicks any pos it checks if the point is inside
the rectangle

self.render *renders the button and winner surface*
used functions `pygame.surface.blit(surface,pos)` *copies the pixels of surface onto the surface instance from which it is called*

Helper files

Text Render

Used Functions

`pygame.font.SysFont(font_str,size)` *creates a font renderer with the name of font and size*
`pygame.font.SysFont.render(str,bool_alias,color)` *renders str with color*
antialias flag specifies if the text needs to have smoothened edges

Configuration File for the Game

this contains all the info needed to init the game

Specification

data
`rows` *the number of rows -> type int*
`cols` *the number of cols -> type int*
`multiplier` *the size of box (it is a square) -> type int*
`speed` *the speed of atom when moving from box to box -> type int*

`rotation_speed` *the range of speed of rotation of atom -> type tuple*
`icon_loc` *the path to icon -> type str*
`img_loc` *the path to atom images -> type str*
`fps` *the frames per second of the game*

player data
the player data is a list with each player as a dict under a specific criteria

specification of player data
`name` *name of the player -> type str*
`color` *color of the player -> type tuple(r,g,b)*

Example Configuration

```
data = {
"rows":7,
"cols":7,
"multiplier":75,
"speed":6, #speed of box to box movement
"icon_loc":"assets/atoms_c.ico",
"img_loc":"assets/atoms.png",
"title":"chainreaction2d",
"fps":75,
"rotation_speed":(7,9),
}
```

```
players = [
{"name":"red","color":(255,0,0)},
{"name":"blue","color":(0,0,255)}, {"name":"green","color":(0,255,0)},
{"name":"yellow","color":(255,255,0)},
{"name":"orange","color":(255,165,0)},
{"name":"turquoise","color":(64,224,208)}
]
data["players"] =players
```