

Comp 388/488 - Introduction to Game Design and Development

Spring Semester 2017 - Week 5

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Contents

- Python and Pygame
 - *basic drawing, colours...*
- Games and formal structure
- Games and engagement
 - *learning to play again...*
- Games and development
- References

Python and Pygame - basic drawing

intro

- Pygame supports various options for drawing to a specified game window
 - *including defined functions for existing shapes*
 - *or custom shapes using lines and a mixture of shapes*
- built-in functions to help draw pre-defined shapes, e.g.
 - *rect* - rectangle shape
 - *circle* - circle shapes drawn around a defined point
 - *line* - draw a straight line
 - *aaline* - anti-aliased line
 - *lines* - draw multiple contiguous lines
 - *aalines* - anti-aliased lines
 - *polygon* - draw a shape with a defined number of sides
 - any number may be chosen...
 - *ellipse* - a round shape contained within a rectangle
 - *arc* - draw a partial section of a standard ellipse

Python and Pygame - basic drawing

drawing with rect

- we may start by adding a rectangle to our existing Pygame window, e.g.

```
pygame.draw.rect(window, WHITE, (200, 200, 100, 50))
pygame.draw.rect(window, CYAN, (300, 150, 100, 100))
pygame.draw.rect(window, MAGENTA, (400, 100, 100, 150))
```

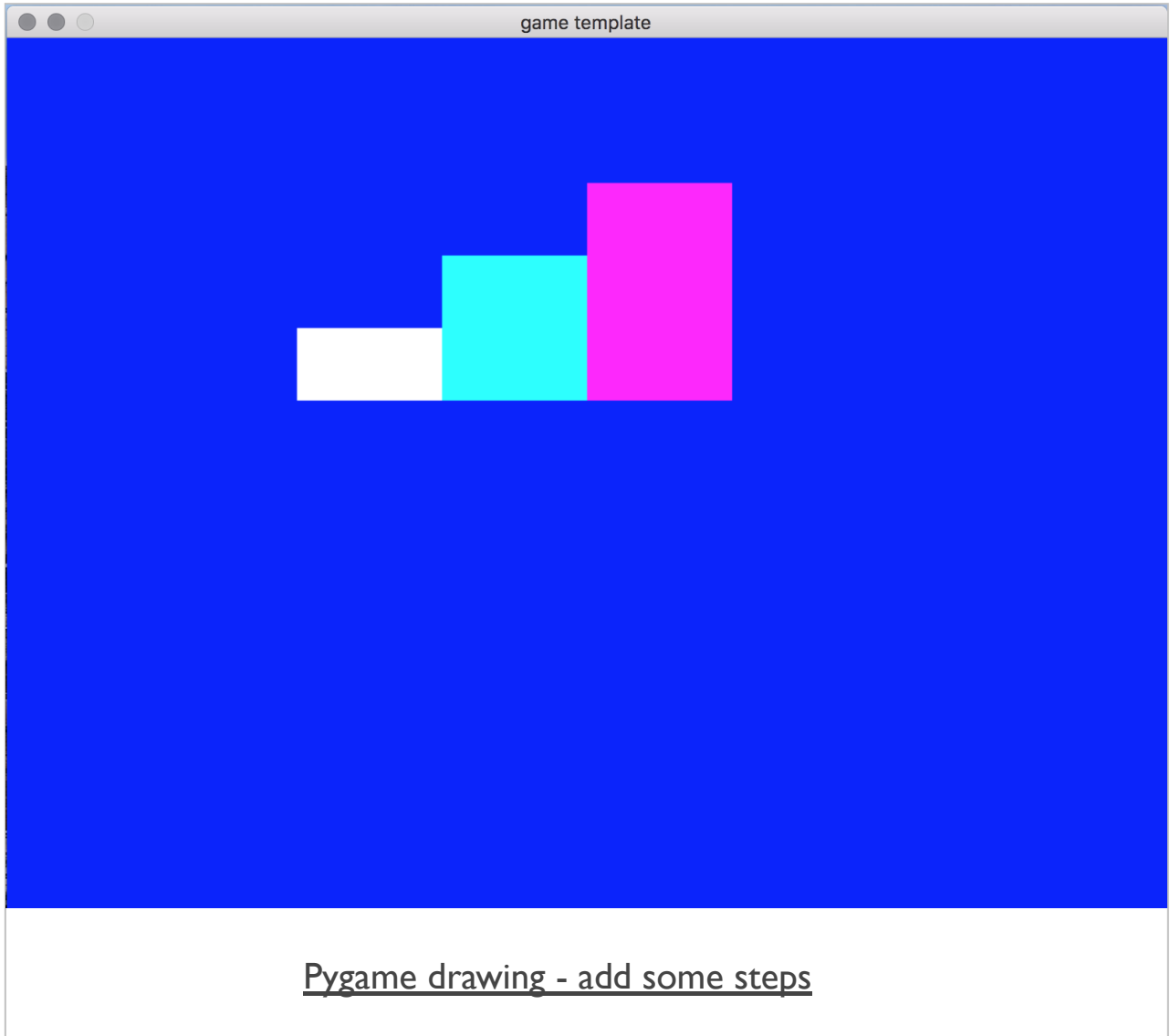
- parameters for these functions use the following example pattern
 - *where we want to draw the shape*
 - e.g. the Pygame window
 - *the RGB colour for our shape*
 - e.g. (255, 255, 255)
 - *pixel coordinates for drawing the shape*
 - x and y coordinates
 - x = position of left side of shape from left side of window
 - y = position of top of shape from top of window
 - *and the size of the shape*
 - width and height in pixels

```
pygame.draw.rect(WHERE, (R, G, B), (X, Y, WIDTH, HEIGHT))
```

- we may create some steps using the rectangles...

Image - Pygame Drawing

Example I - some steps



Python and Pygame - colours

working with RGB - part I

- clearly defined pattern we may use to work with colours in Pygame
- each colour is defined using the standard RGB primary colours
 - *Red, Green, Blue*
- we may then start to create our secondary colours
 - *as variants and combinations of these three primary colours*
- e.g.
 - *cyan = blue + green*
 - *magenta = blue + red*
 - *yellow = green + red*
- we may also create base colours for *black* and *white*. e.g.
 - *black = no colours*
 - *white = red + green + blue*

Python and Pygame - colours

working with RGB - part 2

- to create a particular colour
 - *defining how much of each primary colour we require mixing*
- mixing uses a known scale from **0** to **255** for each primary colour
 - *therefore giving a possible 256 points per colour on the scale*
- we may define some colours as follows
 - *red = rgb(255, 0, 0)*
 - *green = rgb(0, 255, 0)*
 - *blue = rgb(0, 0, 255)*
 - *cyan = rgb(0, 255, 255)*
 - *magenta = rgb(255, 0, 255)*
 - *yellow = rgb(255, 255, 0)*
 - *black = rgb(0, 0, 0)*
 - *white = rgb(255, 255, 255)*
- consider the sheer number of colour options for this scale
 - $256 * 256 * 256 = \mathbf{16,777,216}$
- over 16 million possible colour variations
 - *for our game's design and rendering*

Python and Pygame - basic drawing

drawing with circle

- also draw circles on a Pygame window using `circle()`
- instead of simply passing a width and height
 - *need to define a radius and a point around which the circle may be drawn*
- we can draw a circle, e.g.

```
pygame.draw.circle(window, WHITE, (150, 100), 30, 0)
```

- this equates to the following parameters

```
pygame.draw.circle(WHERE, (R,G,B) (X, Y), RADIUS, LINE_WIDTH)
```

- `LINE_WIDTH` represents the width of the line used to draw the defined circle
 - *0 = a circle that is filled in with the defined RGB colour*
 - *2 = rendered circle would be empty with a 2 pixel wide outline*

Image - Pygame Drawing

Example 2 - circle fill

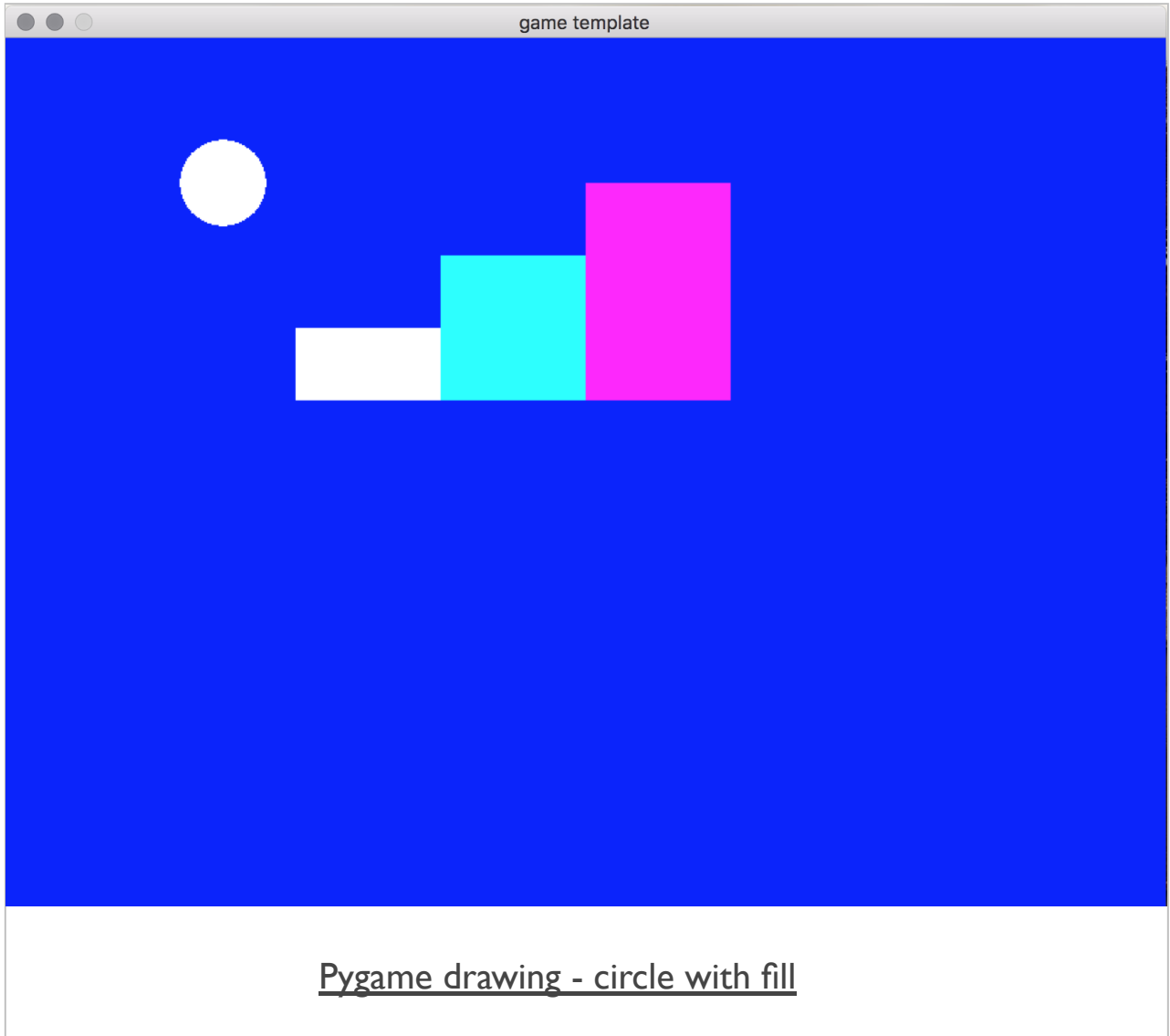
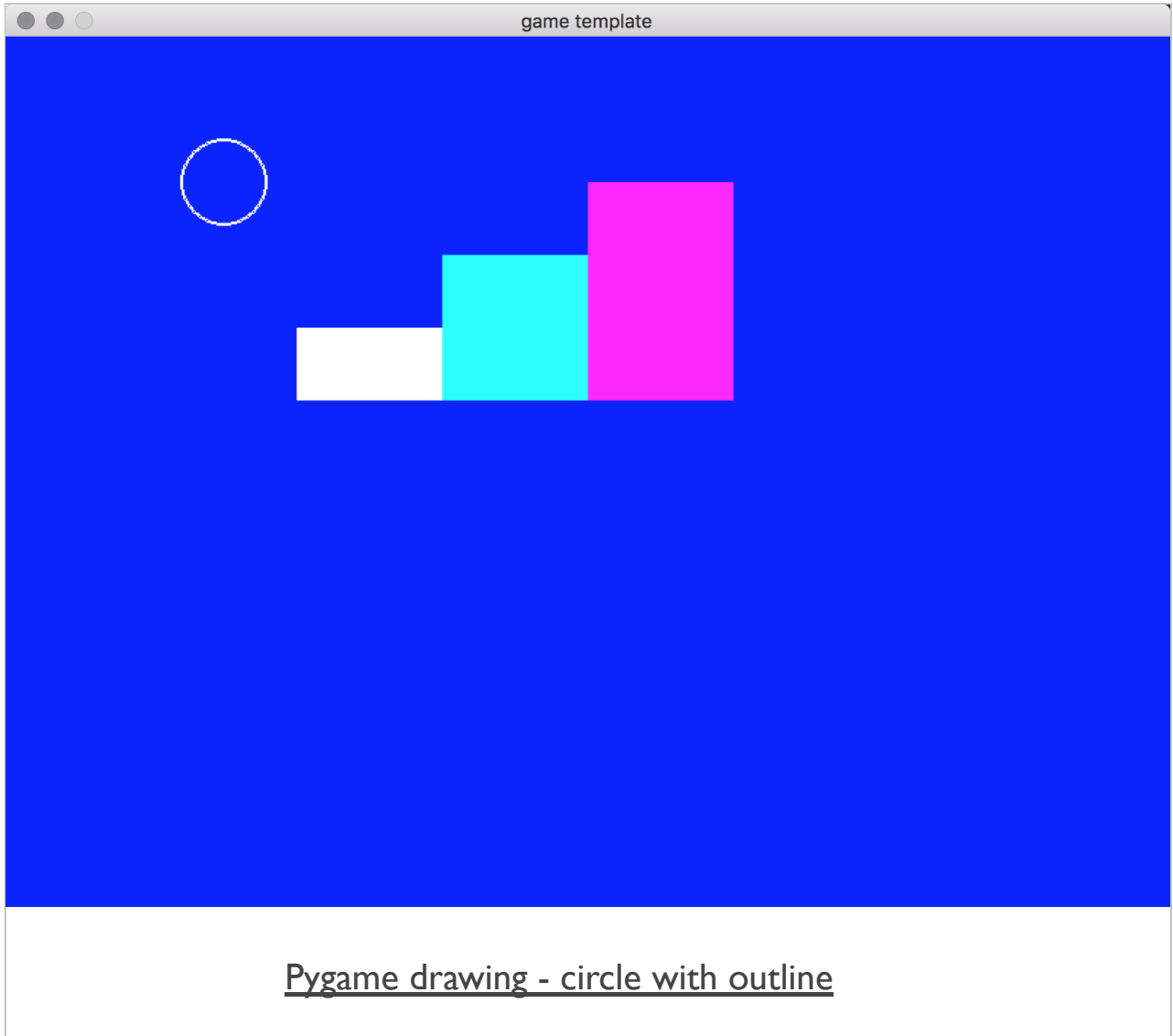


Image - Pygame Drawing

Example 3 - circle outline



Python and Pygame - basic drawing

drawing with ellipse

- draw ellipses using a similar pattern to drawing a rectangle, e.g.

```
pygame.draw.ellipse(window, GREEN, (200, 50, 100, 30))
```

- also possible to create circles using an ellipse
 - *simply set the width and height parameters to the same value*
- create a rectangle with the same values as our ellipse
 - *the ellipse fits exactly within our rectangle, e.g.*

```
# draw an ellipse & containing rectangle - extra 2 is for width of rect  
pygame.draw.ellipse(window, GREEN, (200, 50, 100, 30))  
pygame.draw.rect(window, GREEN, (200, 50, 100, 30), 2)
```

Image - Pygame Drawing

Example 4 - ellipse

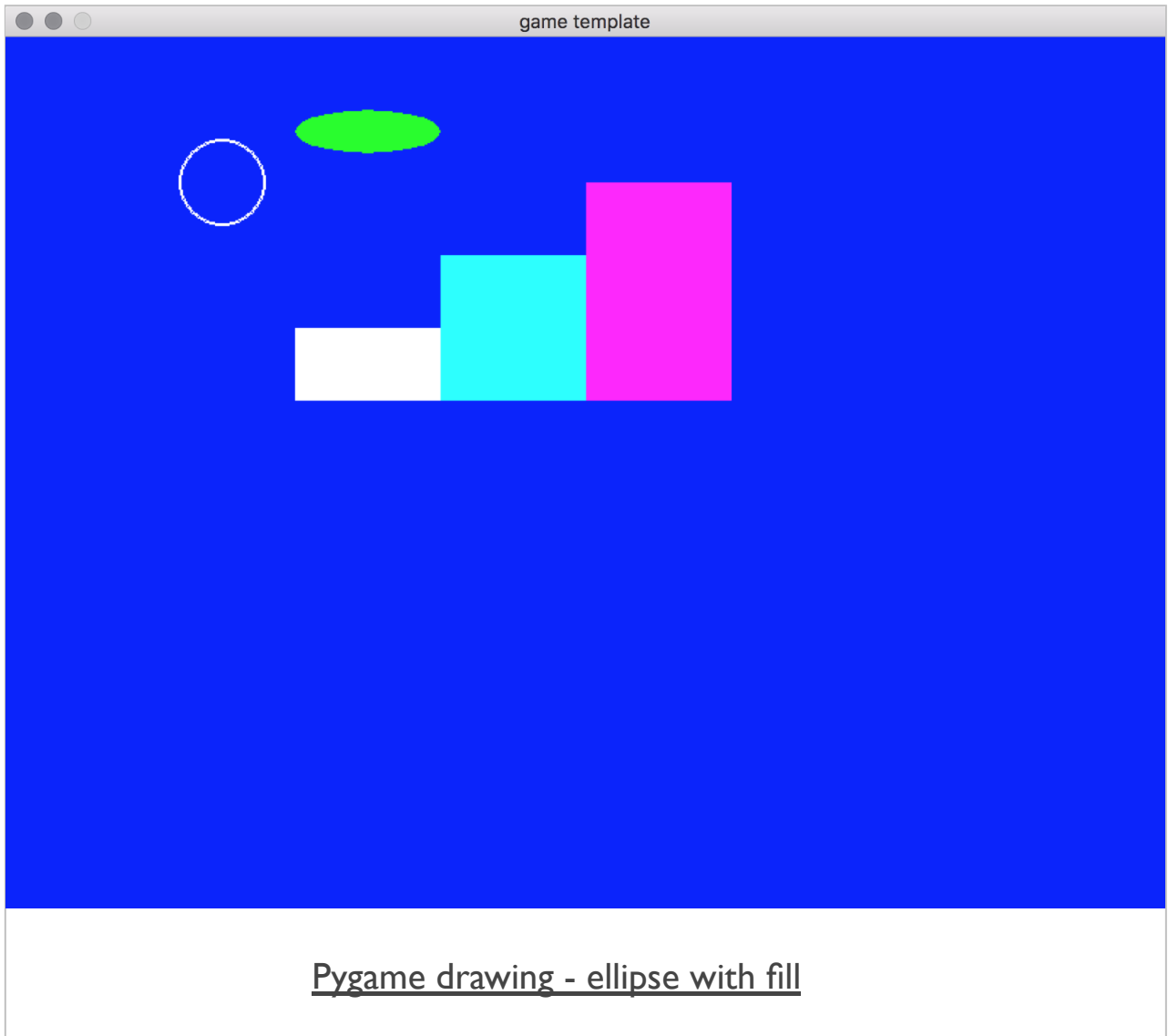


Image - Pygame Drawing

Example 5 - ellipse with bounding



Python and Pygame - basic drawing

drawing other shapes...

- create triangles and other shapes, including a pentagon, hexagon, or octagon
 - *can't use an existing function*
- instead, we need to use **paths**
 - *allow us to draw such irregular shapes*
- able to draw these shapes by defining points on our canvas
 - *then drawing lines between these points*
 - *filling the shape with a defined colour where necessary*
- draw a line using the following example,

```
pygame.draw.line(window, WHITE, (250, 250), (175, 175), 1)
```

- same general pattern as other shapes
 - *add where to draw the line, and the RGB colour*
 - *add a tuple for the X and Y coordinates of the line's start position*
 - *add the X and Y coordinates for the end of the line*
 - *add the width of the line to draw*
- use `lines()` to combines multiple lines to draw various shapes, e.g.

```
pygame.draw.lines(window, WHITE, True, ((400, 350), (450, 400), (350, 400), (300, 350)), 1)
```

- add `True` argument to tell Pygame to close the shape
 - *if set to `False`, the last line will not be drawn...*

Image - Pygame Drawing

Example 6 - lines and shapes

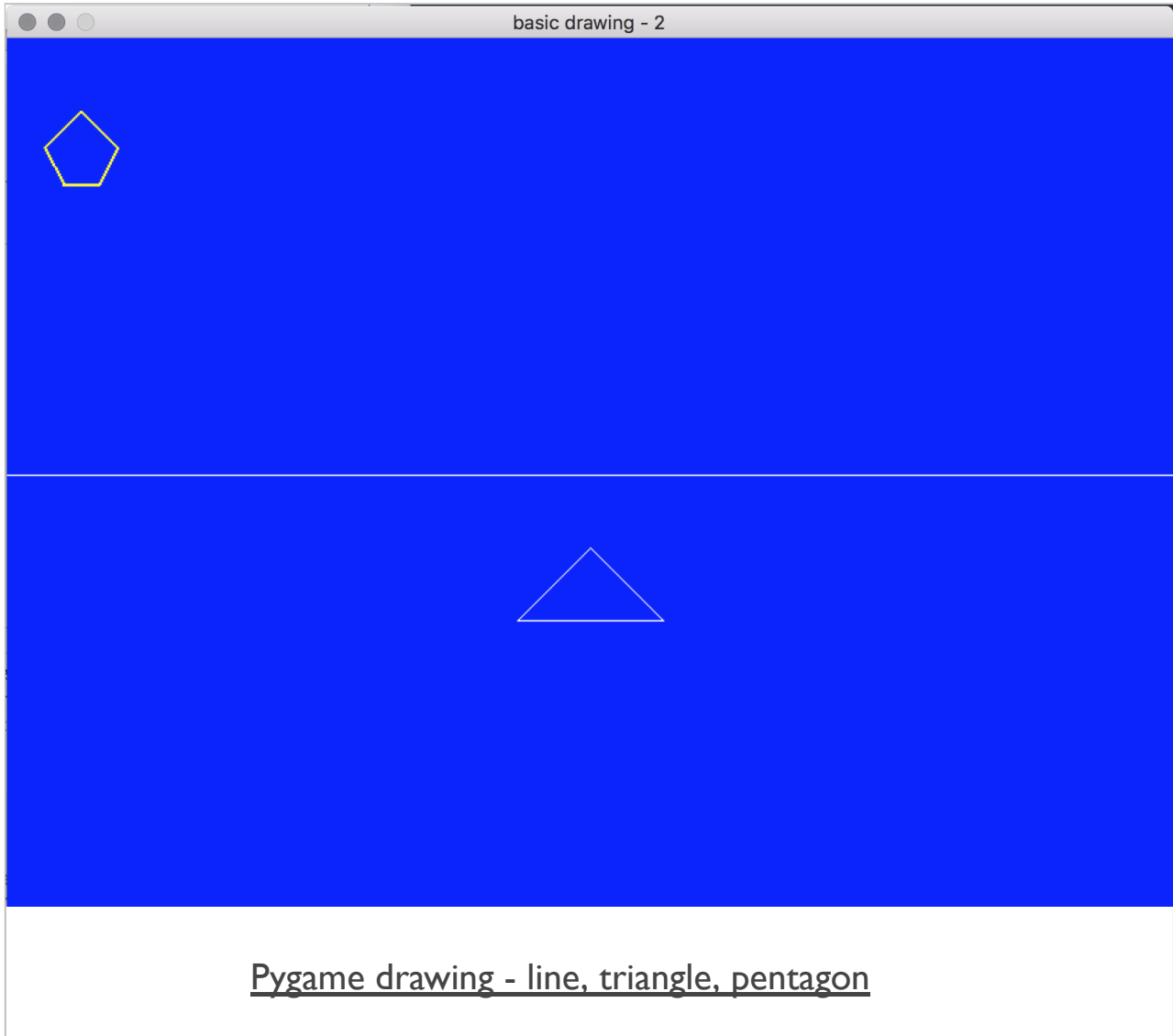
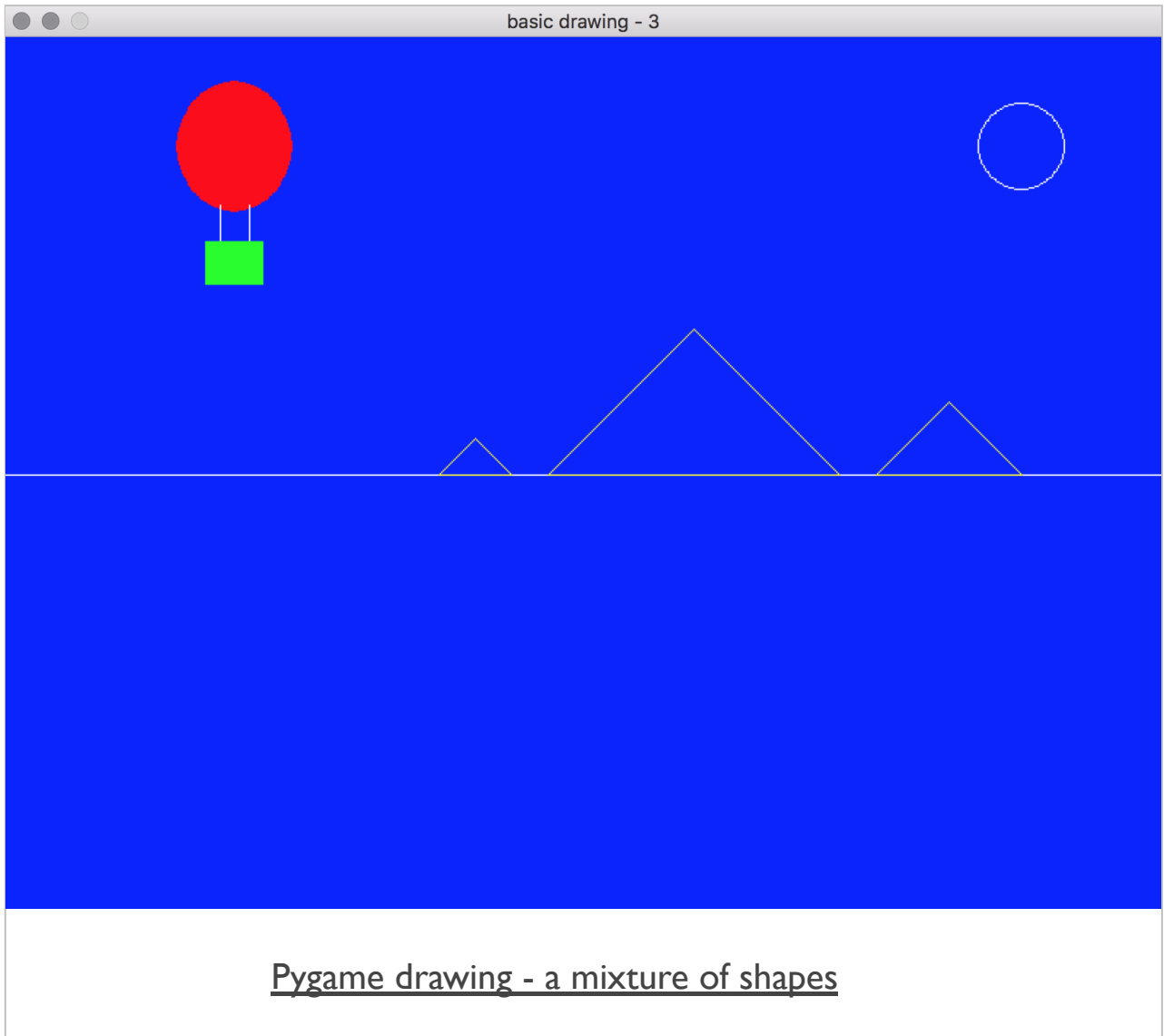


Image - Pygame Drawing

Example 7 - combo drawing



Python and Pygame - moving shapes

basic animation - to the right

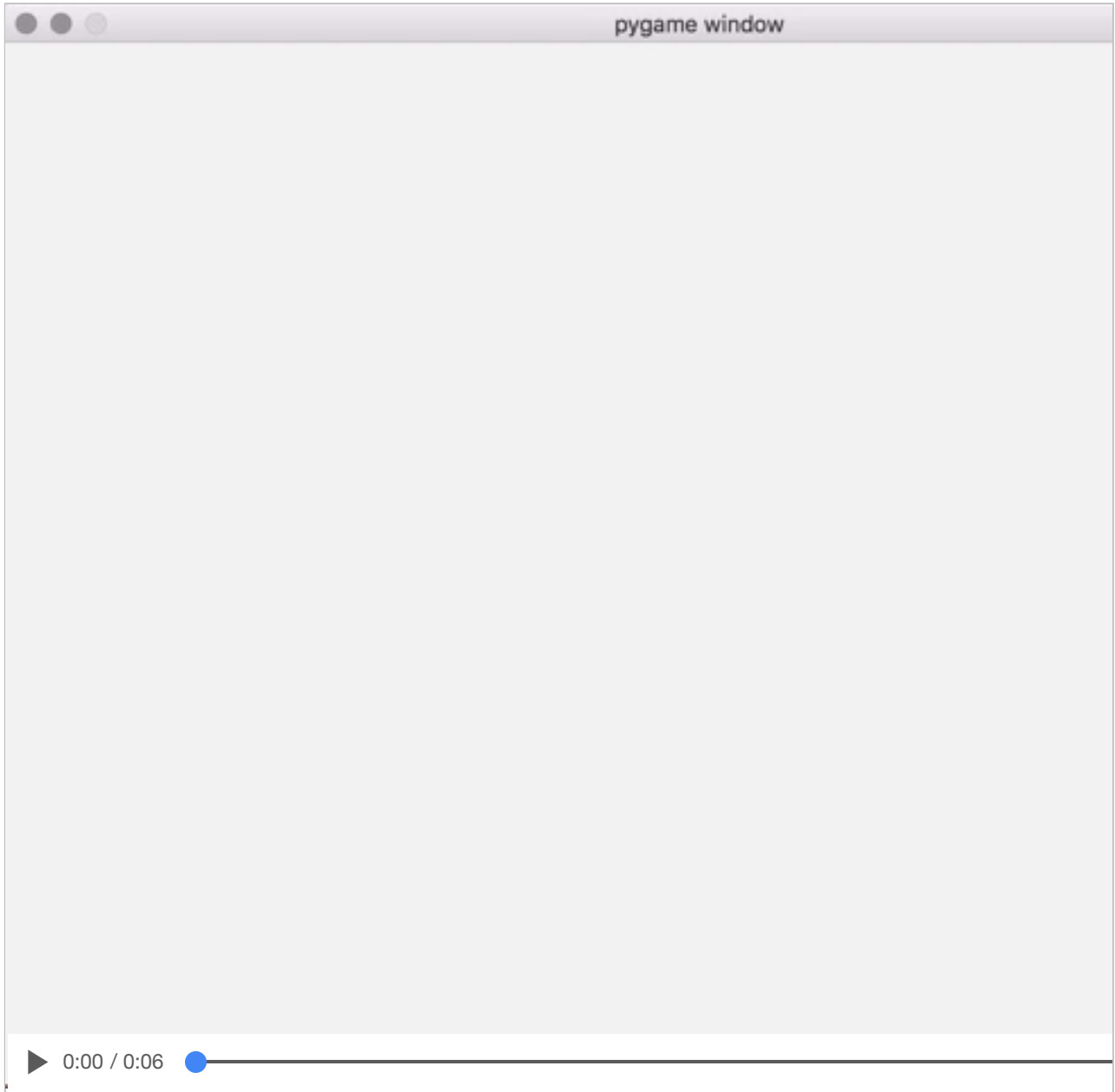
```
...
# rect coords...start at the centre
rectX = winWidth / 2
rectY = winHeight / 2

# create game loop
while True:
    # 'processing' inputs (events)
    ...
    # 'updating' the game
    # modify rectX by 4 pixels - higher creates impression of faster ani
    rectX += 4
    # 'rendering' to the window
    window.fill(WHITE)
    # draw rectangle
    pygame.draw.rect(window, GREEN, (rectX, rectY, 15, 10))
    # 'flip' display - always after drawing...
    pygame.display.flip()
```

- add some variables for the rectangle we want to animate
 - set the X and Y coordinates to the centre of the window
- then modify the game loop
 - add 4 pixels to the X coordinate of the rectangle per update
- then draw the rectangle to the game window as part of the rendering
- either update or flip the game window to show animation

Video - Moving Shapes

basic animation - move to the right



Python and Pygame - moving shapes

basic animation - different directions...

- make the rectangle move to the left side of the screen
 - *again, modify the value of the `rectX` variable*
 - *need to remove pixels to make it go to the left*

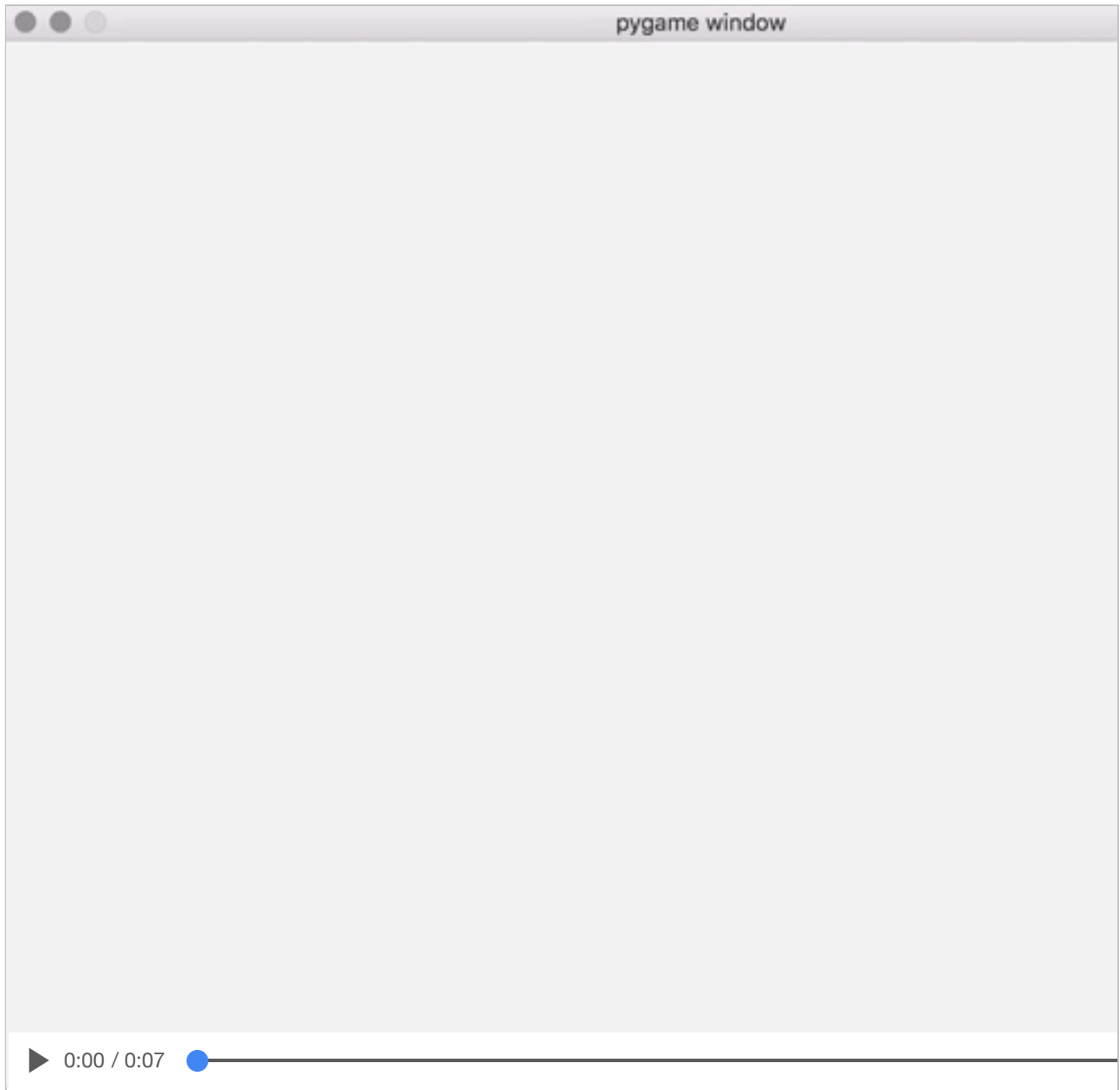
```
...  
# modify rectX by 4 pixels  
rectX -= 4  
...
```

- also make our rectangle move at an angle
- might want to move it an angle down the screen
 - *add a variable for the vertical X and Y coordinates*
 - *incrementally modify to create the angle of animation down to the right*

```
...  
# modify rect coordinates to create angle...to the right and down  
rectX += rectVX  
rectY += rectVY  
rectVX += 0.2  
rectVY += 0.2  
...
```

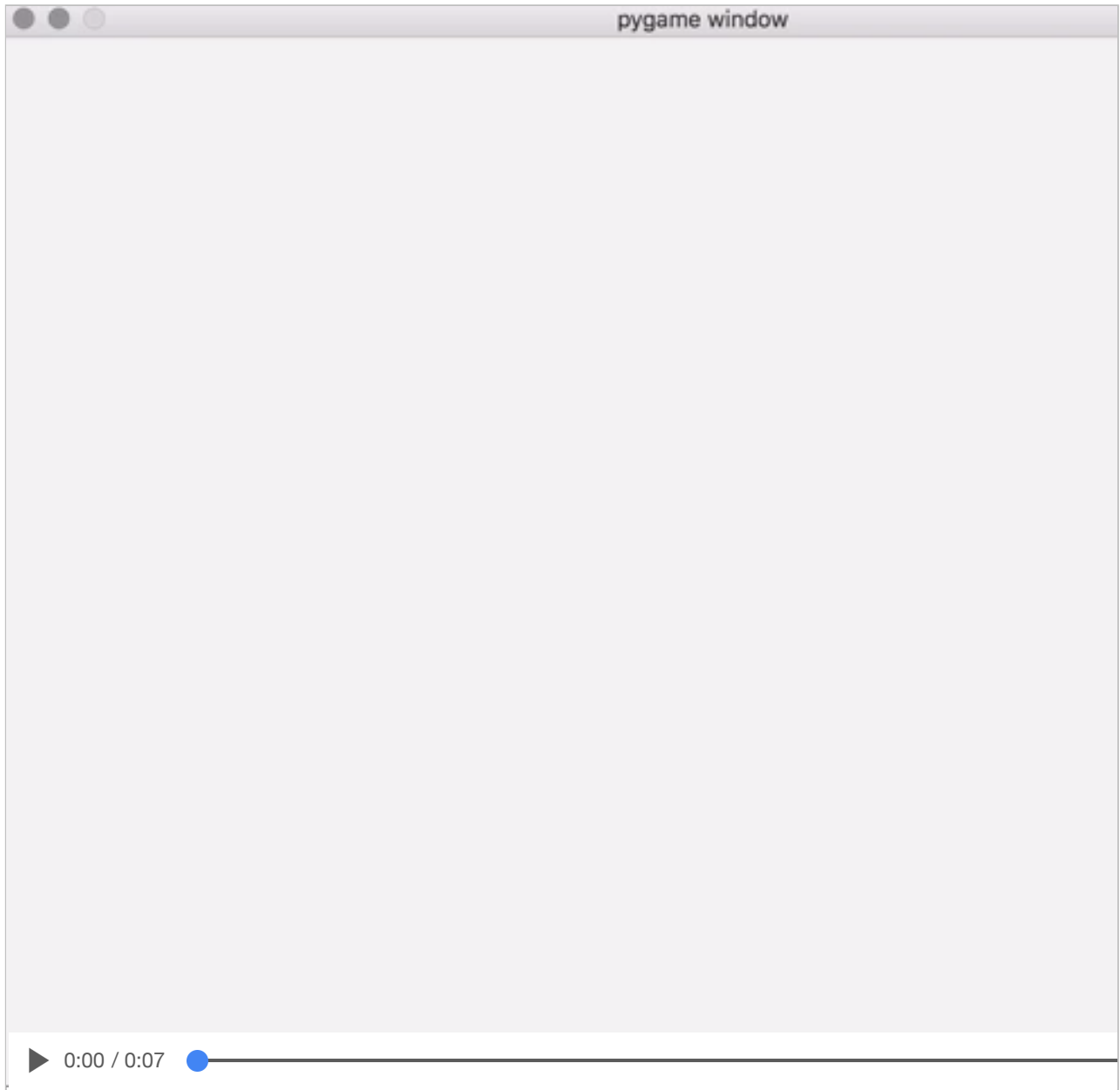
Video - Moving Shapes

basic animation - move to the left



Video - Moving Shapes

basic animation - move at an angle



Python and Pygame - moving shapes

basic animation - different directions...

- modify coordinates using the following pattern
- enough directions for our shapes to be able to recreate many classic games

```
      -x -y    -y    +x -y
        \    |    /
         \    |    /
-x ----- shape ----- +x
        /    |    \
       /     |     \
      -x +y    +y    +x +y
```

Moving in different directions...

Python and Pygame - moving shapes

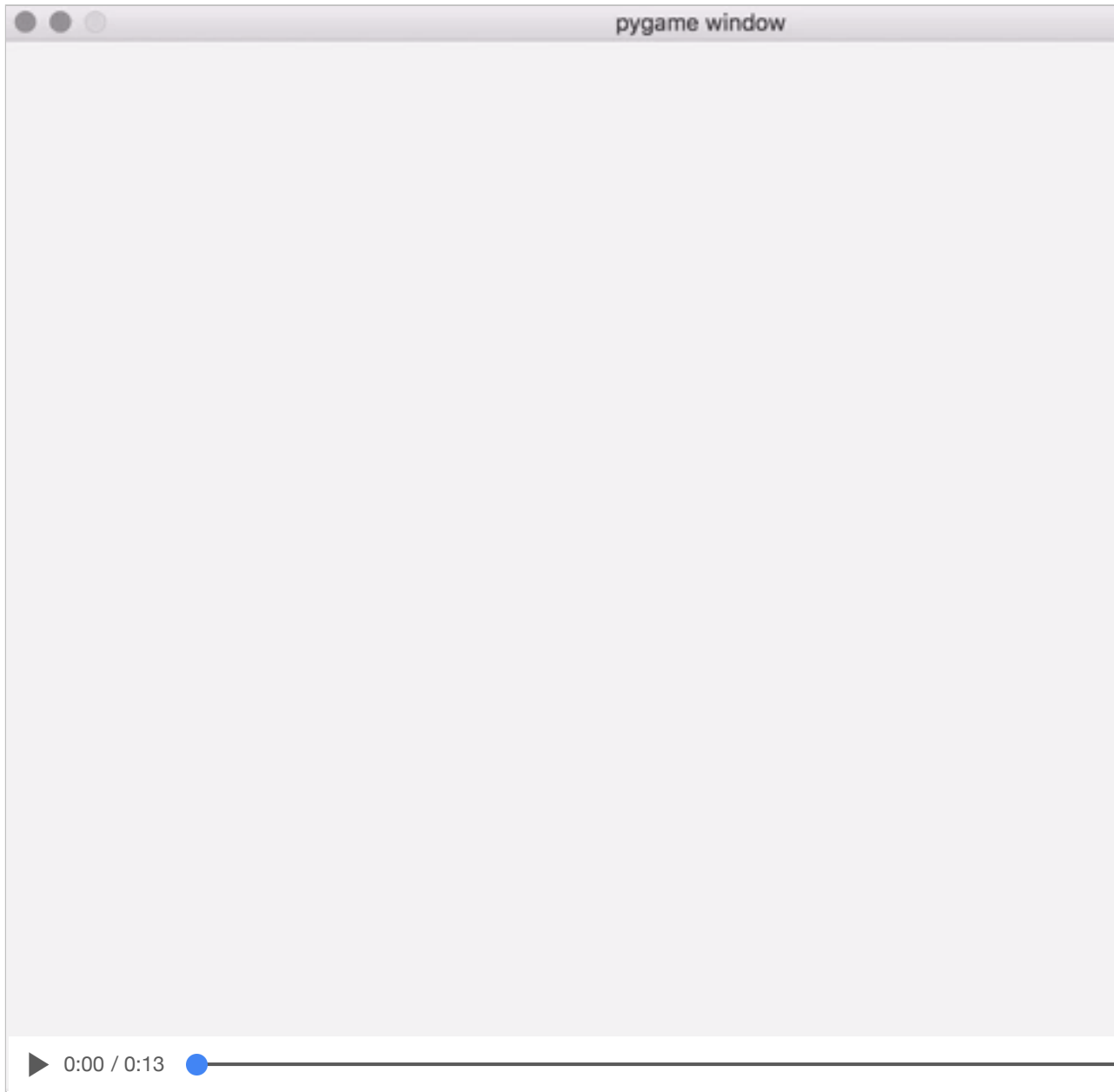
basic animation - check position

- as our shape moves across the screen
 - *may want to check that it doesn't simply disappear from one side*
- add a check for the position of the shape
 - *then reset its coordinates*
- e.g. if we animate our shape from the left side to the right side
 - *we may want it to keep moving from one side to the other*
 - *add a simple check for the value of the shape's X coordinate*
 - *add to the update section of the game loop*

```
# check position of rectX
if rectX > winWidth:
    rectX = 0.0
```

Video - Moving Shapes

basic animation - move from side to side



Python and Pygame

extras

- more Python and Pygame next week
 - *more drawing, animation, interaction and controllers...*
 - *game demo*
- check course GitHub account for
 - *extra notes, various documents - notes*
 - *examples & templates - source*

Games and formal structure

procedures

- player's consideration and perspective of gameplay and objectives
 - *predicated on a clear understanding of procedures and rules*
- for example,
 - *to be able to act as the player in the chosen game*
 - *to actually know what they can and can't do to complete defined objectives*
- procedures allow us as designers and developers to clearly define
 - *how the player may interact with the game*
 - *and modify the interactive nature of the game*
- e.g. in *Draughts*, each player is allowed to
 - *pick up their own pieces*
 - *then physically move them around the board*
 - *they may also stack pieces*
 - *remove their opponents pieces...*
- e.g. in *Space Invaders*, each player may interact with a physical device
 - *to control their spaceship*
 - *fire their cannon*
 - *select game options...*
- such procedures may be abstracted from the game specific rules

Games and formal structure

rules

- a game's rules may be simple or complex
 - *sometimes to the point of a short novel*
 - *but their intention still remains the same*
- creating a set of clearly defined parameters
 - *what a player can and cannot do to achieve the game's objectives*
- rules may also be used to clarify
 - *what does and does not happen when patterns are matched in a game*
- e.g. in *Draughts*, by completing a certain move
- e.g. in *Space Invaders*, by successfully killing all of the advancing aliens
- some of these rules may be used to define objects
 - *such as the pieces in Draughts or the weapons in Space Invaders*
- others may deal with gameplay concepts
- the very nature of procedures and rules infers a sense of authority
 - *they still require additional structures to enforce them within the game*

Games and formal structure

boundaries

- boundaries help us enforce certain procedures and rules
- using boundaries, to some extent, we may ensure that players of our game
 - *need to adhere to rules to be able complete their objectives*
- e.g. in *Space Invaders*, such boundaries may be physical or digital
 - *restricting the player to a given interaction option*
 - *or certain scope or movement in a game's level*
- such boundaries are creating the imaginary realm of the game
 - *where the rules apply to affect the game's objectives.*
- boundaries help us create the immersive nature of the game
- consider VR and AR
 - *we start to see how new boundaries modify our perceptions*
 - *perceptions of procedures, rules, and gameplay itself*

Games and formal structure

conflict, challenge, battle...

- conflict will often be an active part of playing a game
 - *due to certain objectives within our game*
 - *an indirect consequence of rules we define for the game*
- may also occur in both single player and multi-player games
 - *it will necessarily manifest in different ways*
- we may create such conflict using defined structures of the game
 - *challenging the player with the underlying procedures and rules*
- as a player masters a given part of the game
 - *the conflict will then start to diminish*
 - *or simply be replaced by another problem or situation to resolve*
- e.g. in *Draughts*, initially faced with a direct conflict between players
 - *by simply moving and positioning pieces one player against another*
 - *then, one player starts taking another player's pieces...*
- rules of the game have created the potential for conflict
 - *each player directly challenges the other by leveraging available rules*
- such conflict is another useful tool for modifying gameplay
 - *then modifying difficulty and challenges as a player progresses through a game*
- objectives of a player often conflict with the rules and procedures
 - *may often intentionally limit and guide behaviour within a game*

- by resolving such conflict
 - *a player is able to achieve their desired objectives*
 - *hopefully, the game's overall object as well*

Games and formal structure

outcome, end result...

- another noticeable similarity between games
 - *the simple opportunity for an outcome*
- may include a defined winner, a loser, a draw...
 - *even the simple fixed ending of a story, saga or quest*
- some games may represent such an outcome and end result as either
 - *stay alive and win or die and lose*
- such outcomes may often be a natural conclusion to the defined rules
 - *and the primary, over-arching objective of the game itself*
- however, it doesn't always need to be so clear cut
 - *the end of one adventure, but the beginning of another*
 - *Tolkien-esque in scope and consideration*
- also clear distinction between a game's various objectives and defined outcome
- e.g. in *Space Invaders*, we may see many objectives for a player
 - *destroying aliens, maintaining lives, advancing through different levels...*
- in *Space Invaders*, the single outcome is to
 - *successfully complete each level to complete the game*
- how we use such objectives towards the overall outcome
 - *is an option we can use to modify gameplay itself*
 - *and the overall experience of our game*

- in multi-player games, a key component of a game's outcome
 - *includes the palpable sense of uncertainty*
- as we increase conflict and competition
 - *uncertainty will likewise be increased*
 - *becomes a key factor in encouraging player's to return to a game*

Image - Create a memorable ending

Super Mario Bros. vs Castlevania



Super Mario Bros.	Castlevania
 <p>A screenshot of the Super Mario Bros. ending screen. The background is black with white text. At the top, it displays 'MARIO 088600', 'WORLD 8-4', and 'TIME 243'. Below this, it says 'THANK YOU MARIO!', 'YOUR QUEST IS OVER.', 'WE PRESENT YOU A NEW QUEST.', and 'PUSH BUTTON B'. At the bottom, there is a small illustration of Mario and Luigi standing on a brick platform.</p>	 <p>A screenshot of the Castlevania Game Over screen. The background is black with white text. At the top, it displays 'SCORE-001200', 'TIME 0187', and 'STAGE 02'. Below this, it says 'PLAYER' and 'ENEMY' with corresponding red bar indicators. In the center, it says 'GAME OVER'. At the bottom, it says 'CONTINUE' and 'END'.</p>

Image - Create a memorable ending

Legend of Zelda



Game example - Space Invaders

a classic bit of fun...

- Space Invaders - Sega and Taito
 - *close fidelity example from 1985 - graphics almost identical to original 1979 version released in Japan*
 - *streaming version of game*
- Draughts/Checkers
 - *playable version*

Games and engagement - learning to play again

concept & premise

- formal structures for a game may also benefit from a concept or premise
 - *helps frame or wrap the general gameplay*
- we're creating an underlying reason for a given game
- something we hope our players will enjoy
 - *and consider worthy of their time and investment*
- a concept or premise is a great way to hook our players into a game
- player needs a valid reason to play the game
 - *rarely just the mechanics...*
- **Space Invaders** has a simple hook for the game and play
- for **Mario** games, Miyamoto uses a simple premise to wrap the mechanics and gameplay
 - *progress through varied levels to save the Princess*
 - *a means of showcasing each game's formal structures*

Games and engagement - learning to play again

story and characters

- development of video games includes a shift in design and story telling
 - *e.g. towards a consideration of characters*
- character development has been growing since the earliest games
 - *a useful, fun part of developing a premise for a game*
 - *Mario, Donkey Kong, Sonic, Pac Man...*
- each character development acted as a tool to help engage players
- characters help a player to become engaged and immersed
 - *in the general premise of a game*
 - *a specific story in particular*
- characters act as a direct link and interaction
 - *between a game's narrative and its player*
- designers and developers may also use characters
 - *a means to manipulate stories, and general gameplay...*
- a player may impart their own characteristics and personality on a game character
 - *need to be careful not to restrict a character too much*
- players often deeply invested in a game due to characters
 - *they form an attachment with characters...*
 - *conventions and cosplay continue to grow in popularity*

- story and characters may fulfill a dramatic context within our game
 - *depends how far we wish to push such elements within our game*

Games and engagement - learning to play again

pushing boundaries

- many examples we may reference as archetypal games
- many games break this mould
 - *may even push the standard perception of a game*
- recent development in games is towards the use of immersive environments
 - *simply promote calm and relaxation.*
- gaming to reduce stress by exploration
 - *instead of high paced action and adventure*
- a natural progression from earlier games, e.g. *Civilization, Age of Empires...*
 - *to a new audience and emerging genres*
 - *Abzu, Journey, Proteus...*
- annual *Games for Change* festival in New York
 - *considers games in a broader social context*
 - *Games for Change*
- boundaries are also being pushed with indie development and experimental gaming concepts
- *Independent Games Festival*
 - *a great place to start exploring such ideas and concepts*
 - *Independent Games Festival*
- *IndieCade* festival, the International Festival of Independent Games

- *IndieCade*

Video - Abzu

Abzu Official Trailer - E3 2016



Source - [Abzu trailer](#) - YouTube

Games and development

***Enter the Mummy's Tomb* - objects, attributes...**

- in our earlier game, *Enter the Mummy's Tomb*, we introduced three initial characters
 - *explorer (our Egyptologist)*
 - *high priest*
 - *scary pharaoh*
 - *the mummy*
- objects may include known characteristics and attributes from real world, e.g.
 - *name*
 - *health*
 - *current value & status, lives, regeneration...*
 - *physical characteristics*
 - *height, speed, strength, vision...*
 - *skills*
 - *fighting, shooting, intelligence (problem solving &c.) ...*
 - *motion*
 - *e.g. walking, running...*
 - *actions*
 - *pick-up, throw, move, drop...*
- each character possesses such attributes, to a greater or lesser extent...
- may also reuse such attributes as a definition, template
 - *help guide the subsequent development of other characters*
- new characters might include
 - *earth-bound creatures*

- horse, scarab beetle, snake...
- *Egyptian gods*
- e.g. *Anubis, Osiris, Isis, Horus, Ma'at, Sekhmet, Seth...*
- *enemies*
- *allies...*
- *other explorers...*

Games and development

Enter the Mummy's Tomb - attributes...

- consider attributes useful and applicable to each of our main characters
 - *characteristics and actions our characters may need and use in the game*

explorer	high priest	scary pharaoh/mummy
name	name	name
health	health	health
fight/attack		fight/attack
	help/aid	
info	info	info
retreat		retreat

- list of attributes is not exhaustive, and it may grow as we develop a game
- may also find it useful to combine some of these attributes into a given class
 - *fight and health attributes may only apply for an **attack** method*
- may also consider the tombs as an additional object within our game
 - *attributes may include, e.g.*

tomb
name/number (e.g. KV17)
owner

tomb
owner type
find treasure
info

- may start to see common attributes and characteristics
- create methods to help us structure and call such characteristics within a given class
 - *e.g. a class for the explorer*
- owner of each tomb is unknown until we randomly pick a character
 - *may be an instance of the high priest or the mummy class*
- owner type may end up either helping or attacking the explorer

Games and development

***Enter the Mummy's Tomb* - initial structure**

- many of these objects share common traits and attributes
 - *explorer, high priest, and mummy may use inheritance*
- allows us to create a useful superclass/parent class
 - *this will be our initial **GameCore***
- *GameCore* may include the following:
 - *attributes*
 - name
 - owner
 - health
 - *methods*
 - fight/attack
 - help/aid
 - info
 - retreat
- add to the *GameCore* as we build out our current game
 - *each of the characters may inherit from this GameCore class*
 - *each character class may also override default methods*
- for example
 - *give the explorer enhanced options to fight/attack*
 - *perhaps the mummy will have a higher initial health value*
- a *tomb* may also inherit certain default attributes from the *GameCore*
 - *including name and info*
- each *tomb* will also contain, or be composed of, another object

- *such objects may be used to perform specific tasks*
- *perhaps an owner composed of a high priest or mummy*

Games and development

quick exercise

consider the following 4 characters:

- poet / bard
- archer
- scout
- knight

then outline the following:

- abstract objects and attributes for all of these characters
- show developer pattern from abstract to specific character
- show relationship between character objects and attributes
- similarities and differences between developer and player updates
 - *for abstract and specific characters...*

Games

- Abzu
- Journey

References

- Draughts
- Space Invaders

References - Pygame

- `pygame.event`
- `pygame.locals`

Videos

- [Abzu trailer - YouTube](#)