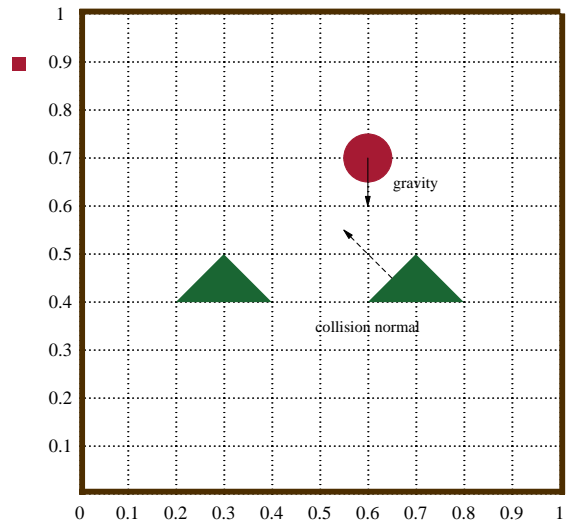


## PGE Input and Timers

- PGE is a Predictive physics Game Engine
  - it operates by predicting the time of next collision rather than using a frame based approach

## PGE Screen and world coordinates 1m x 1m



## PGE input

- PyGame keyboard and mouse events can be utilised in PGE
- you can define a call back and register it within the game

`examples/breakout/breakout.py`

```
...
pge.register_handler (myquit, [QUIT])
pge.register_handler (key_pressed, [KEYDOWN])
pge.register_handler (mouse_hit, [MOUSEBUTTONDOWN])
...
```

## Breakout input handler functions

`examples/breakout/breakout.py`

```
def finish_game (event = None, unused = None):
    sys.exit (0)

def myquit (e):
    print "goodbye"
    finish_game ()

def key_pressed (e):
    if e.key == K_ESCAPE:
        myquit (e)
```

- notice that the PyGame Event object `e` is passed into `myquit`

## Breakout mouse input

examples/breakout/breakout.py

```

def mouse_hit (e):
    global gb
    mouse = pge.pyg_to_unit_coord (e.pos)
    if e.button == 1:
        # left button
        gb.put_xvel (gb.get_xvel ()-0.3)
    elif e.button == 3:
        # right button
        gb.put_xvel (gb.get_xvel ()+0.3)
    elif gb.moving_towards (mouse[0], mouse[1]):
        # middle button
        pos = gb.get_unit_coord ()
        gb.apply_impulse (pge.sub_coord (mouse, pos), 0.4)
    else:
        # middle button
        gb.put_yvel (gb.get_yvel ()+0.4)

```

## Breakout mouse input

- notice a series of helper function/methods exist
- `mouse = pge.pyg_to_unit_coord (e.pos)`
  - `mouse` is a unit vector  $[x, y]$  containing the current mouse position
  - `x` and `y` are in the PGE world range 0.0 to 1.0
- `pos = gb.get_unit_coord ()`
  - `pos` is a unit vector containing the gold ball position

## Breakout mouse input

- we can test whether an object is moving towards a position using

```

mouse = pge.pyg_to_unit_coord (e.pos)
if gb.moving_towards (mouse[0], mouse[1]):
    ...

```

## Newton's laws of motion

- he stated three physical laws that, together, laid the foundation for classical mechanics
- describe the relationship between a body and the forces acting upon it
- describe its motion in response to those forces

## Summary of the First law

- in an inertial reference frame, an object either remains at rest or continues to move at a constant velocity, unless acted upon by a net force

## Summary of the Second law

- in an inertial reference frame, the vector sum of the forces  $F$  on an object is equal to the mass  $m$  of that object multiplied by the acceleration  $a$  of the object:
- $F = ma$

## Summary of the Third law

- when one body exerts a force on a second body, the second body simultaneously exerts a force equal in magnitude and opposite in direction on the first body
- these three laws of motion were first compiled by Isaac Newton in his *Philosophiæ Naturalis Principia Mathematica* (Mathematical Principles of Natural Philosophy), first published in 1687
- Newton used them to explain and investigate the motion of many physical objects and systems

## Adding energy into the PGE world

- one of the considerations in building a game engine, is how to introduce new energy into the simulation
- you need to be careful, too much and objects become chaotic
  - too little and the objects are starved of motion
- the amount of energy depends whether the object collisions are elastic or inelastic
- elastic object collisions, energy is never lost
- inelastic object collisions, energy is lost (modelling friction, heat, noise energy)

## Applying an impulse to an object

- `examples/breakout/breakout.py`  

```
gb.apply_impulse (pge.sub_coord (mouse, ball), 0.4)
```
- applies an impulse to an object
- an impulse is a non-physics term and in the game engine it means
  - a force applied instantaneously to an object

## Applying an impulse to an object

- notice that in Newtons 2<sup>nd</sup> law we see the equation  $F = ma$
- the acceleration, implies time  $ms^2$
- we don't necessarily have a change in velocity over some time
  - we simply want to introduce energy into the engine
- we will see this same problem when handling collisions
  - it is not always necessary to model the world exactly to get the desired effect in the game engine

## Applying an impulse to an object

- we can also instantaneously change an objects velocity
  - violating Newtons 2<sup>nd</sup> law
- `examples/breakout/breakout.py`  

```
gb.put_yvel (gb.get_yvel ()+0.4)
```
- obviously we need to be careful with these hacks, or the game will feel unnatural

## Timers

- PGE allows users to introduce timer callbacks
- here is how a simple second count down might be implemented

- `examples/breakout/breakout.py`  

```
def timer (event = None, unused = None):
    global seconds_left, previous
    if seconds_left >= 0:
        pge.at_time (1.0, timer)
        s = "%d" % seconds_left
        if previous != None:
            previous.rm ()
        previous = pge.text (0.8, 0.9, s, white, 100, 1)
        seconds_left -= 1
```

## Timers

- which when called from `main()` will display the current number of seconds left and register itself to be called 1.0 seconds in the future
- `at_time` returns an integer `id` representing the timer created
- this timer can be cancelled using `at_cancel (id)`

## Timers

- if it is cancelled, the callback still occurs, your program could check cancellation by:

- ```
def timer (event = None, unused = None):
    global seconds_left, previous
    if seconds_left >= 0:
        if event != None and event.was_cancelled ():
            print "event was cancelled"
        pge.at_time (1.0, timer)
        s = "%d" % seconds_left
        if previous != None:
            previous.rm ()
        previous = pge.text (0.8, 0.9, s, white, 100, 1)
        seconds_left -= 1
```

## Conclusion

- we have seen how energy can be added into PGE
- we have also explored some of the API calls surrounding
  - timer events
  - mouse movement
  - object movement and how to detect if two objects are moving towards each other
- next week we will examine how the an application can interact with collisions