COMP150: Game Development Practices

The main loop

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  - Low level frameworks (e.g. SDL, OpenGL, DirectX) usually require you to implement your own main loop

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What's the difference?

- **Event**: "The space bar was (pressed / released)"
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- What goes in here depends on the game...

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- Rendering in SDL is **double buffered**
  - `SDL_Render`... functions actually draw to an **off-screen buffer**
  - `SDL_RenderPresent` displays the off-screen buffer on screen

Screen refresh rate

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- Hence the term **(vertical) refresh rate**
- Refresh rate is measured in **cycles per second** i.e. **Hz**
- Other monitor technologies work differently, but still refresh the screen at regular intervals

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- If the main loop runs too slowly, we get "lag"
- If the main loop runs too quickly, we waste resources on drawing things faster than the display can show them

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- This limits the game's frame rate to the refresh rate of the device
- However, refresh rates can vary
  - Older TVs: $\sim$ 30Hz
  - HDTVs and standard monitors: 60Hz
  - High-end "gaming" monitors: 120Hz or higher

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  - The game could appear to run in slow or fast motion, completely changing the gameplay
- This was the situation on older consoles: American/Japanese versions of games actually ran a little faster than European versions, due to the NTSC TV standard having a higher refresh rate than PAL!

Variable time step

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- E.g. instead of this:

```
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```

- do this:

```
player.positionX += player.velocityX * deltaTime;
```

Measuring elapsed time

```
bool running = true;
Uint32 lastFrameTime = SDL_GetTicks();

while (running)
{
    Uint32 currentTime = SDL_GetTicks();
    Uint32 deltaTime = currentTime - lastFrameTime;
    // deltaTime is the number of milliseconds since ↩
        the last update

    handleInput();
    update(deltaTime);
    render();

    lastFrameTime = currentTime;
}
```

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- If refresh rate $<$ 60Hz, update several times per frame
- If refresh rate $>$ 60Hz, update once every few frames

Fixed time step

```
bool running = true;
Uint32 lastUpdateTime = SDL_GetTicks();
const Uint32 timePerUpdate = 1000 / 60;

while (running)
{
    Uint32 currentTime = SDL_GetTicks();
    handleInput();

    while (currentTime - lastUpdateTime >=
        timePerUpdate)
    {
        update();
        lastUpdateTime += timePerUpdate;
    }

    render();
}
```

Stalling

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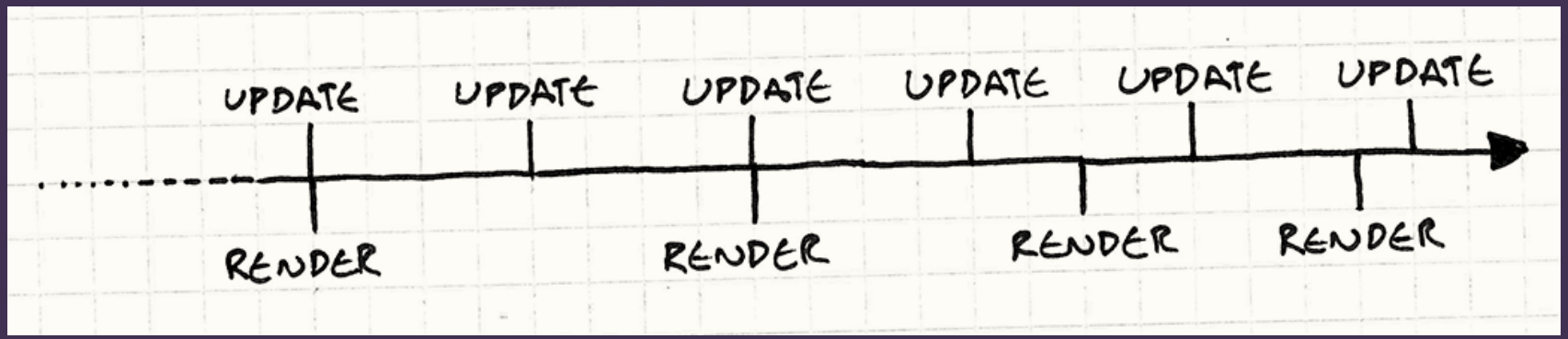
- What if `update` takes longer than `timePerUpdate` to execute?
- The `while` loop will perform more and more iterations in an effort to catch up, eventually grinding the game to a halt
- **Solution:** `break` out of the loop after a maximum number of iterations (e.g. 10)

Interpolation



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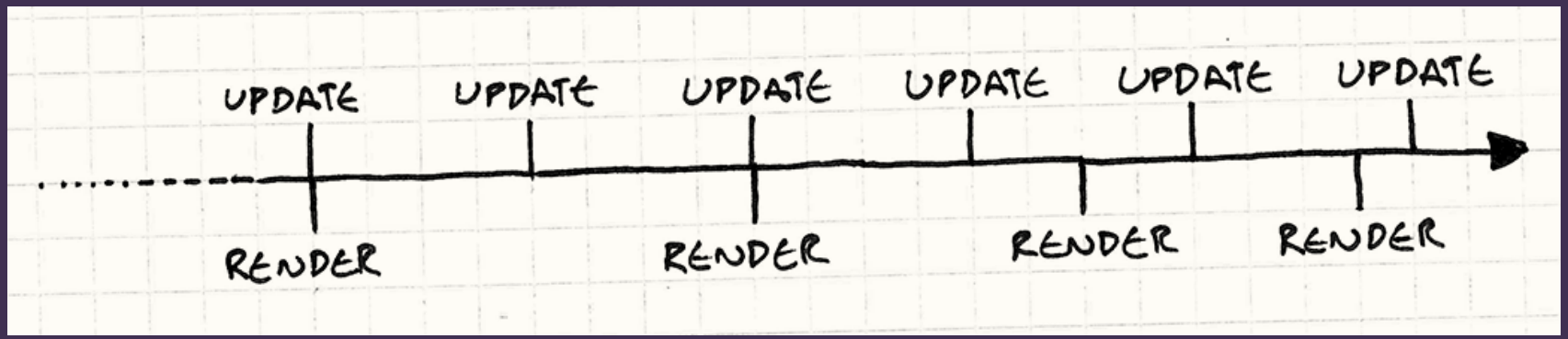

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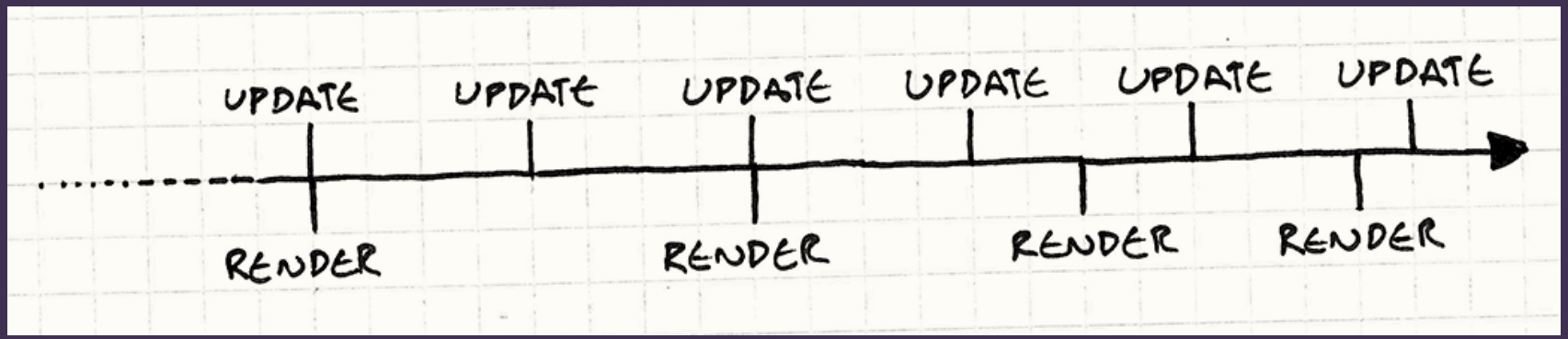

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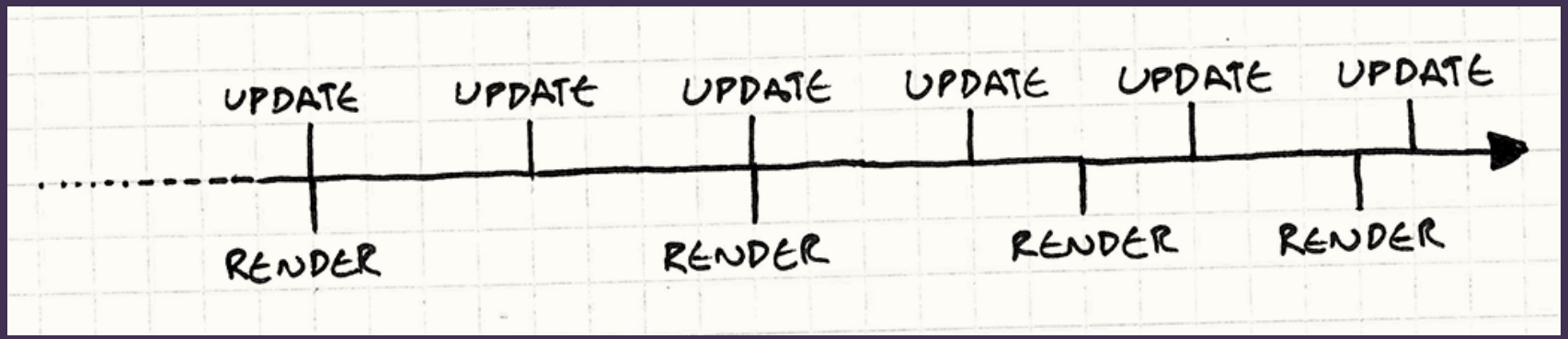
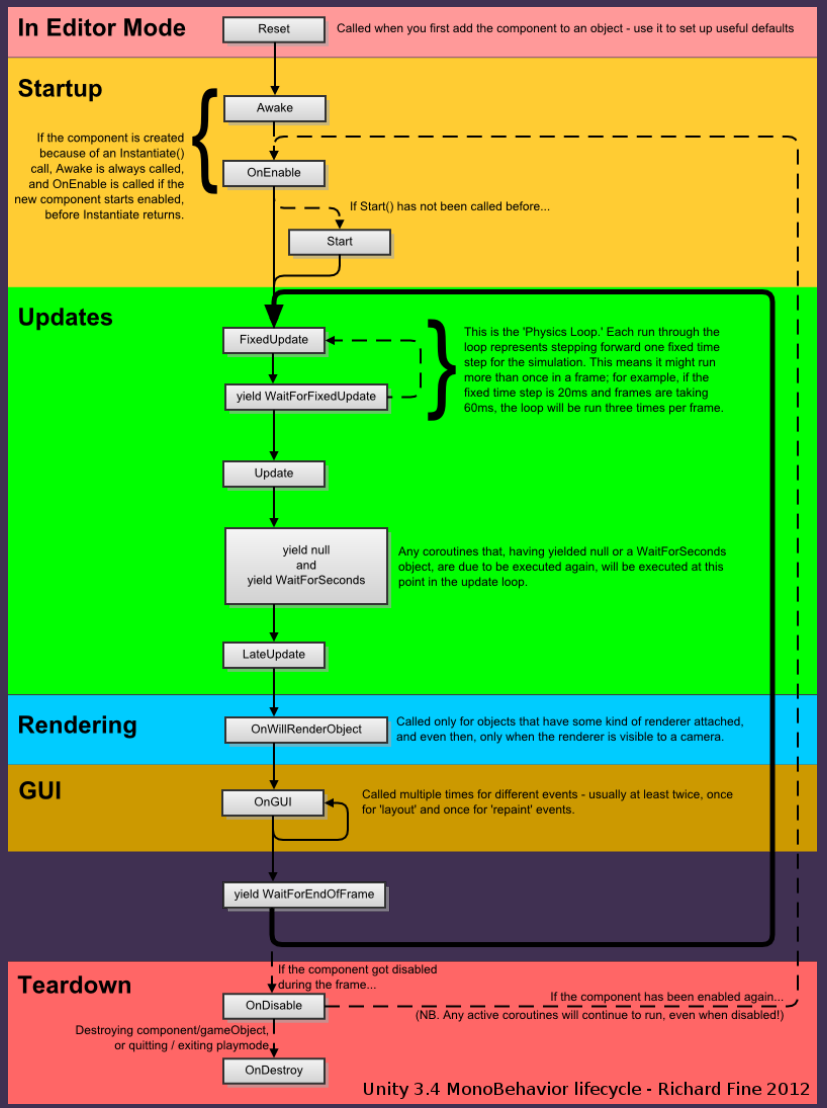


- Rendering at "irregular" intervals (with respect to update) can result in jerky movement
- Solution: **interpolate** between the two previous updates
  - E.g. if the render falls exactly halfway between two updates, render each object exactly halfway between its positions **before** and **after** the most recent update

Further information on fixed time steps

- http://gafferongames.com/game-physics/fix-your-timestep/
- http://gameprogrammingpatterns.com/game-loop.html

The "main loop" in Unity



Summary

- The **main loop** of a game runs once per frame, and handles **input**, **updating** and **rendering**
- Using a **fixed time step** is a good idea, but be careful of **stalling**