COMS30020 - Computer Graphics

Week 5 Briefing

Dr Simon Lock

Mid-Term In-Class Test

It's not really the "middle" of the term
Test is Tuesday next week (reading week) @ 1pm

It doesn't actually take place in the class
It will be downstairs in MVB 1.11 (or other !)

But it certainly is a test !
Closed book (no notes can be brought in)
Non-programmable calculators permitted

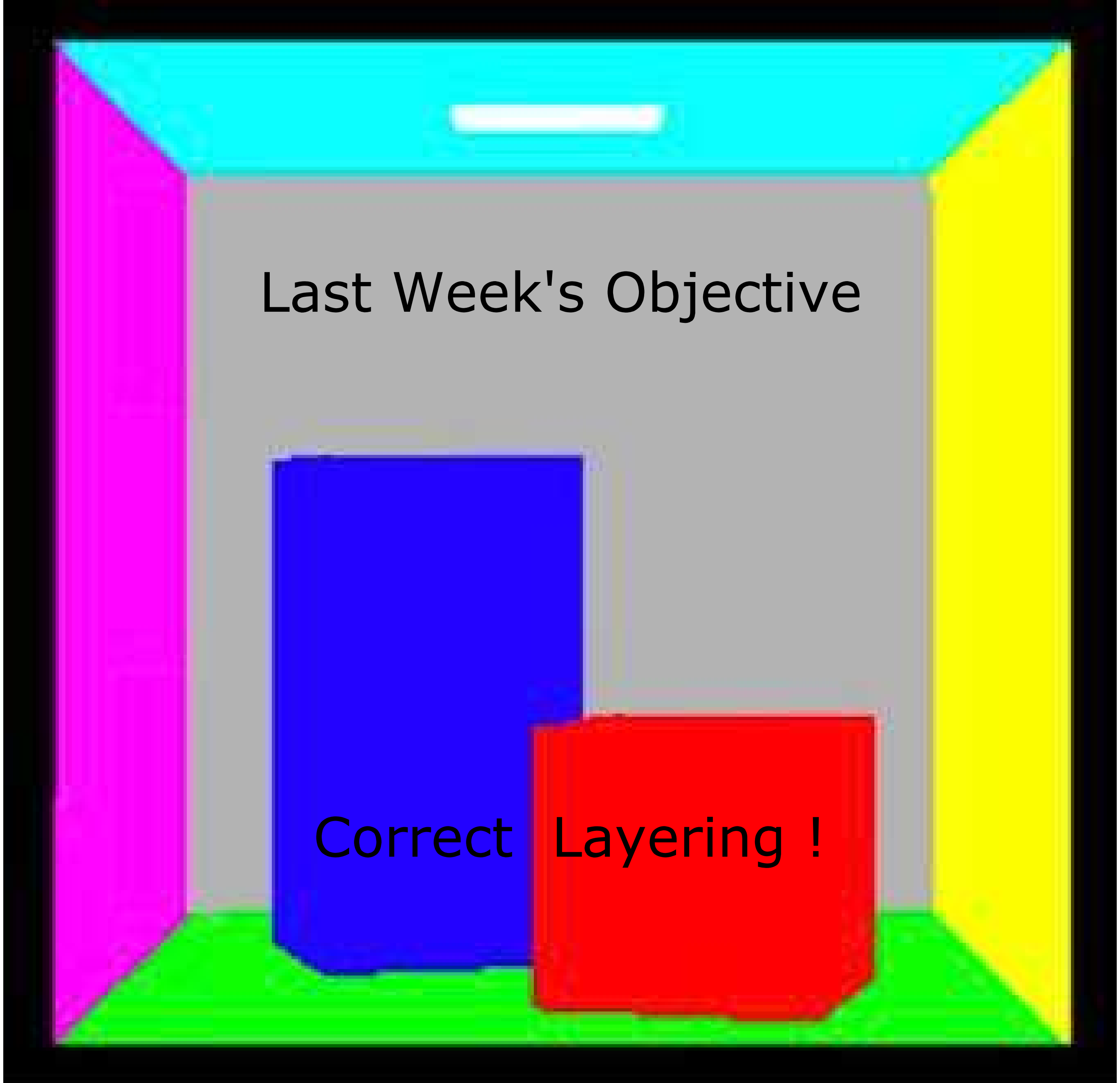
`Mock test + sample answers on GitHub !`

This coming week

I'm NOT saying that this coming week is easy...
However, there were a lots tasks in last workbook
Not so many (mandatory) tasks in this workbook

This was just the way the topics clustered
(We put them into the most logical workbook)

If you didn't finish all tasks from the last workbook
There should be a *little* bit of slack to catch up !


Last Week's Objective
Correct Layering !

This week's topics

The focus of this week's workbook is "navigation"
That is: moving the camera around in 3D space

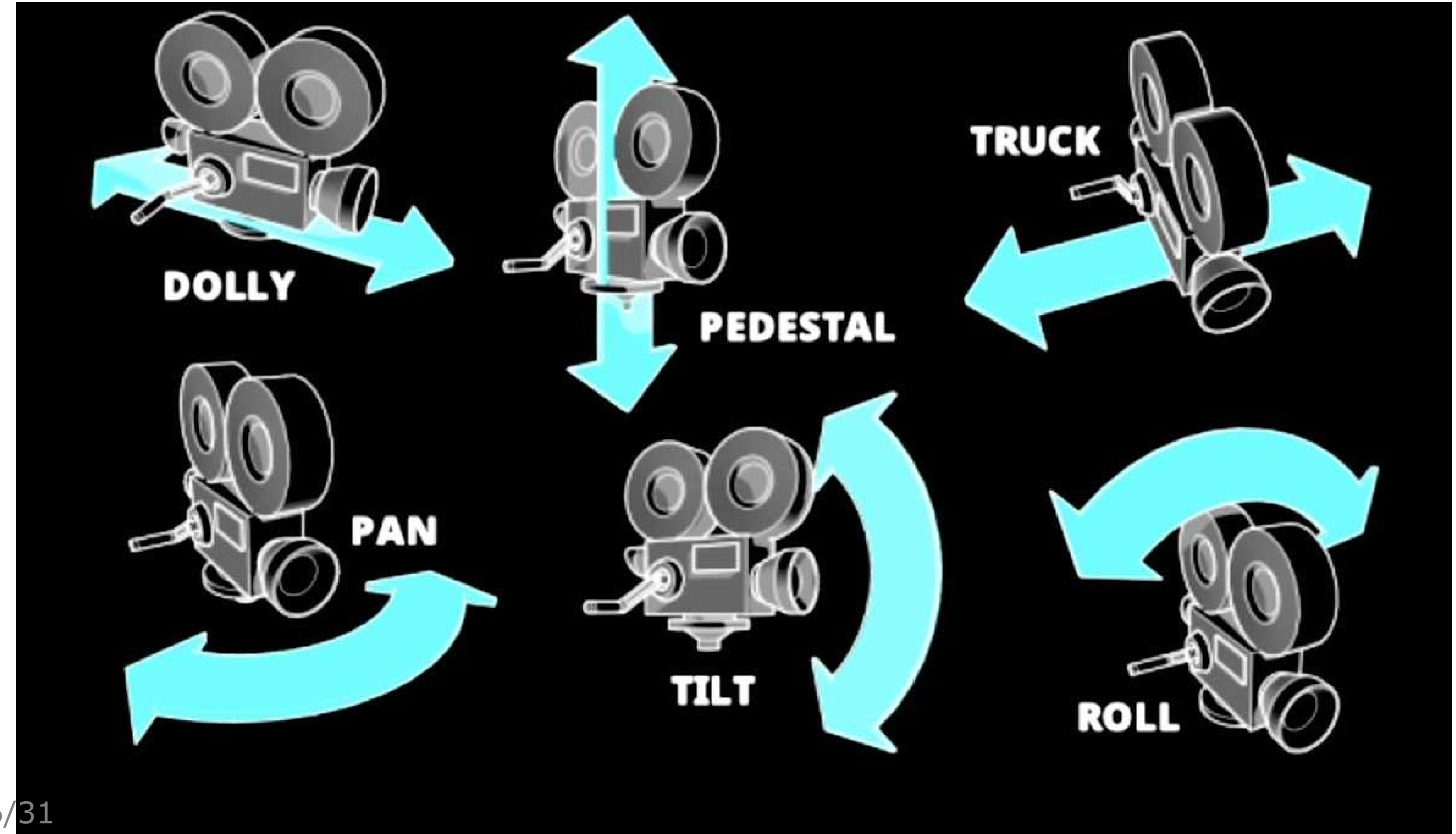
This includes basic translation and rotation
Also encompasses more complex scripted movement

The following animation provides an illustration:

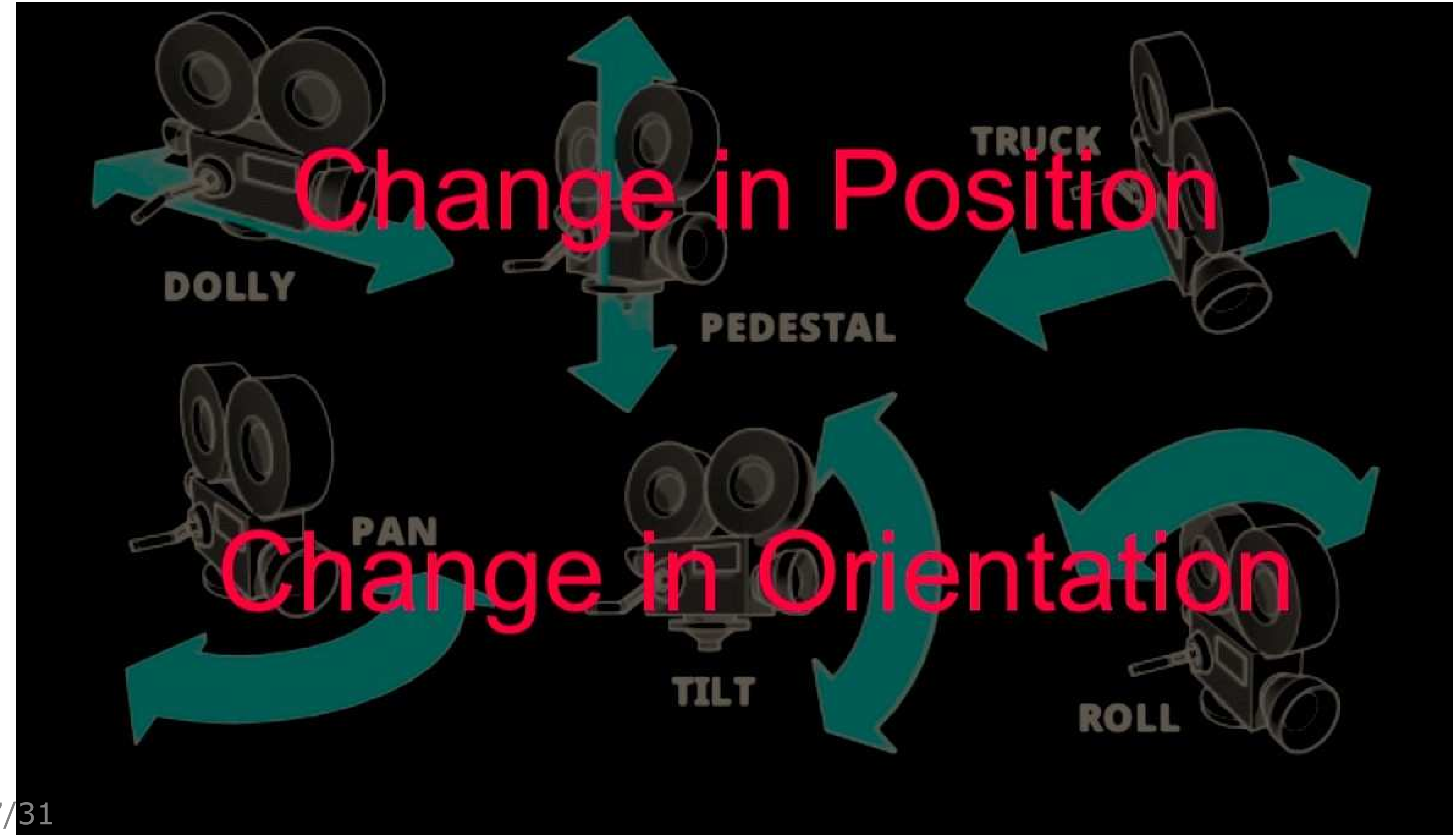
CameraMovement

Although it seems simple, people often mix them up !

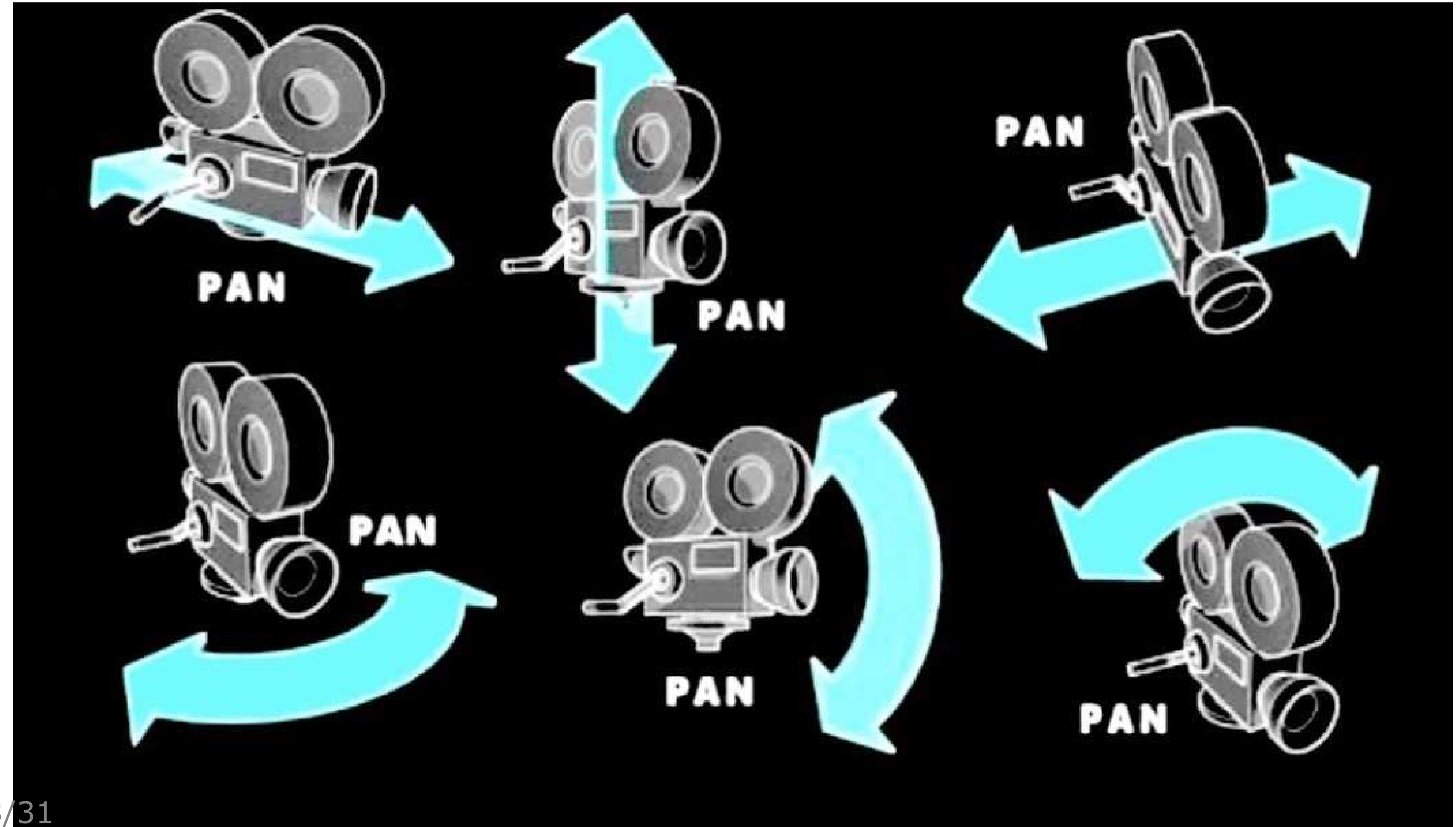
Cinematography Camera Movement



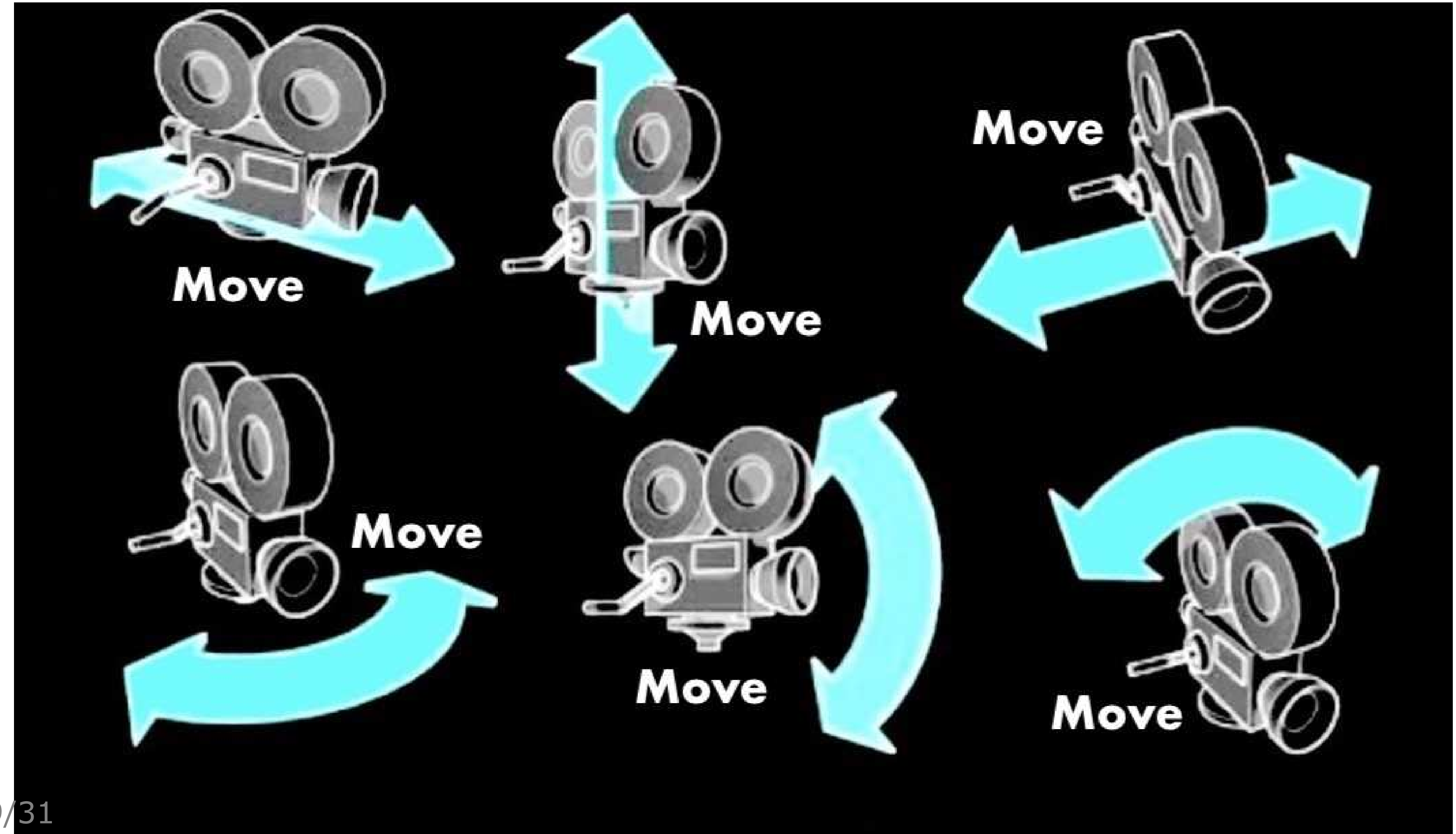
Cinematography Camera Movement



Client (incorrect !) Camera Movement



Student (ambiguous !) Camera Movement



Optional: 3D Texture Mapping

If you implemented 2D texture mapping last week

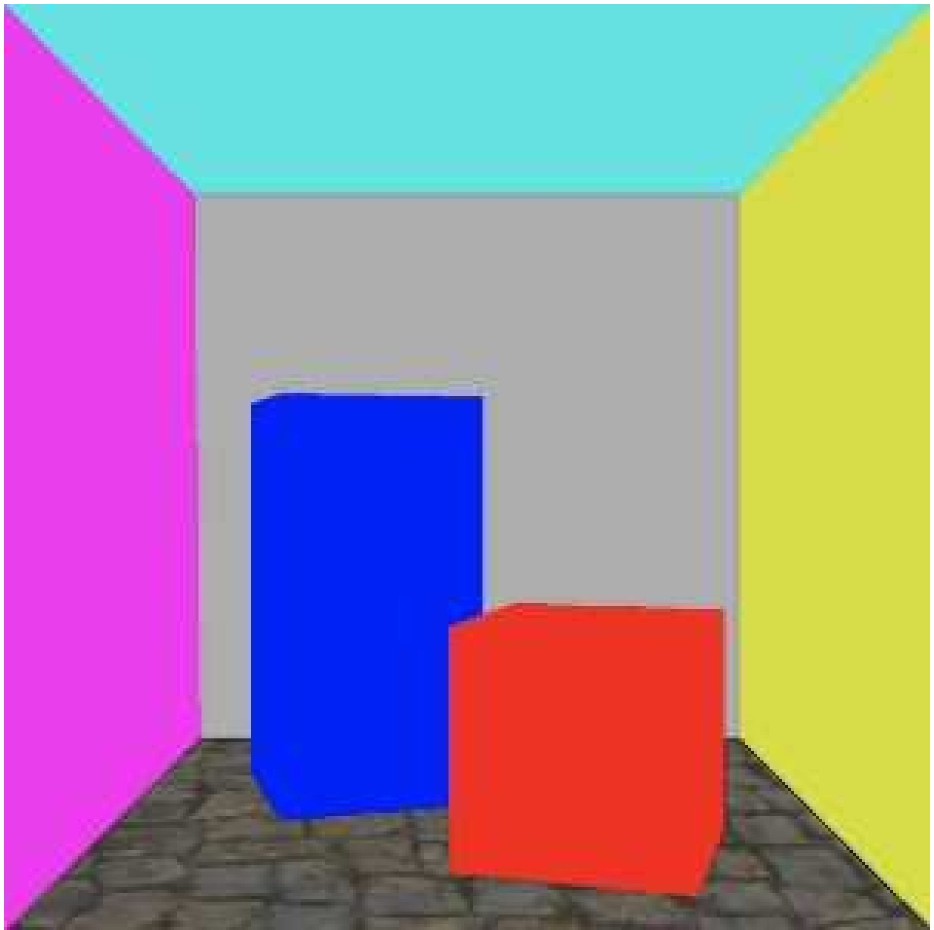
You can (optionally) use it in this week's workbook

Updated OBJ files provide vertex->texture mappings

```
o floor
usemtl Cobbles
v -2.7470112 -2.7382329 2.806401
v 2.780989 -2.7382329 2.806401
v 2.780989 -2.742686 -2.785598
v -2.7150111 -2.742686 -2.785598
vt 0.1 0.1
vt 0.1 0.9
vt 0.9 0.9
vt 0.9 0.1
f 14/3 16/1 13/2
f 14/3 15/4 16/1
```

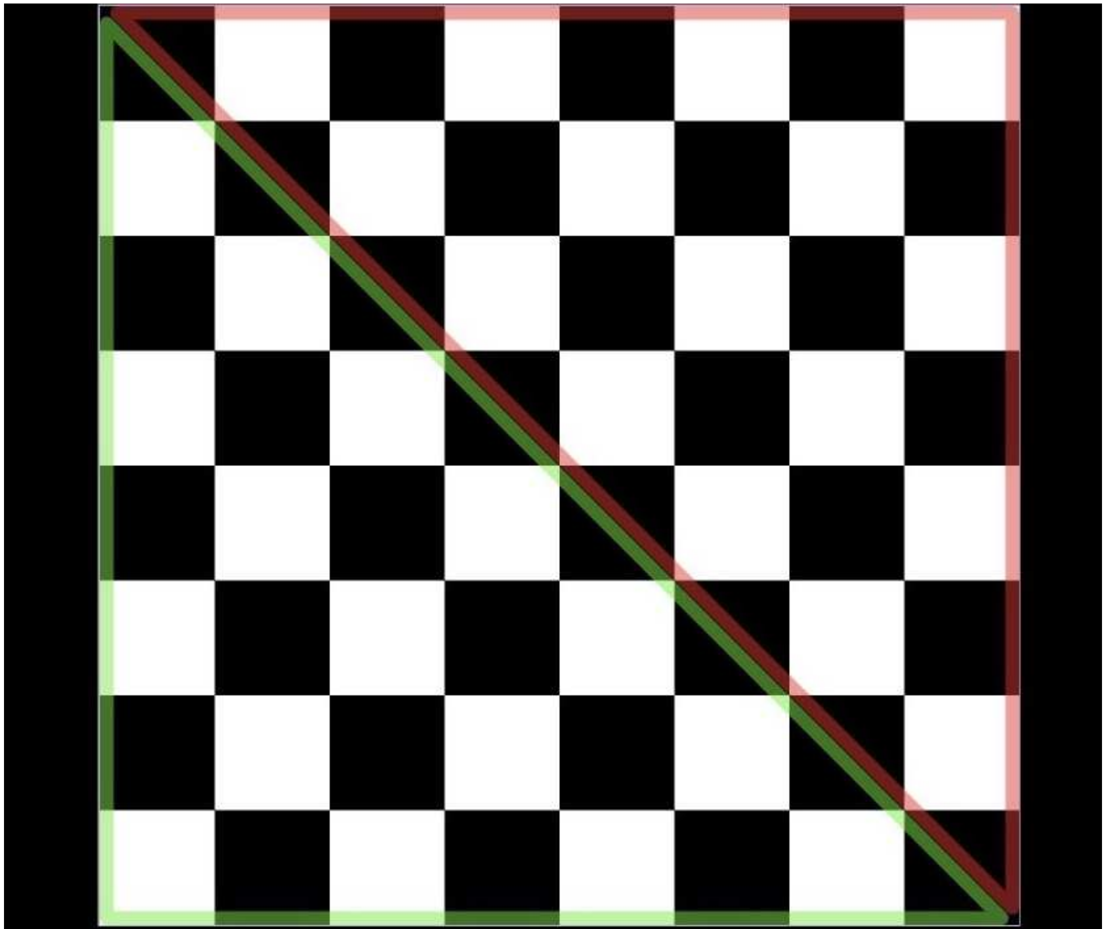
The *conceptual* objective is shown below

(note: you won't get yours looking quite this good !)



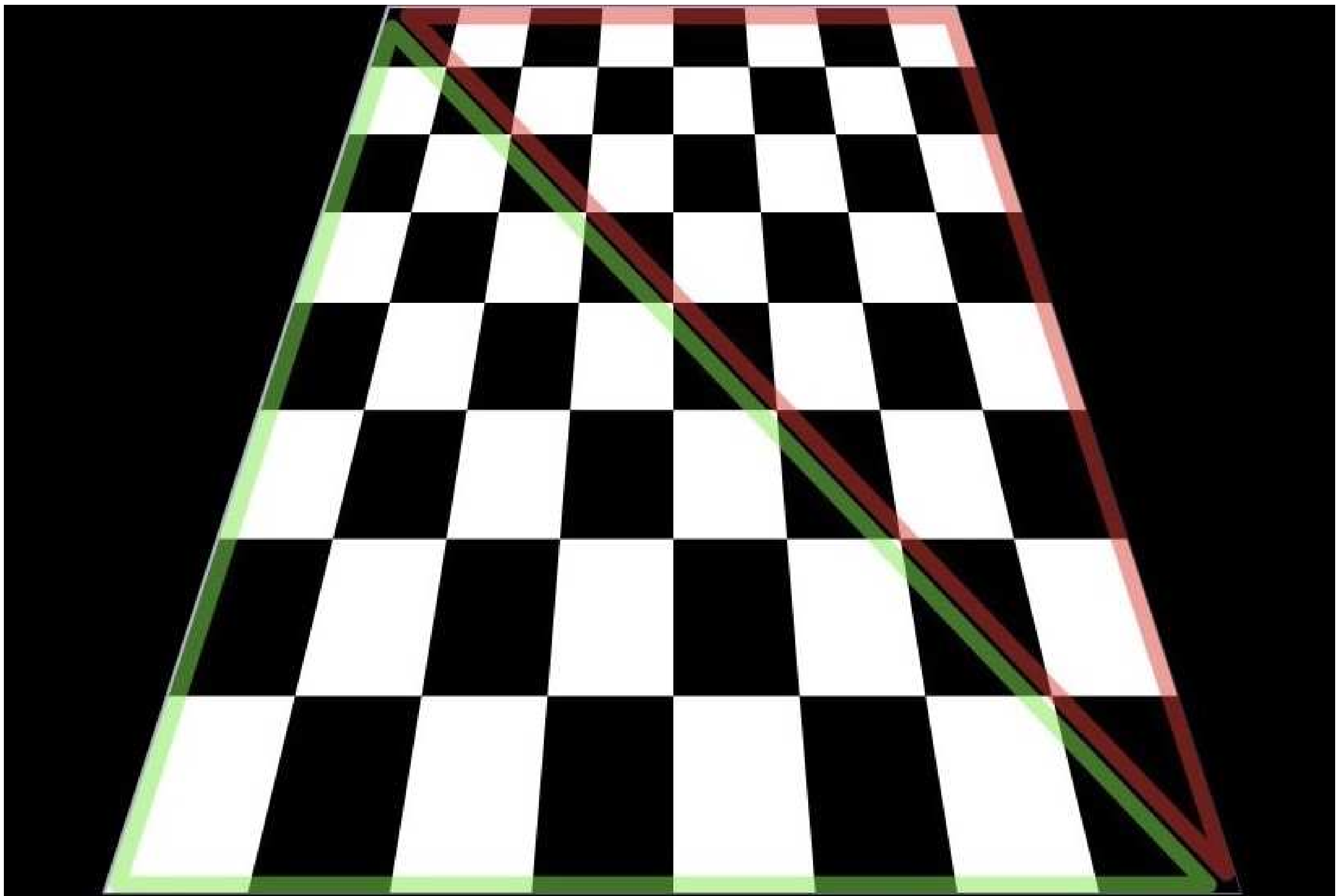
Consider the below "checkerboard" texture

Two triangles used to render a flat square board



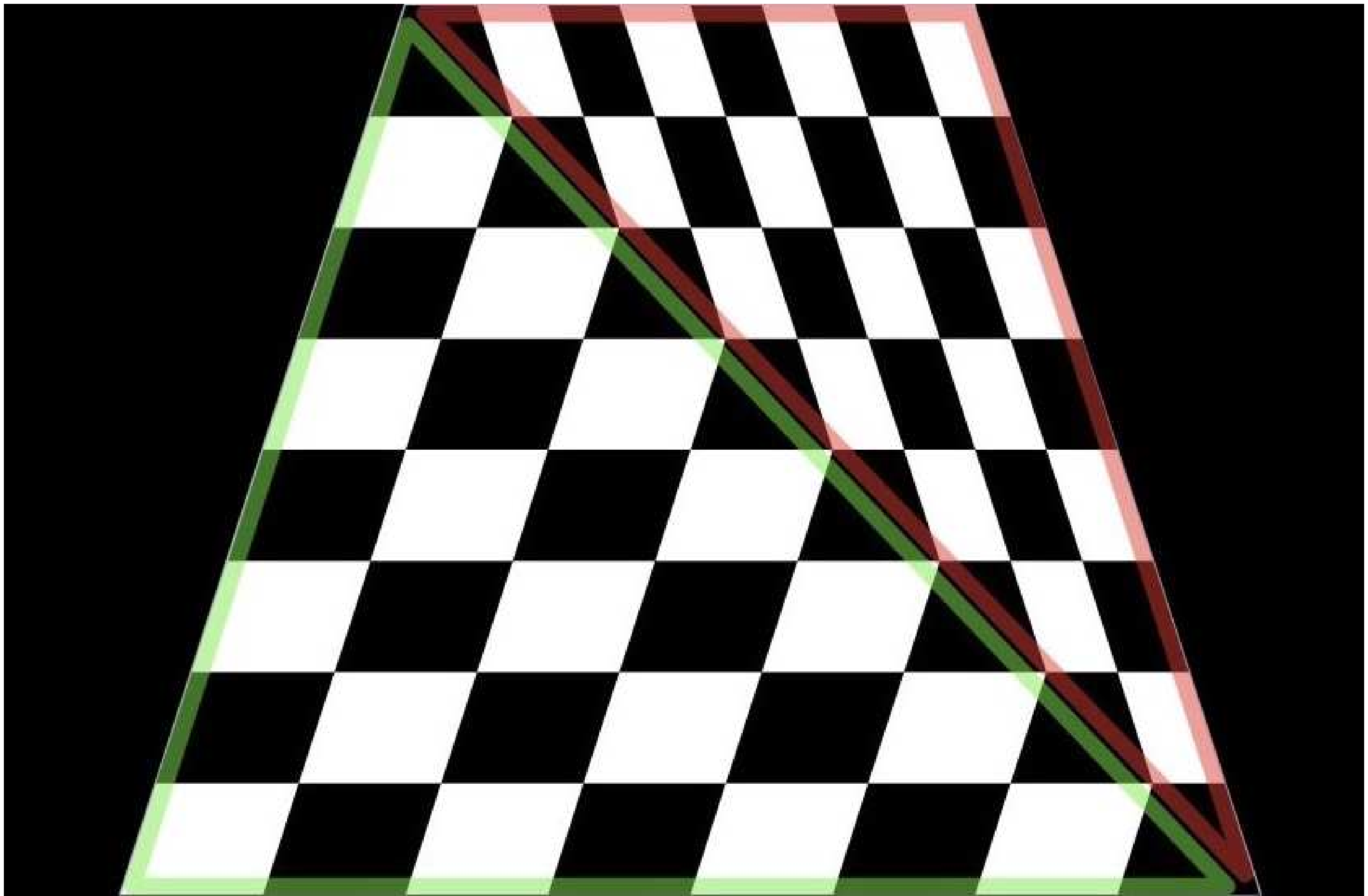
However, we are now working in 3D

Due to perspective, distant artefacts appear smaller

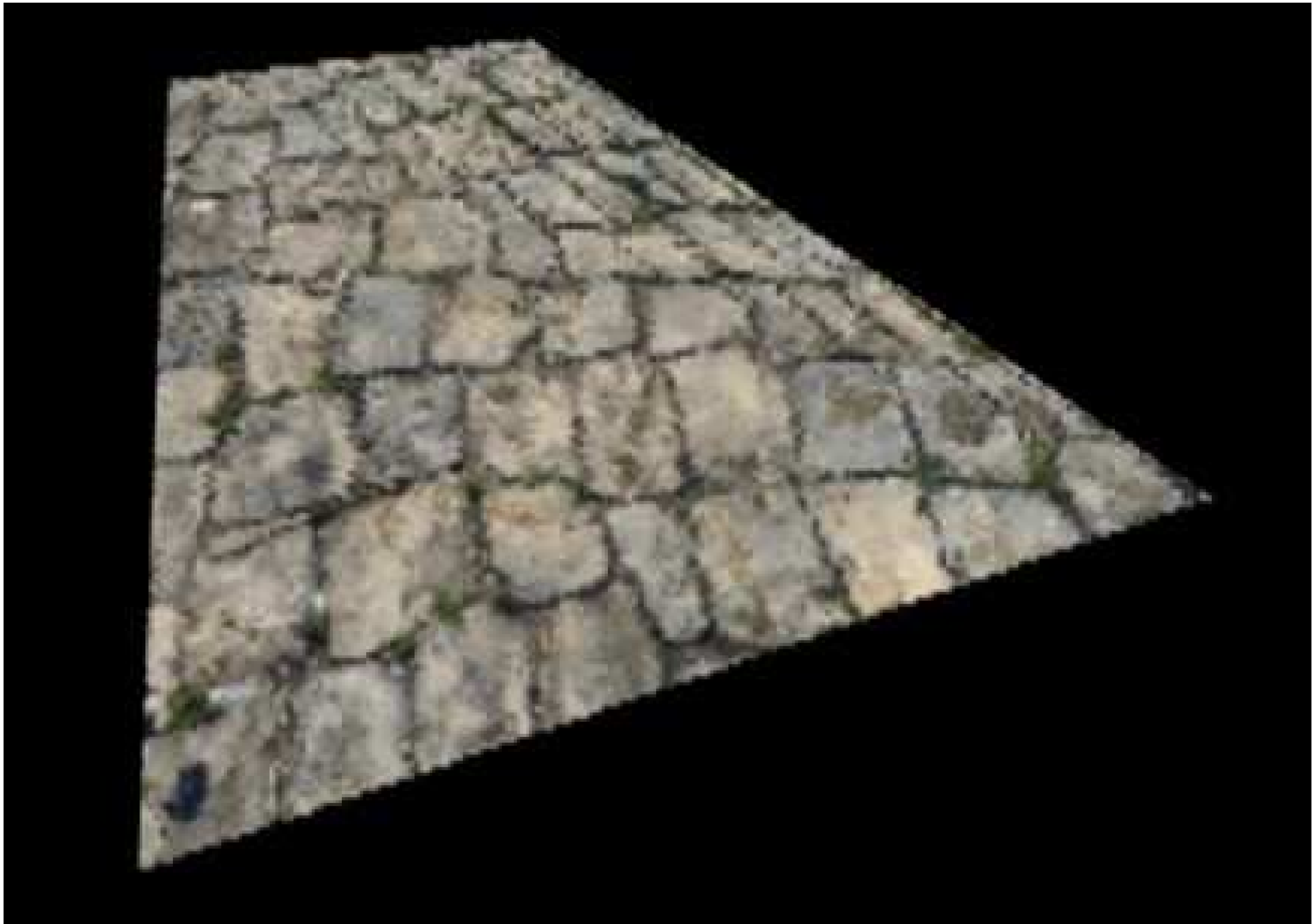


What YOUR texture mapper would produce

Currently it's just 2D (it doesn't consider Z depth)



The best it will look (at this stage !)



Don't worry about perfecting this for the time being...

There is in fact a much easy way to texture in 3D !

Which you *might* get the opportunity to explore later

Additional Guidance

Camera Orientation

You would have *thought* that camera orientation would be expressed in terms of *front* of camera

Instead it makes reference to rear/back of camera

The reason for this is simple...
This representation just makes it
a lot easier to apply orientation
(when doing vertex projection)

We just multiply !

Overriden Operators

vec3 & mat3 override the basic maths operators:

```
+  -  *  /
```

So we can do things like:

```
glm::vec3 from;
glm::vec3 to;
glm::vec3 difference = to - from;

glm::mat3 orientation;
glm::mat3 rotation;
glm::mat3 adjustedOrient = rotation * orientation;
```

Versatile vec3

We've discussed the versatility of the vec3 class:

`Position, Direction, Colour, Intersection etc.`

Just like arrays, elements can be accessed by index:

```
float red = myVec[0];
```

This can however make code hard to understand
For example, you have to remember that 2 is blue !

To aid readability, vec3s have various "aliases"...

vec3 Aliases

vec3s used as Colours:

```
float red = myVec.r;
float green = myVec.g;
float blue = myVec.b;
```

vec3s used as Positions or Directions:

```
float x = myVec.x;
float y = myVec.y;
float z = myVec.z;
```

Printing out vec3s

Often we need to know the content of a vec3
We *could* print out the elements individually
(maybe using the aliases shown previously)

However...

GLM provides a method to convert vec3s to strings

```
#include <glm/gtx/string_cast.hpp>
std::cout << glm::to_string(myVec)
```

This might save you a bit of time when debugging !
(Although, so would using a proper debugger ;o)

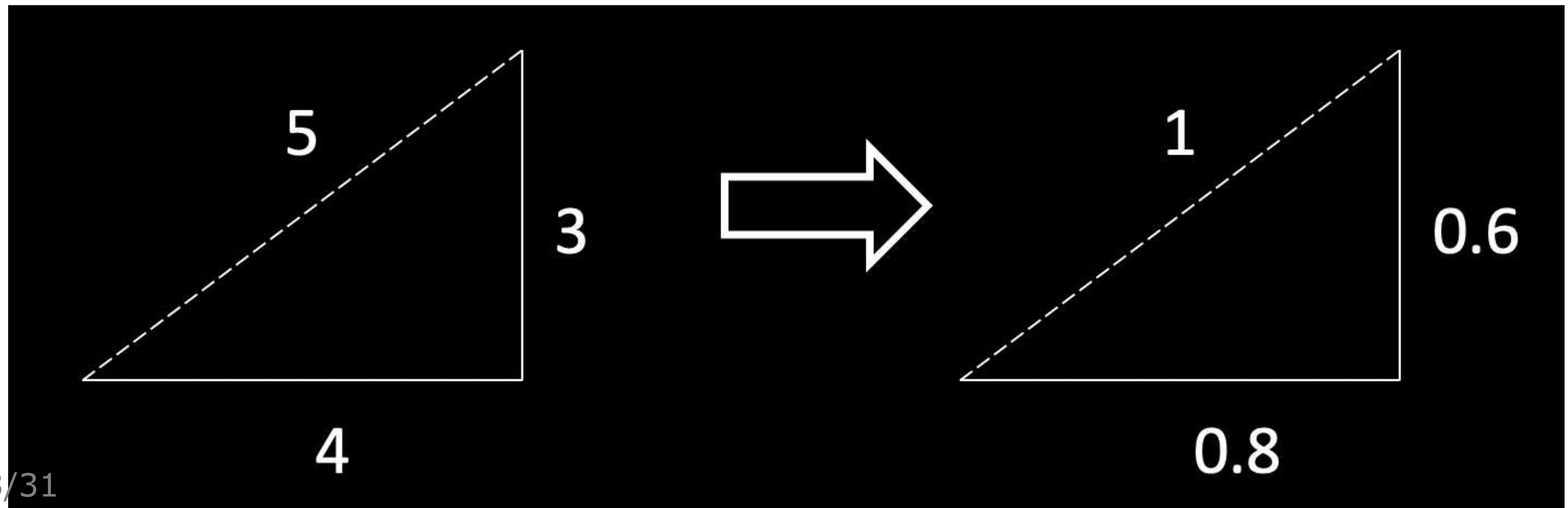
Normalisation

Important when you multiply vectors together...

If they are not "unitary" (have a magnitude of 1)

You might end up with strange scaling effects !

So you may need to "normalise" some vectors:



How to normalise ?

You *could* write your own function to normalise
But GLM already provides one, so let's use that:

```
glm::normalize(vec3)
```

Note the *crazy* spelling !

When to normalise ?

A GOOD "principle to work by" is as follows:

If you NEED the distance - then DON'T normalise
(Since normalisation would destroy that distance)

If you DON'T need distance - then NORMALISE !
(It can't hurt, if distance is not important)

The MOST popular approach is however...

If the render is broken...

Randomly normalise a few vectors

(in the vague hope that it will fix something :o)

Initialising mat3s

Note that GLM mat3s are "column major"...

You initialise them with columns, rather than rows:

```
glm::vec3 colOne, colTwo, colThree;
glm::mat3 myMatrix;
myMatrix = glm::mat3(colOne, colTwo, colThree);
```

You could initialise with 9 separate floats

But these must be ordered by column

The way I remember...


A39
A3059
St Columb Major
Quoit
Trebudannon

```
int main(int argc, char* argv[])
{
    triangles = loadModel("cornell-box.obj", 0.35);
    while(true) {
        if(window.pollForInputEvents(event)) handleEvent(event);
        draw();
        window.renderFrame();
    }
}

void handleEvent(SDL_Event event)
{
    if(event.key.keysym.sym == SDLK_UP) cameraPosition.y-=0.1;
    if(event.key.keysym.sym == SDLK_DOWN) cameraPosition.y+=0.1;
    if(event.key.keysym.sym == SDLK_LEFT) cameraPosition.x-=0.1;
    if(event.key.keysym.sym == SDLK_RIGHT) cameraPosition.x+=0.1;
}

void draw()
{
    window.clearPixels();
    for(int i=0; i<triangles.size() ;i++) {
      // Code goes in here !
    }
}
```

And Finally

We can use navigation and transformation
To explore numerical data using animation
Powerful tool to put across convincing arguments

2D animation is useful
3D animation *can* be even more powerful
Here is a nice example I saw recently:

climate-spiral-fast