COMS30020 - Computer Graphics

Week 3 Briefing

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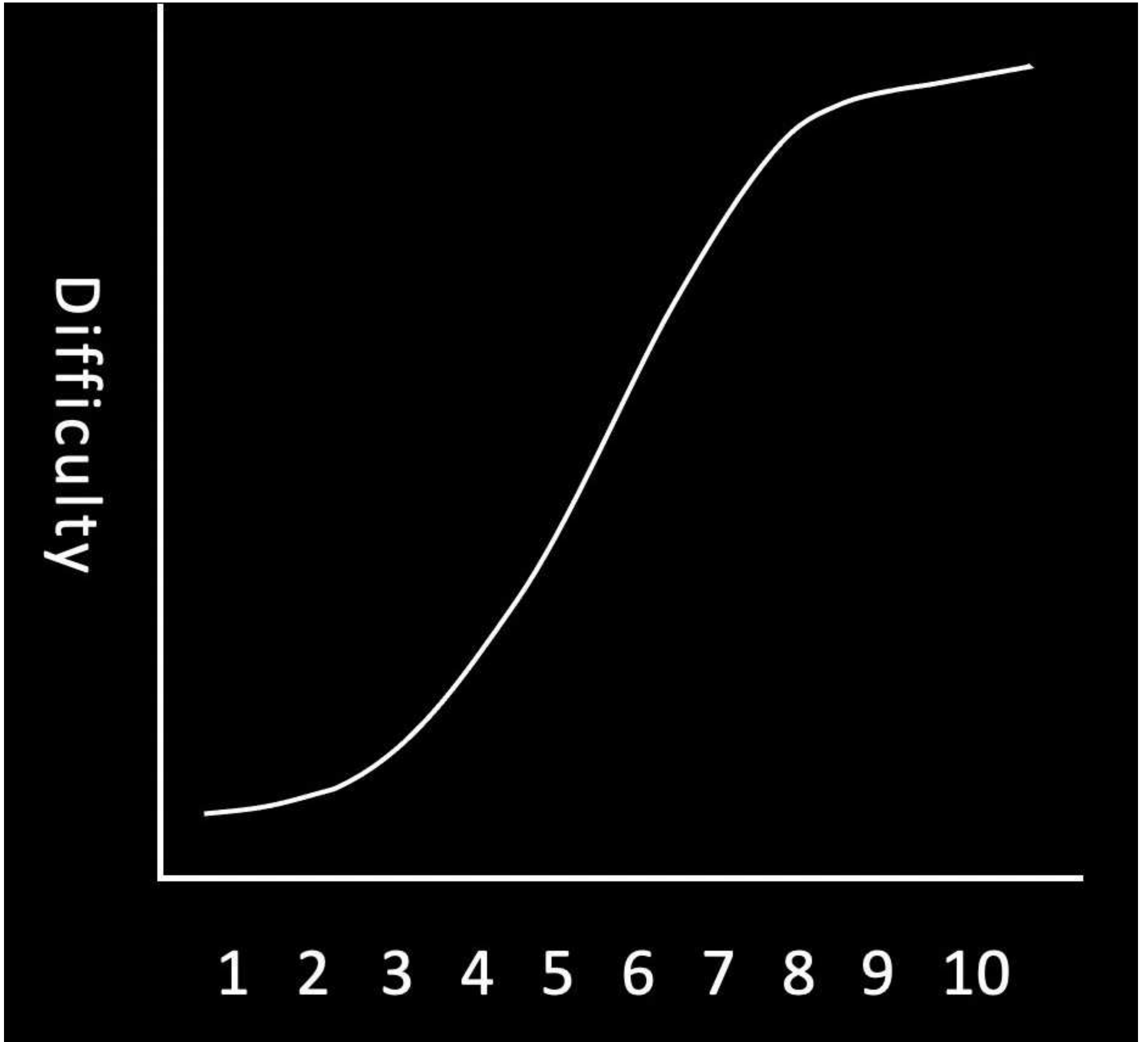
Where are we ?



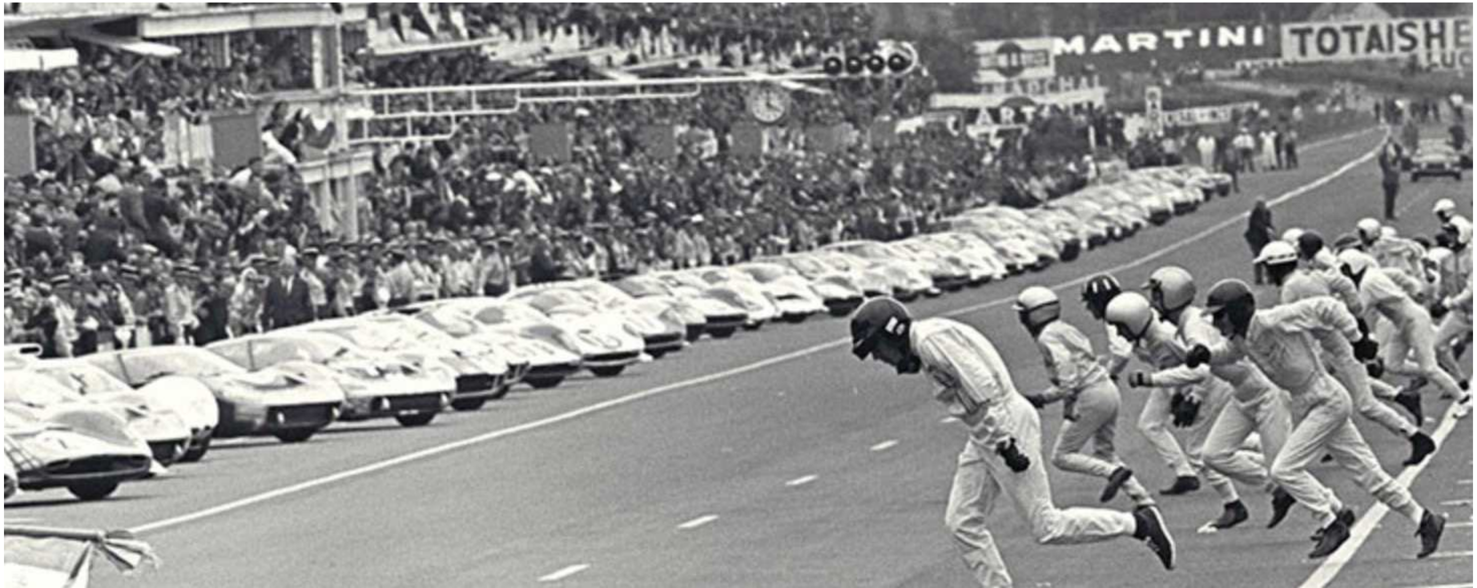
Metaphor

There are three ways to start a motor race:

Standing Start

Rolling Start

"Le Mans" Start



Which One ?

The "Rolling Start" is arguably the safest...

Everyone is already moving

Reduced risk of running into the back of people

We can be sure all cars are working correctly

Everyone is familiar with the circuit

This is the approach we are using on this unit

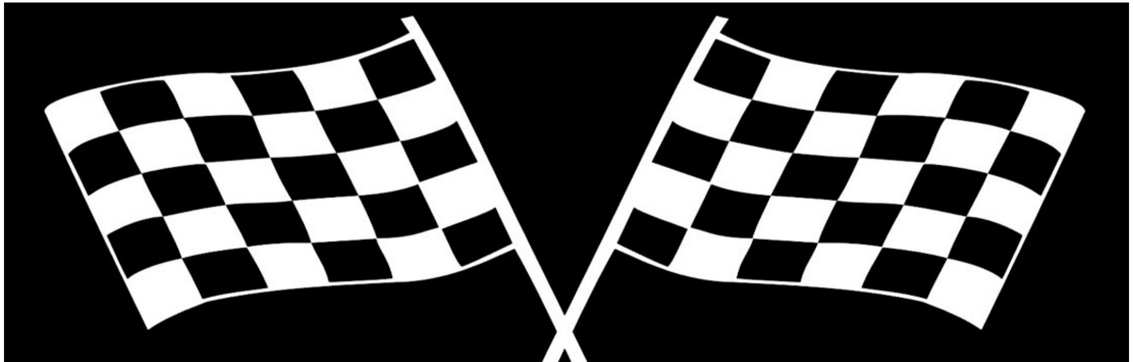
This coming week on "Computer Graphics"

We are actually going to draw something useful !

Our focus will be on a key drawing primitive:

△ △ △ "The Triangle" △ △ △

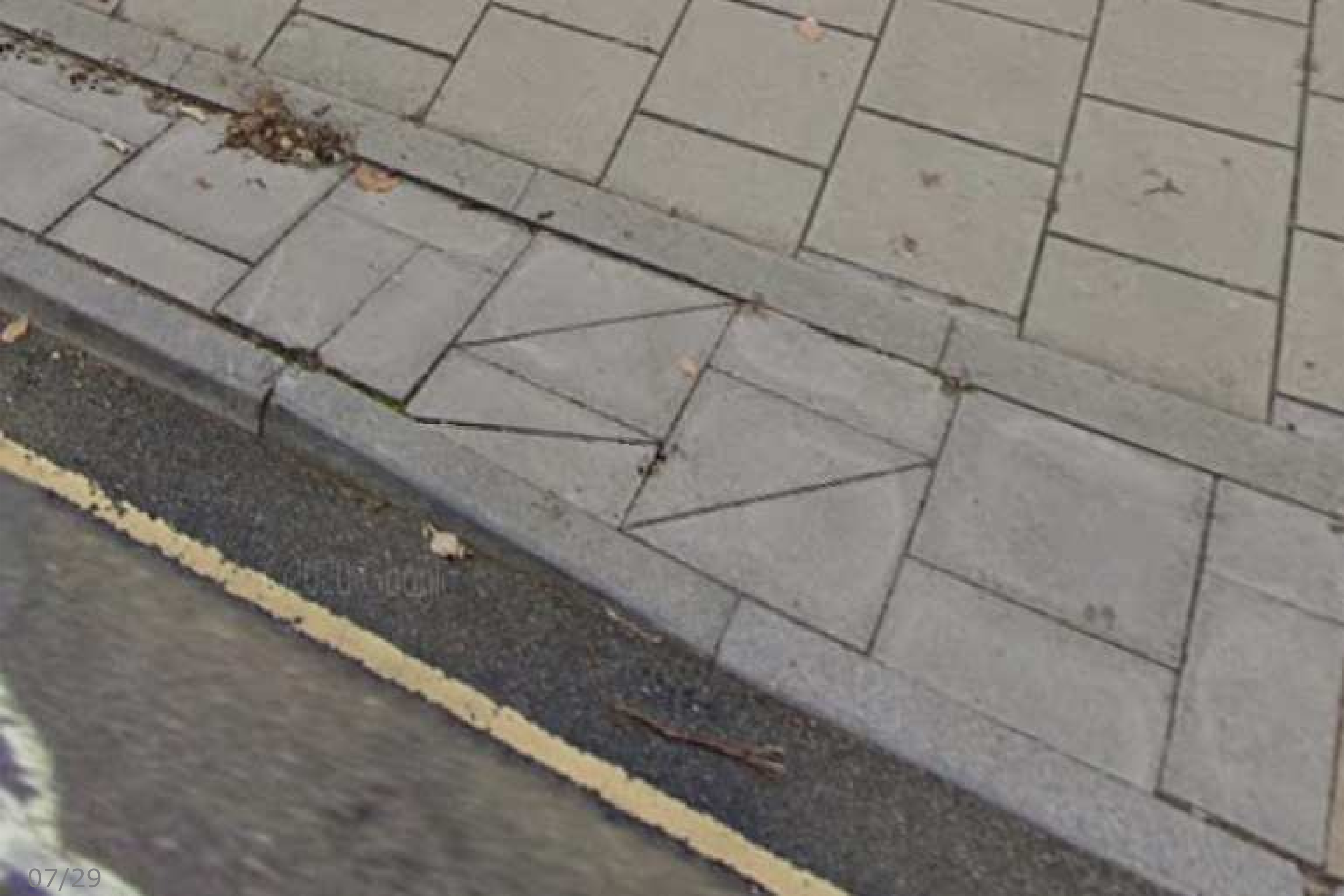
The primary building block for the rest of this unit !!!



Powerful Triangles

Although simple, Triangles are VERY powerful

A convenient structure to cover ANY surface



Using MANY triangles, we can create complex shapes

The Stanford Bunny (70k triangles)

What kinds of Triangle ?

In coming week we'll draw various types of triangle:

- Unfilled (also known as "stroked") triangles
- Filled triangles (with a choice of colours !)
- Composite triangles (filled AND stroked !!!)

Drawing triangles might seem trivial at first glance
But the devil is in the detail...
There is hidden complexity that we must deal with !

Challenges

Surely a "stroked" triangle is easy ?
It's just three straight lines ! △

Sure, currently we don't have a `drawLine` function
But we can just use the `setPixelColour` function
Call it lots of times to draw a sequence of pixels

We'll just need to calculate X and Y
for each point along the line
(with a nice bit of interpolation)

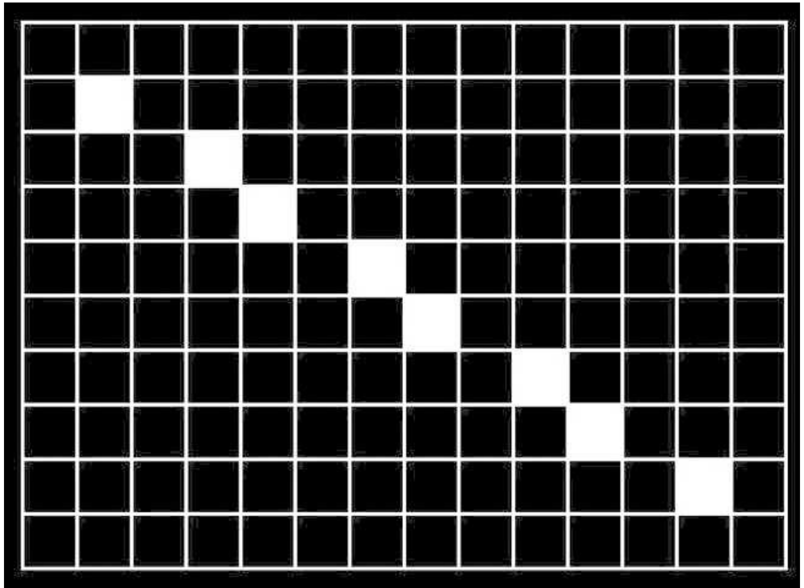
Not that easy !

We need to be a little bit careful

If we just loop through each ROW of the screen

```
for(int x=1; x<=8 ;x++) y = interpolate(x, ...)
```

We could end up drawing something like this:

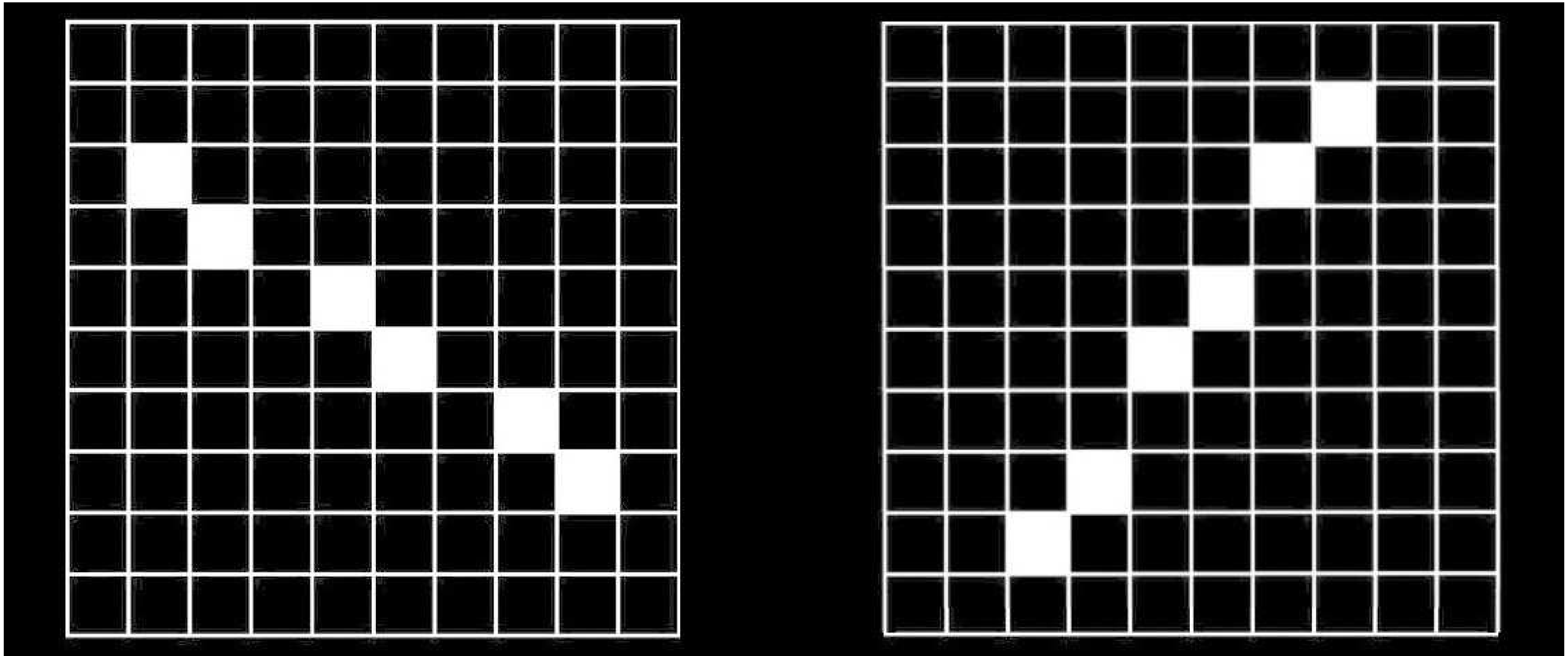


Needs Careful Handling

Neither can we ALWAYS just loop through columns

We must consider gradient of line when drawing pixels

Workbook provides details on how to deal with this



Filled Triangles - Any Easier ?

Filled triangles must surely be easier then ?

All we need to do is draw some horizontal lines

Starting and ending at the correct x positions

We just draw from the "left hand side"...

All the way to the "right hand side"

One row at a time

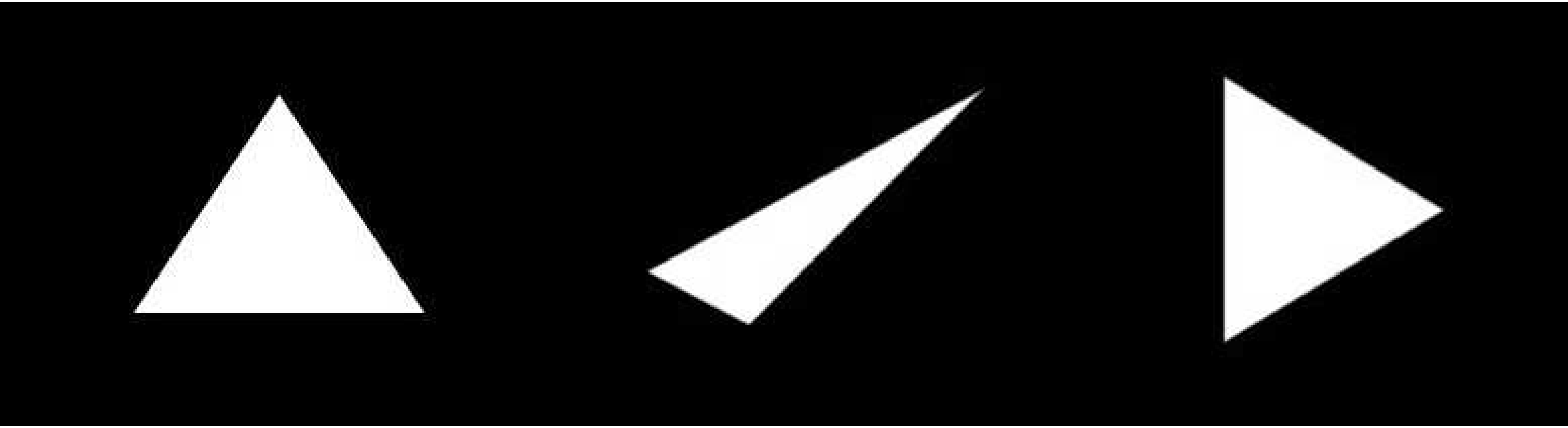
Top to bottom

Different types of triangle

However, non flat top/bottom triangles are harder

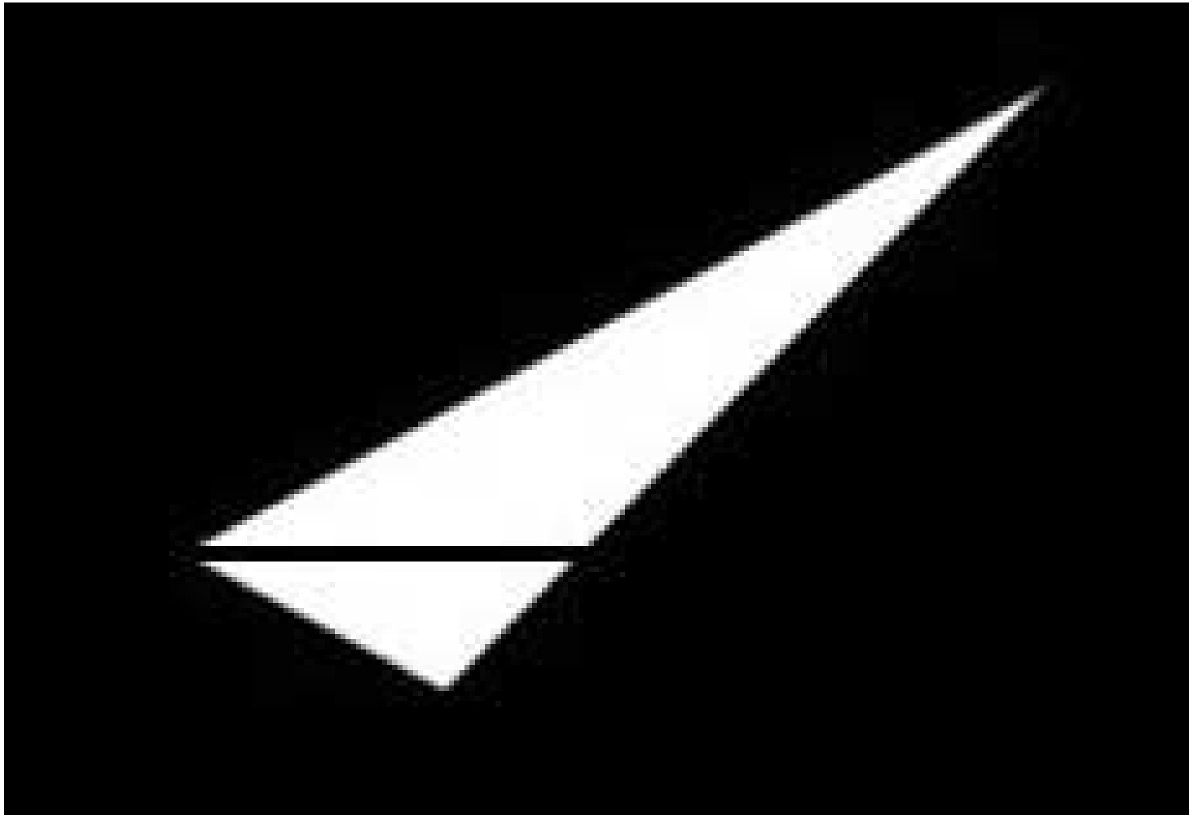
There isn't a "left hand side" and "right hand side"

This is because each triangle has THREE sides...



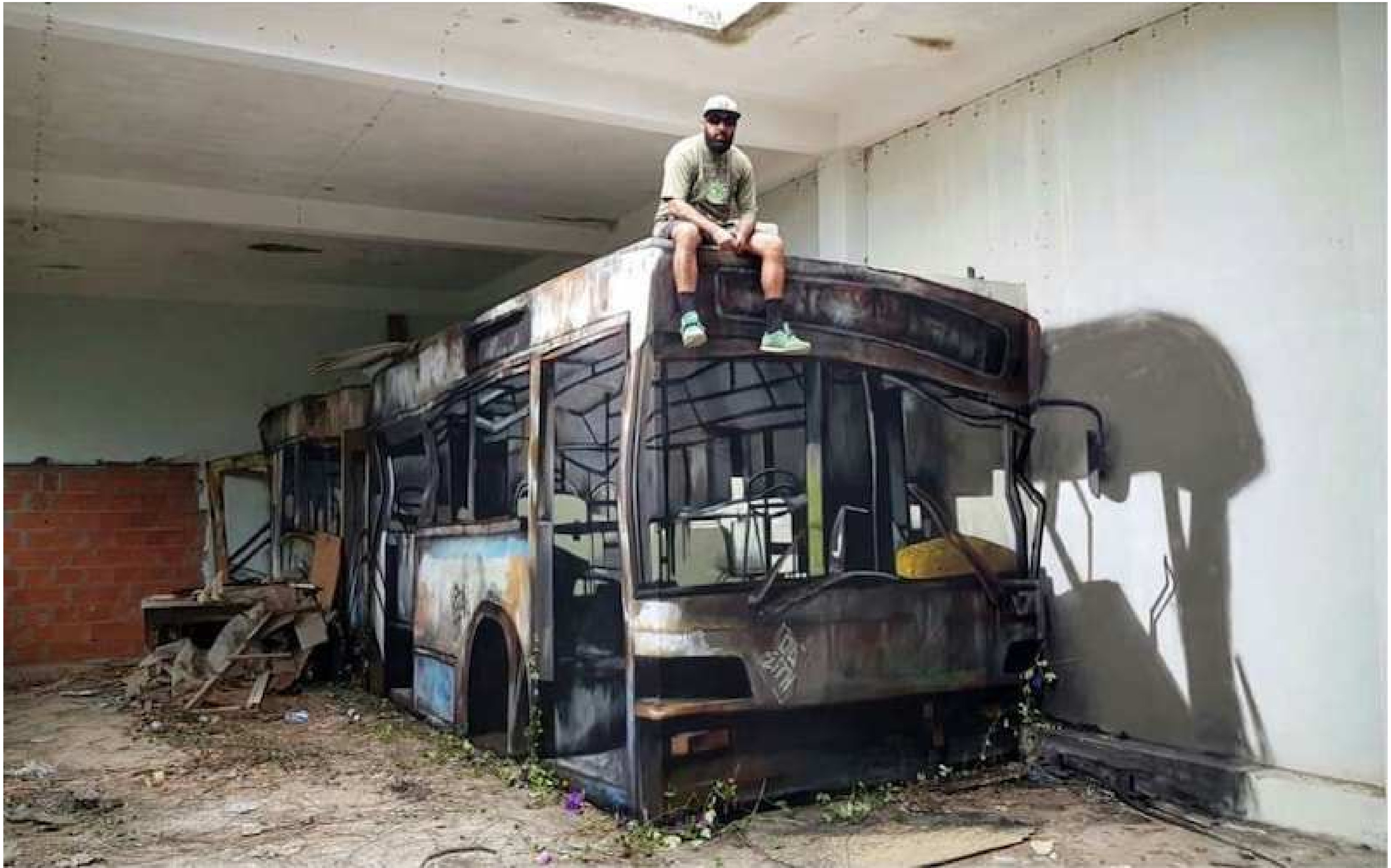
Workbook explains a technique for dealing with this !

(Hint: It's a lot easier if we split the triangle into 2)

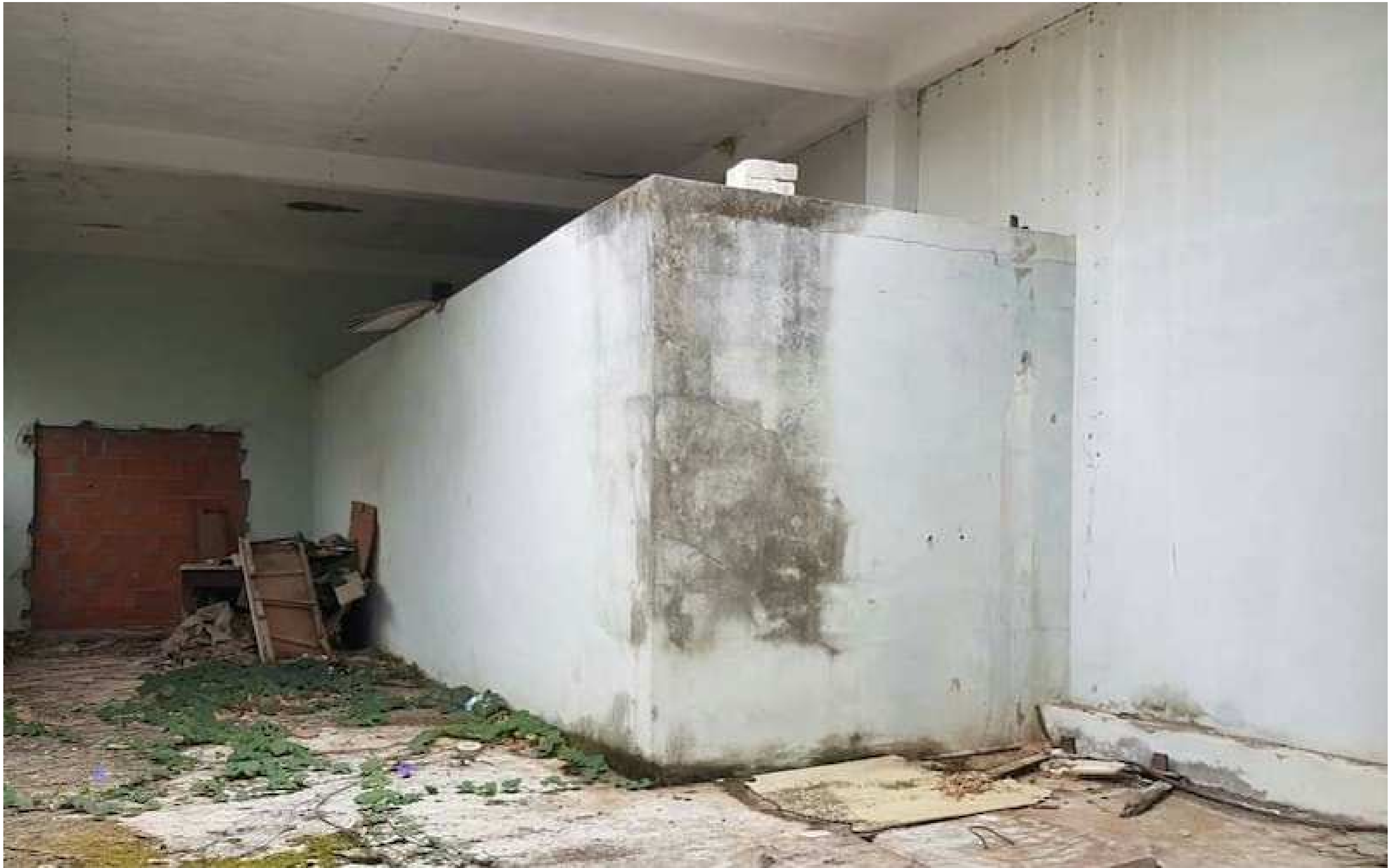


And if all that wasn't exciting enough...

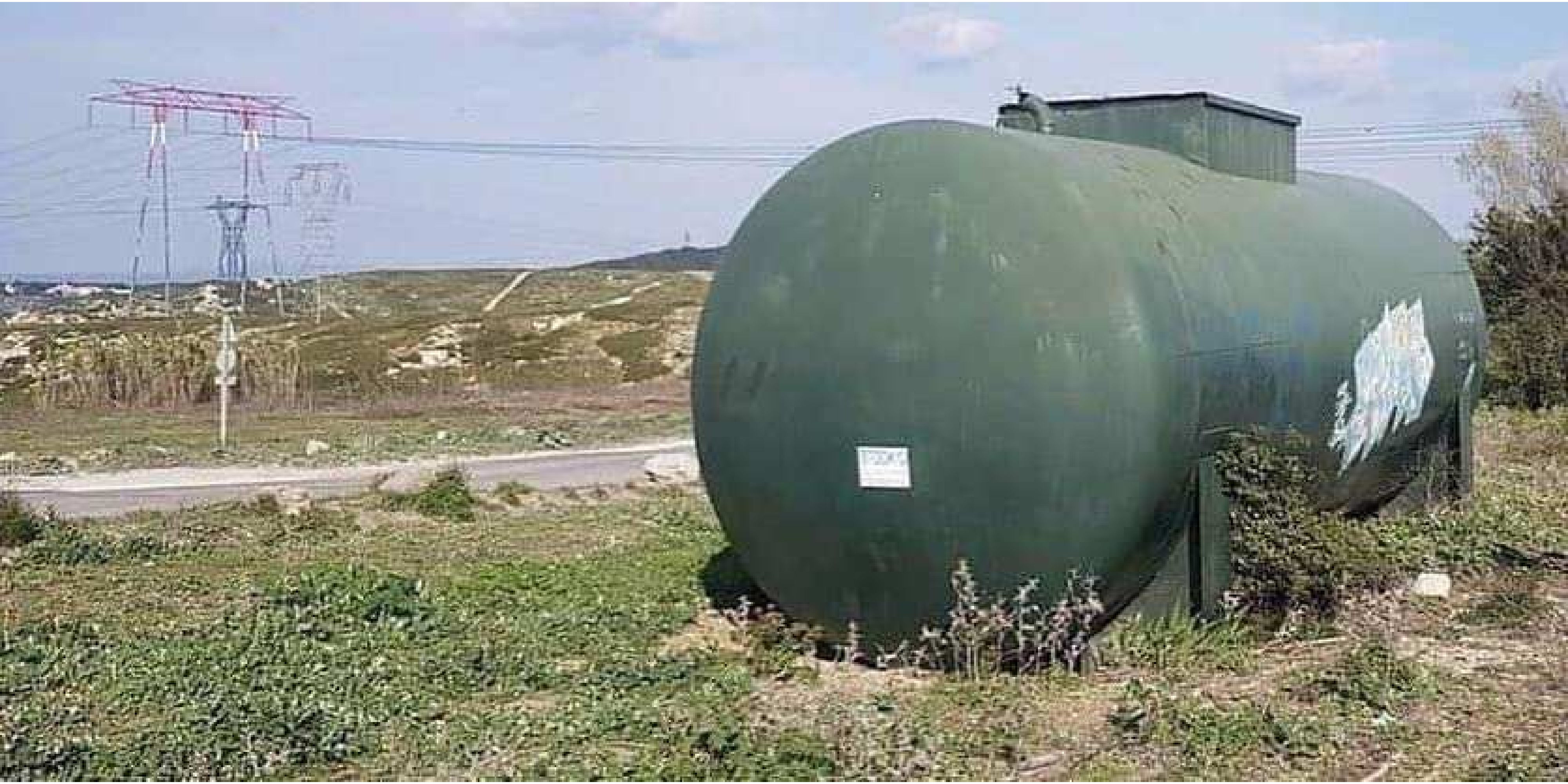
Sergio Odeith



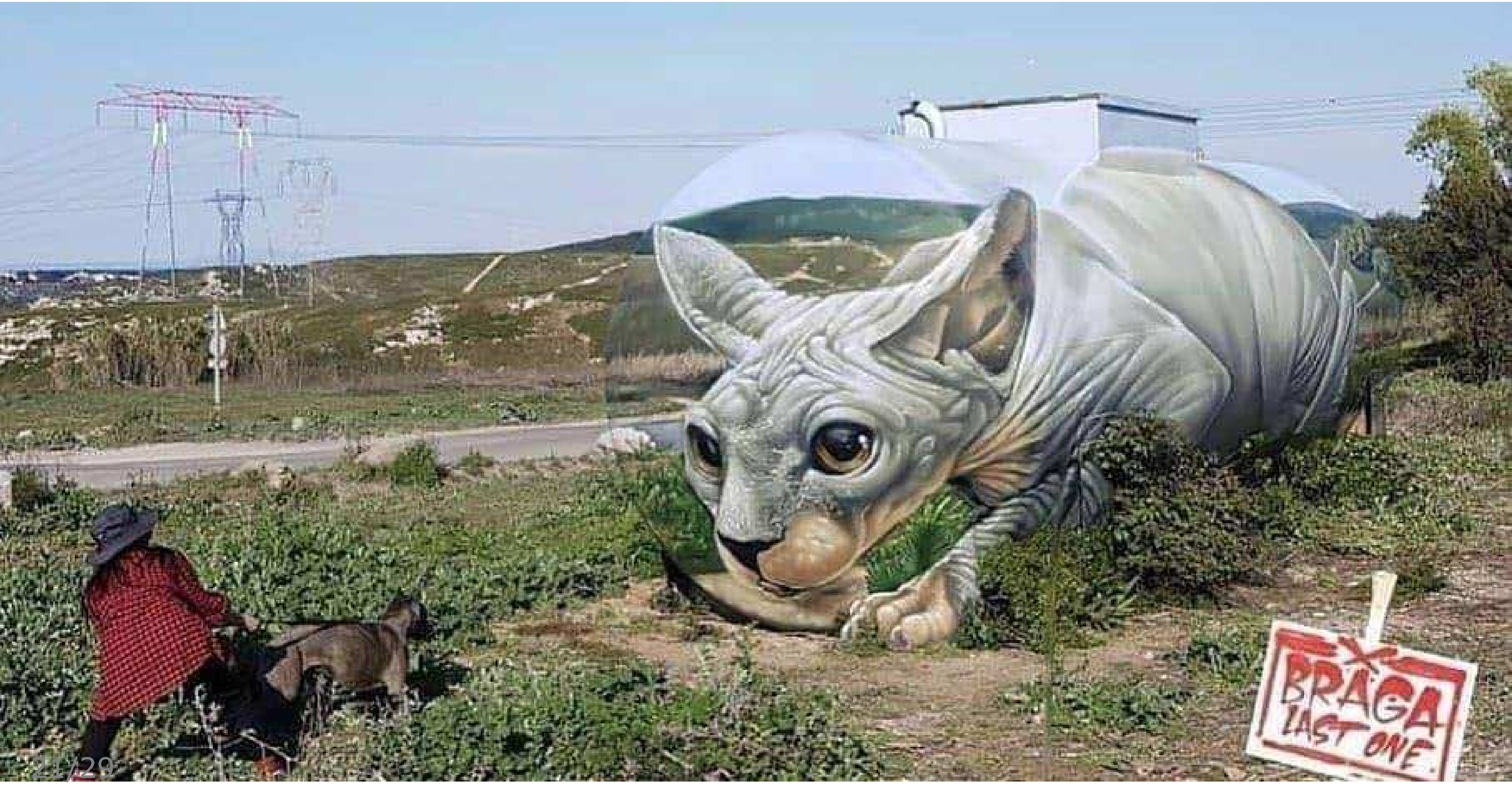
Sergio Odeith



Tom Bragado Blanco



Tom Bragado Blanco

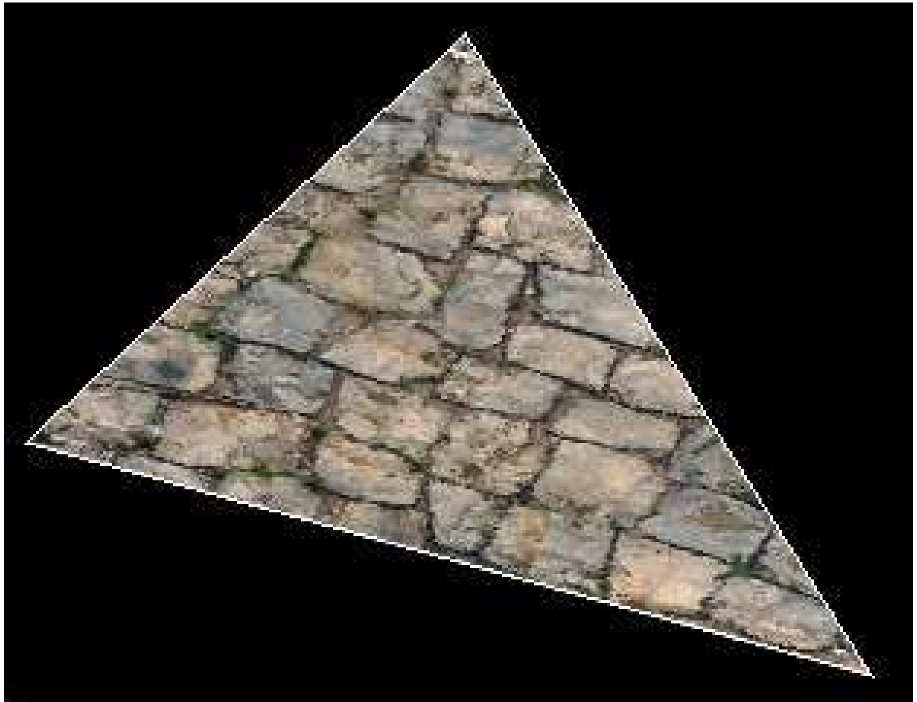


Your Objective

A texture is provided for you in the workbook

A reference image illustrates your final objective

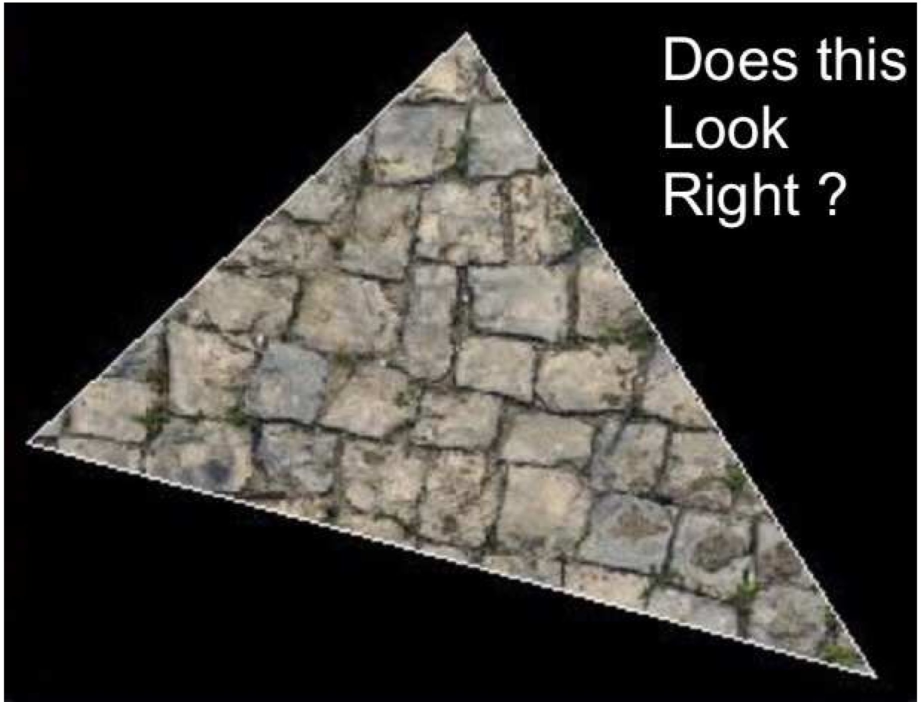
This allows you to "visually verify" your success



Implicit Feedback

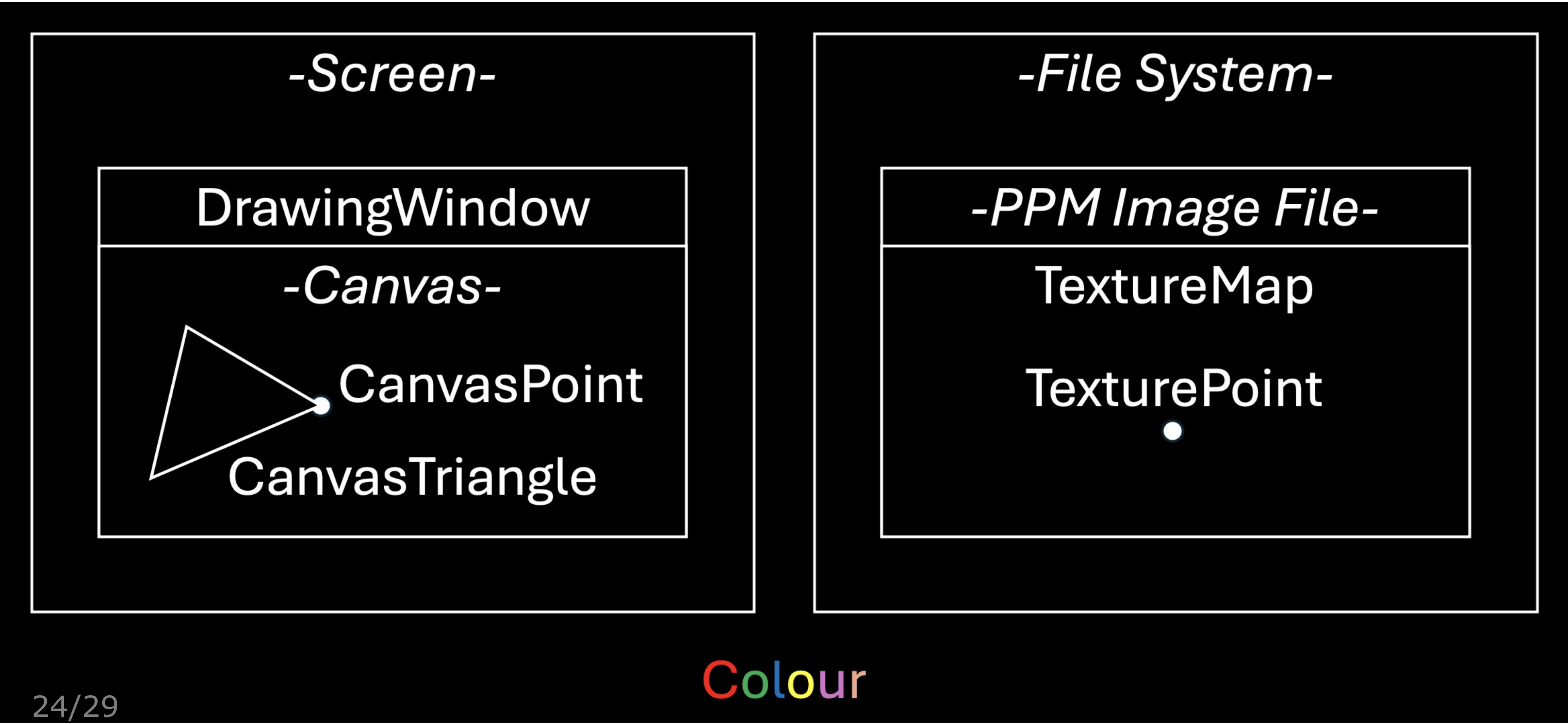
Reference image provides passive/implicit feedback

You can gauge how well you are currently doing and what aspects of your work need improving



Key Concepts and Provided Classes

All class source files can be found in libs/sdw



-Screen-

DrawingWindow

-Canvas-

CanvasPoint

CanvasTriangle

-File System-

-PPM Image File-

TextureMap

TexturePoint

Colour

Top Tips

You are about to embark on some complex coding

Just because it is "graphical" and "mathematical"
You shouldn't forget good programming practice

DON'T try to write it as one monolithic function
Remember to "Divide and Conquer"

Try to write modular reusable functions...

Potentially Useful Reusable Functions

Given a start and end point on a canvas...
Return a vector of ALL pixel positions along that line

Given a start and end point on a canvas...
Return the position of a SINGLE pixel on that line...
A specified proportional distance along that line

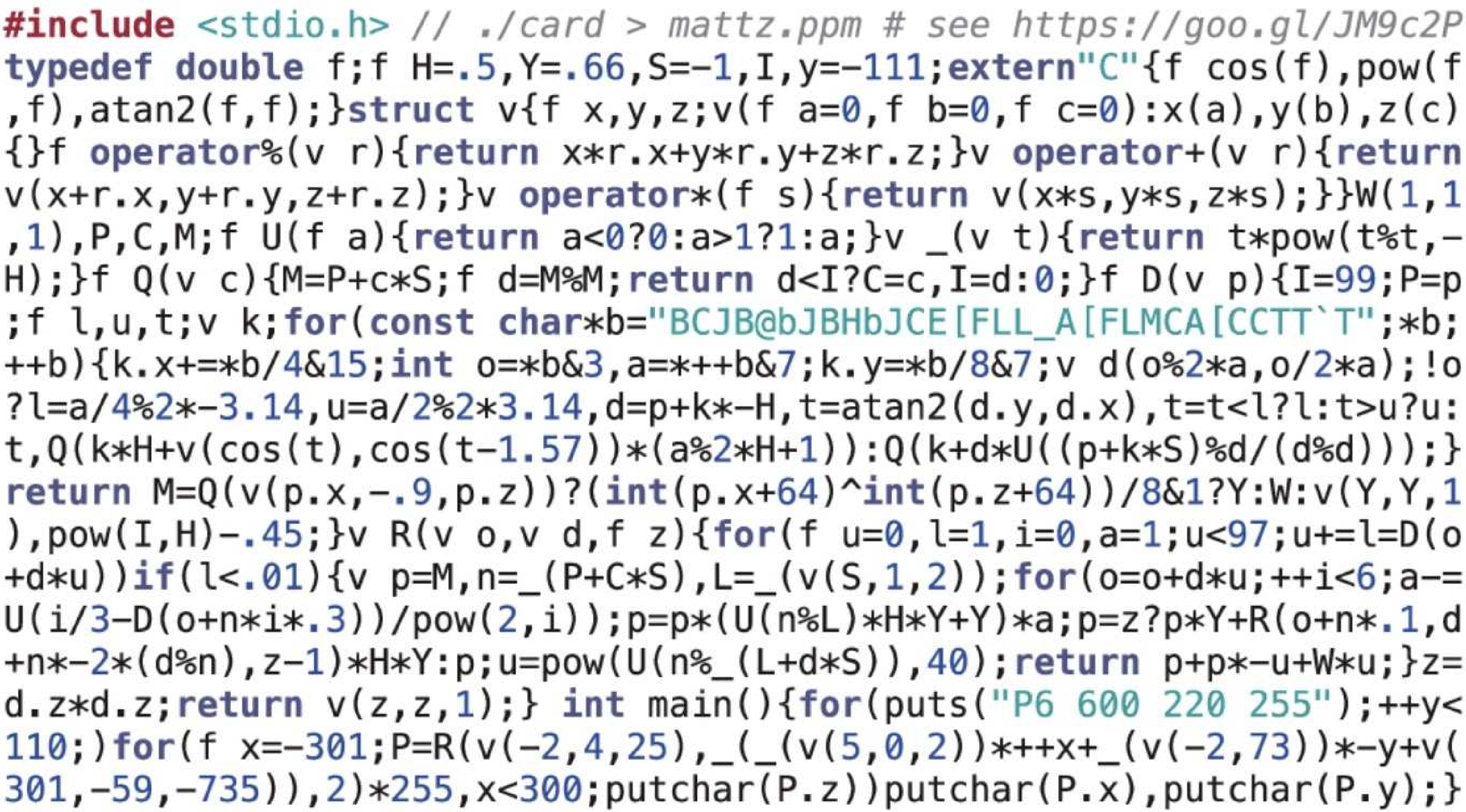
Given a start and end point on a texture...
Return the position of a SINGLE pixel on that line...
A specified proportional distance along that line

Meaningful Names

Mathematicians use very short names [x,y,z]
This is fine for tightly constrained problems

Complex and extensive code is very different
We soon get into difficulty if all names are short

Use useful and meaningful names for everything
Makes everyone's life much easier when debugging



```
#include <stdio.h> // ./card > mattz.ppm # see https://goo.gl/JM9c2P
typedef double f;f H=.5,Y=.66,S=-1,I,y=-111;extern"C"{f cos(f),pow(f
,f),atan2(f,f);}struct v{f x,y,z;v(f a=0,f b=0,f c=0):x(a),y(b),z(c)
{}f operator%(v r){return x*r.x+y*r.y+z*r.z;}v operator+(v r){return
v(x+r.x,y+r.y,z+r.z);}v operator*(f s){return v(x*s,y*s,z*s);}}W(1,1
,1),P,C,M;f U(f a){return a<0?0:a>1?1:a;}v _(v t){return t*pow(t%t,-
H);}f Q(v c){M=P+c*S;f d=M%M;return d<I?C=c,I=d:0;}f D(v p){I=99;P=p
;f l,u,t;v k;for(const char*b="BCJB@bJBHbJCE[FLL_A[FLMCA[CCTT`T";*b;
++b){k.x+=*b/4&15;int o=*b&3,a=*++b&7;k.y=*b/8&7;v d(o%2*a,o/2*a);!o
?l=a/4%2*-3.14,u=a/2%2*3.14,d=p+k*-H,t=atan2(d.y,d.x),t=t<l?l:t>u?u:
t,Q(k*H+v(cos(t),cos(t-1.57))*(a%2*H+1)):Q(k+d*U((p+k*S)%d/(d%d)));}
return M=Q(v(p.x,-.9,p.z))?(int(p.x+64)^int(p.z+64))/8&1?Y:W:v(Y,Y,1
),pow(I,H)-.45;}v R(v o,v d,f z){for(f u=0,l=1,i=0,a=1;u<97;u+=l=D(o
+d*u))if(l<.01){v p=M,n=_(P+C*S),L=_(v(S,1,2));for(o=o+d*u;++i<6;a-=
U(i/3-D(o+n*i*.3))/pow(2,i));p=p*(U(n%L)*H*Y+Y)*a;p=z?p*Y+R(o+n*.1,d
+n*-2*(d%n),z-1)*H*Y:p;u=pow(U(n%_(L+d*S)),40);return p+p*-u+W*u;}z=
d.z*d.z;return v(z,z,1);} int main(){for(puts("P6 600 220 255");++y<
110;)for(f x=-301;P=R(v(-2,4,25),_(_(v(5,0,2))*++x+_(v(-2,73))*-y+v(
301,-59,-735)),2)*255,x<300;putchar(P.z))putchar(P.x),putchar(P.y);}
```

Final Thoughts

Many of you still just use println/cout for debugging
You might like to consider using a *proper* debugger

`gdb on the command line, integrated tools in IDEs`

No pressure - whatever you are comfortable with...
...it's just that debugging 3D renders is a bit tricky
You are going to need all the help you can get !

debug