Shaders

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What is a shader ?

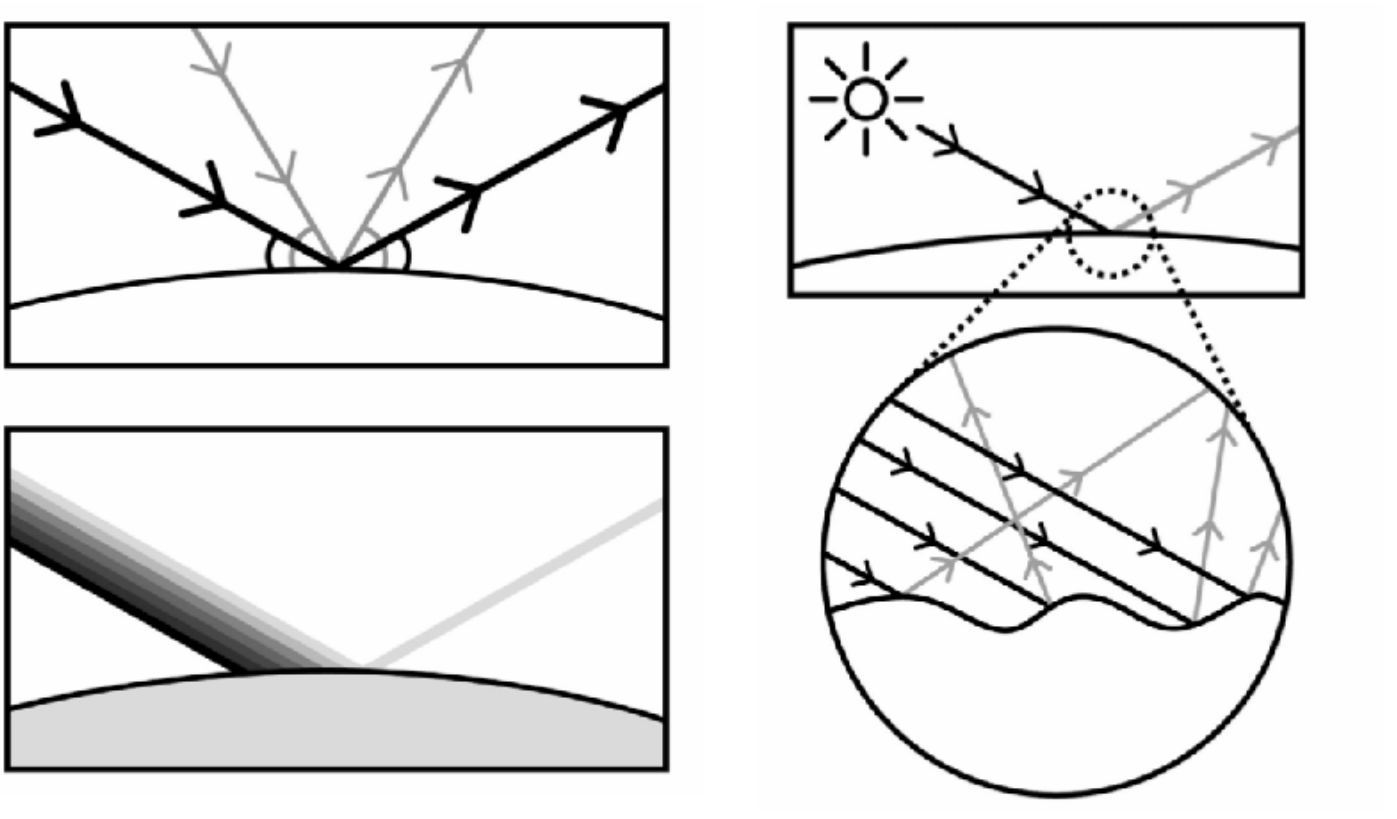
What is a shader ?

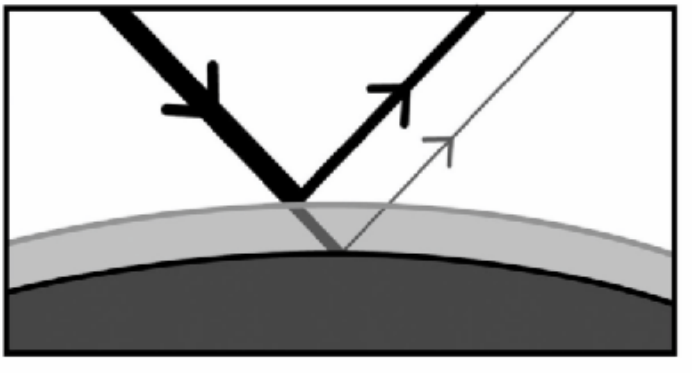
- A piece of code that runs on GPU
- ...which simulates some microscopic behaviour to create a photorealist image

- In the physical world, light bounces (or is absorbed) on atoms with complex shapes
- This is not possible in graphics rendering: the computing would be too expensive.
- So we use simple shapes (triangles) and shaders to SIMULATE light behaviour on surfaces.
- There are two phases to render with shader : the outline phase and the painting phase.
  The first choose to which triangle will belong a certain pixel of the screen
  The second calculates the color of each pixel

Why a shader ?

- In the physical world, light bounces (or is absorbed) on atoms with complex shapes

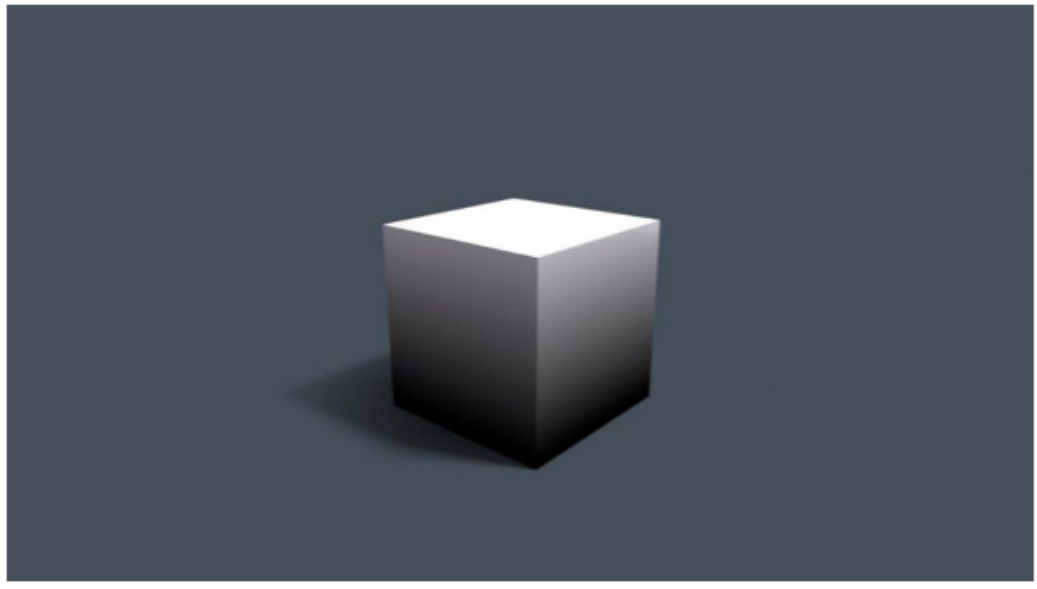




- This is not possible in graphics rendering: the computing would be too expensive.
- So we use simple shapes (triangles) and shaders to SIMULATE light behaviour on surfaces.

An exemple of rendering

- There are two phases to render with shader : the outline phase and the painting phase.
  The first choose to which triangle will belong a certain pixel of the screen
  The second calculates the color of each pixel



This scene has eight vertices, and it has been rendered to a 1920x1080 image (full HD resolution). What is happening exactly in the rendering process?

1. The scene's vertices and their respective data are passed to the vertex shader.

2. A vertex shader is executed on each of them.

3. The vertex shader produces an output data structure from each vertex, containing information such as color and position of the vertex on the final image.

4. Sequences of vertices are assembled into primitives, such as triangles, lines, points, and others. We'll assume triangles.

5. The rasterizer takes a primitive and transforms it into a list of pixels. For each potential pixel within that triangle, that structure's values are interpolated and passed to the pixel shader. (For example, if one vertex is green, and an adjacent vertex is red, the pixels between them will form a green to red gradient.) The rasterizer is part of the GPU; we can't customize it.

6. The fragment shader is run for any potential pixel. This is the phase that will be more interesting for us, as most lighting calculations happen in the fragment shader.

7. If the renderer is a forward render, for every light after the first, the fragment shader will be run again, with that light's data.

8. Each potential pixel (aka, fragment) is checked for whether there is another potential pixel nearer to the camera, therefore in front of the current pixel. If there is, the fragment will be rejected.

9. All the fragment shader light passes are blended together.

10. All pixel colors are written to a render target (could be the screen, or a texture, or a file, etc.)

Different kinds of shaders

- Vertex shader: Executed on every vertex.
- Fragment shader: Executed for every possible final pixel (known as a fragment).

In this course, we will use Unity. Unity has special shaders :

- Unlit shader: Unity-only, a shader that combines a vertex and pixel shader in one file.
- Surface shader: Unity-only, contains both vertex and fragment shader functionality, but takes advantage of the ShaderLab extensions to the Cg shading language to automate some of the code that's commonly used in lighting shaders.
- Image Effect shader: Unity-only, used to apply effects like Blur, Bloom, Depth of Field, Color Grading, etc. It is generally the last shader run on a render, because it's applied to a render of the geometry of the scene.

Unity uses two languages in its shaders : NVidia's CGLanguage, and ShaderLab, built in Unity.

There are also ohers shaders, for instance :

- Compute shader: Computes arbitrary calculations, not necessarily rendering, e.g., physics simulation, image processing, raytracing, and in general, any task that can be easily broken down into many independent tasks.

Programming your first shader

Most editors have visual programming tools to create shaders, but they restrict programming freedom, and sometimes generate bad code. So we will learn to program shaders by hand.

- Create a 3d object / sphere
- Create a Materials folder and a material that you will name RedMaterial
- Create a Shaders folder and create an Unlit shader inside
- Assign the RedShader to the RedMaterial by changing the "standard" shader in the material's dropdown menu. Then drag and drop the material on the sphere. It will become completely white.
- Open the shader code

Default unlit shader

```
Shader "Unlit/RedShader"
{
	Properties
	{
		_MainTex ("Texture", 2D) = "white" {}
	}
	SubShader
	{
		Tags { "RenderType"="Opaque" }
		LOD 100

		Pass
		{
			CGPROGRAM
			#pragma vertex vert
			#pragma fragment frag
			// make fog work
			#pragma multi_compile_fog

			#include "UnityCG.cginc"

			struct appdata
			{
				float4 vertex : POSITION;
				float2 uv : TEXCOORD0;
			};

			struct v2f
			{
				float2 uv : TEXCOORD0;
				UNITY_FOG_COORDS(1)
				float4 vertex : SV_POSITION;
			};

			sampler2D _MainTex;
			float4 MainTexST;

			v2f vert (appdata v)
			{
				v2f o;
				o.vertex = UnityObjectToClipPos(v.vertex);
				o.uv = TRANSFORM_TEX(v.uv, _MainTex);
				UNITY_TRANSFER_FOG(o,o.vertex);
				return o;
			}

			fixed4 frag (v2f i) : SV_Target
			{
				// sample the texture
				fixed4 col = tex2D(_MainTex, i.uv);
				// apply fog
				UNITY_APPLY_FOG(i.fogCoord, col);
				return col;
			}
			ENDCG
		}
	}
}
```

Properties of the shader

There can be different subshaders with several passes

Information. Here, which rendering queue (opaque or transparent)

Starts program. Uses Nvidia CGLanguage

Shader compilation info

Library files needed to compile shaders

Information that comes from the app to the vertex shader

Information that will pass from vertex to fragment shader

Names after semicolumns are Semantics, that will be stored in the struct

Define the properties types and variables used in the shader program

The names that were defined in the #pragma

Ends program

The red shader code

Simplify the shader so it will become :

```
Shader "Unlit/RedShader"
{
	SubShader
	{
		Tags { "RenderType"="Opaque" }

		Pass
		{
			CGPROGRAM
			#pragma vertex vert
			#pragma fragment frag

			#include "UnityCG.cginc"

			struct appdata
			{
				float4 vertex : POSITION;
			};

			struct v2f
			{
				float4 vertex : SV_POSITION;
			};

			v2f vert (appdata v)
			{
				v2f o;
				o.vertex = UnityObjectToClipPos(v.vertex);
				return o;
			}

			fixed4 frag (v2f i) : SV_Target
			{
				return fixed4(1, 0, 0, 1);
			}
			ENDCG
		}
	}
}
```

Add properties

Let's add a property. We don't want a hard coded color. Let's add a property :

```
Properties
{
        _Color ("Color", Color) = (1,0,0,1)
}
```

Add the variable in the program, and return the variable in the fragment shader.

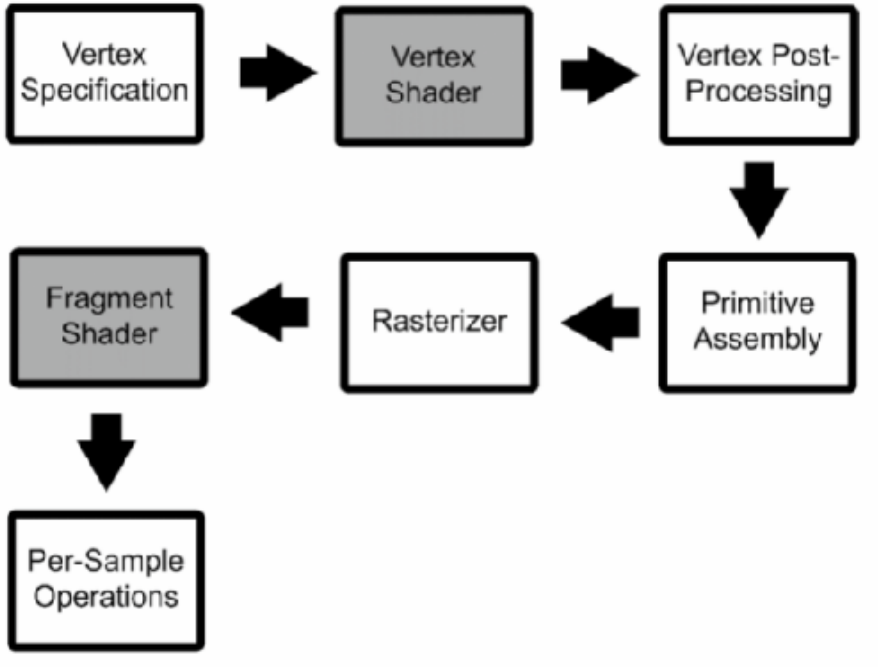
```
fixed4 _Color;
...

fixed4 frag (v2f i) : SV_Target
{
    return _Color;
}
```

Now you can modify the color in the material.

Rename the shader to MonochromeShader, and update the path.

The graphics pipeline in a real-time engine

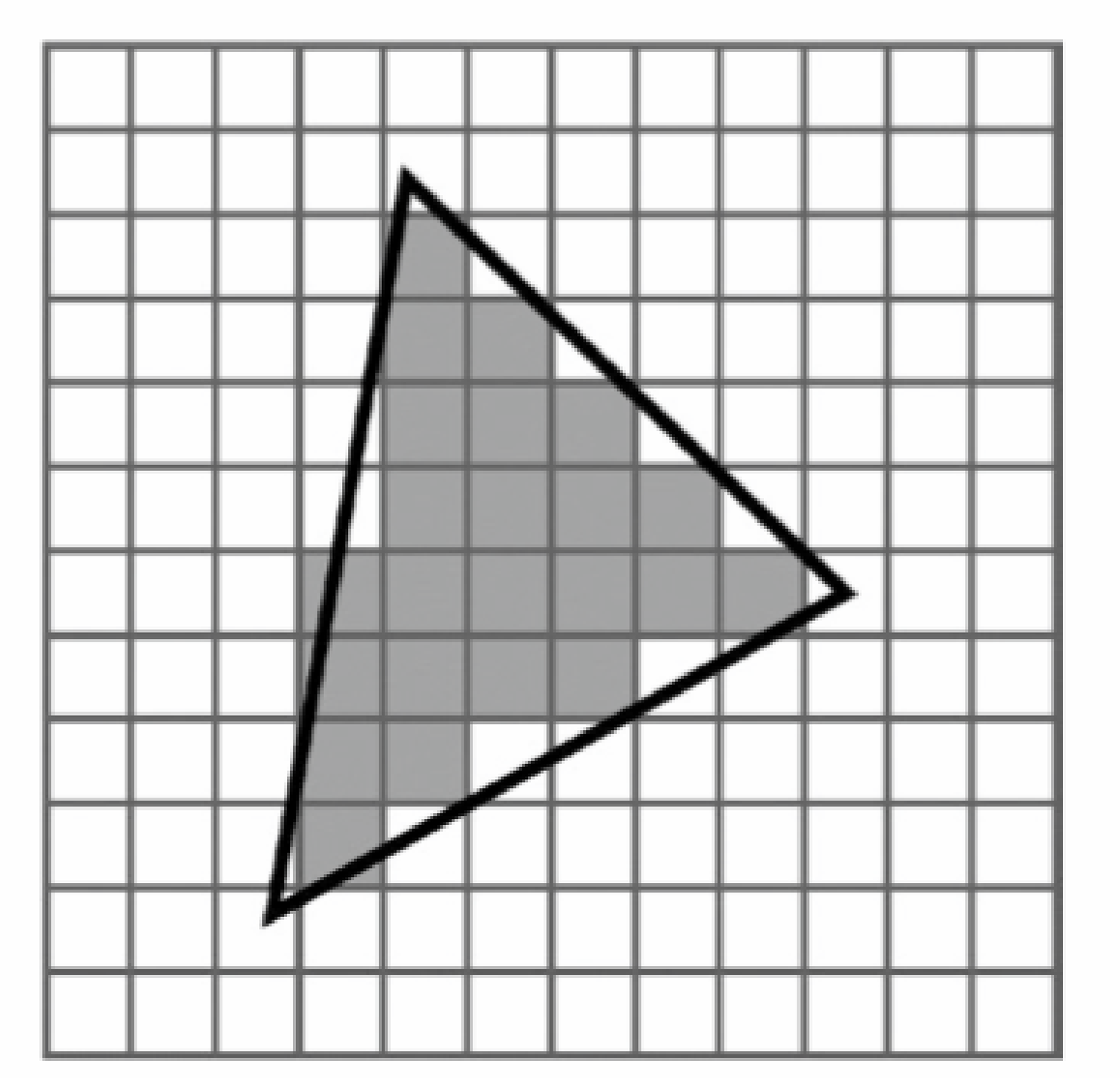
Stages



The stages of an example graphics pipeline are as follows:

- The input assembly stage gathers data from the scene (meshes, textures, and materials) and organizes it to be used in the pipeline.
- The vertex processing stage gets the vertices and their info from the previous stage and executes the vertex shader on each of them. The main objective of the vertex shader used to be obtaining 2D coordinates out of vertices. In more recent API versions, that is left to a different, later stage.
- The vertex post-processing stage includes transformations between coordinate spaces and the clipping of primitives that are not going to end up on the screen.
- The primitive assembly stage gathers the data output by the vertex processing stages in a primitive and prepares it to be sent to the next stage.
- The rasterizer is not a programmable stage. It takes a triangle (three vertices and their data) and creates potential pixels (fragments) out of it. It also produces an interpolated version of the vertex attributes data for each of the fragments and a depth value.
- The fragment shader stage runs the fragment shader on all the fragments that the rasterizer produces. In order to calculate the color of a pixel, multiple fragments may be necessary (e.g., antialiasing).
- The output merger performs the visibility test that determine whether a fragment will be overwritten by a fragment in front of it. It also does other tests, such as the blending needed for transparency, and more.

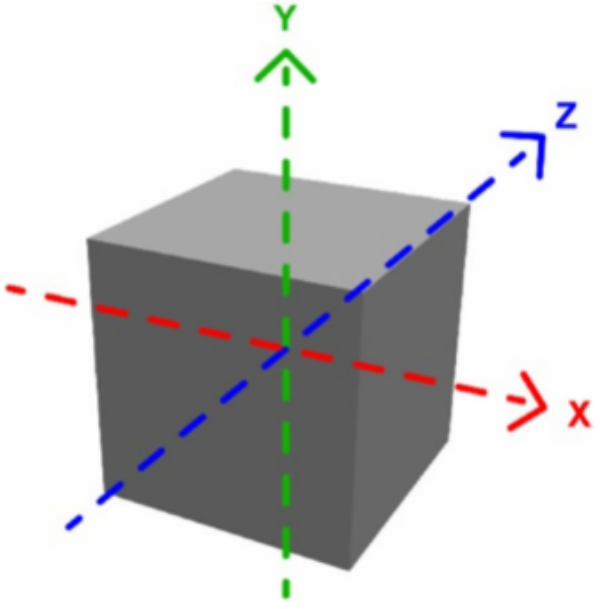
What the rasterizer does



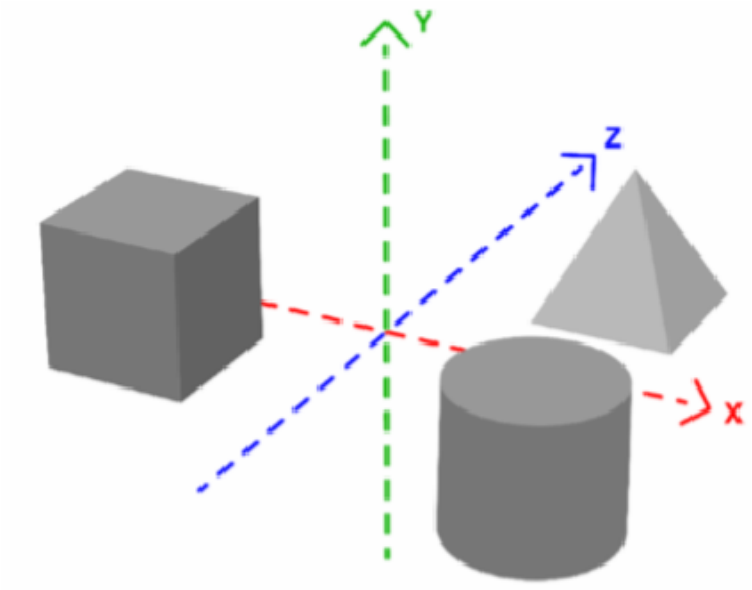
Transformations between spaces

Spaces

In real time graphics, coordinates are transformed between different spaces. Shaders computations are supposed to be done in specific coordinates spaces. This part of the lesson will presents the commonly used spaces.



Local/Object space



World space

- float3 UnityObjectToWorldDir(in float3 dir)

takes a direction in Object Space and transforms it to a direction in World Space

- float3 UnityObjectToWorldNormal(in float3 norm)

takes a normal in Object Space and transforms it to a normal in World Space; useful for lighting calculations

- float3 UnityWorldSpaceViewDir(in float3 worldPos)

takes a vertex position in World Space and returns the view direction in World Space; useful for lighting calculations

- float3 UnityWorldSpaceLightDir(in float3 worldPos)

takes a vertex position in World Space and returns the light direction in World Space; useful for lighting calculations

Mathemaically, space transformations are 4x4 matrix multiplications. Here are some of the built-in Unity matrices for transformation from and to Object Space:

- unity_ObjectToWorld, which is a matrix that transforms from Object Space to World Space
- unity_WorldToObject, the inverse of the above, is a matrix that transforms from World Space to Object Space

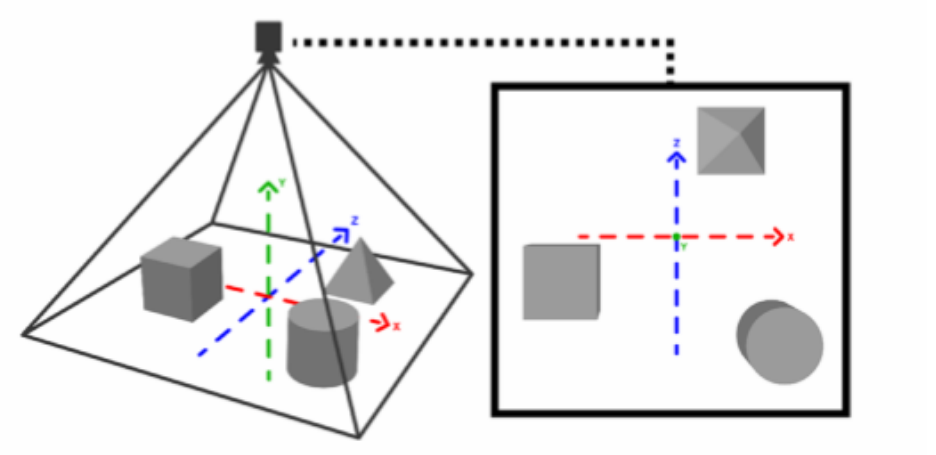
As an example, let's translate the vertex position from Object Space to World Space:

```
float4 vertexWorld = mul(unity_ObjectToWorld, v.vertex);
```

Spaces

Camera space

Also called View space :



There are a couple of built-in matrices for Camera Space:

- unity_WorldToCamera, which transforms from World Space to Camera Space
- unity_CameraToWorld, the inverse of the above, transforms from Camera Space to World Space

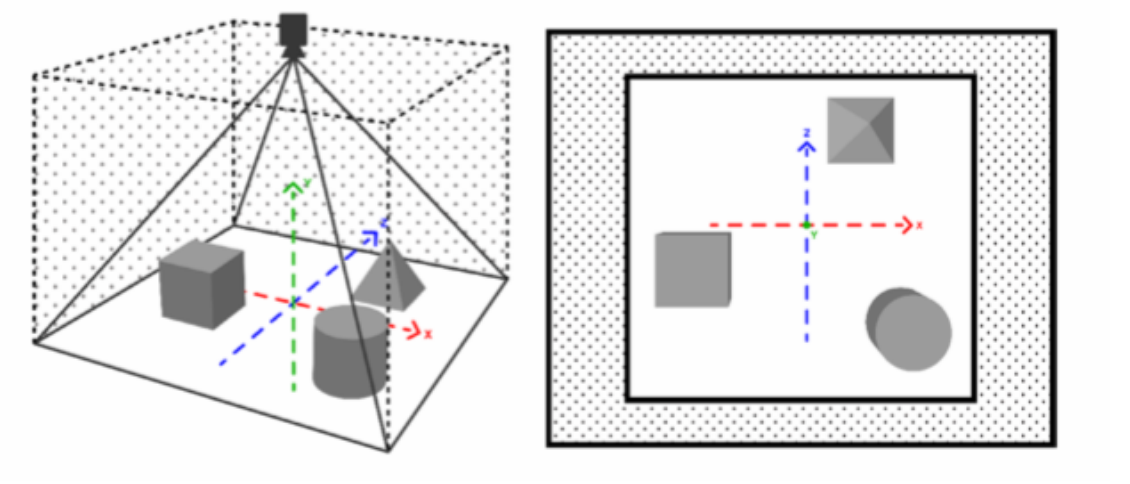
There is also one built-in function:

- float4 UnityViewToClipPos(in float3 pos) transforms a position from View Space to Clip Space

Spaces

Clip space

Range from -1 to 1 and remove all primitives outside the frustrum (cf. rendering basics).



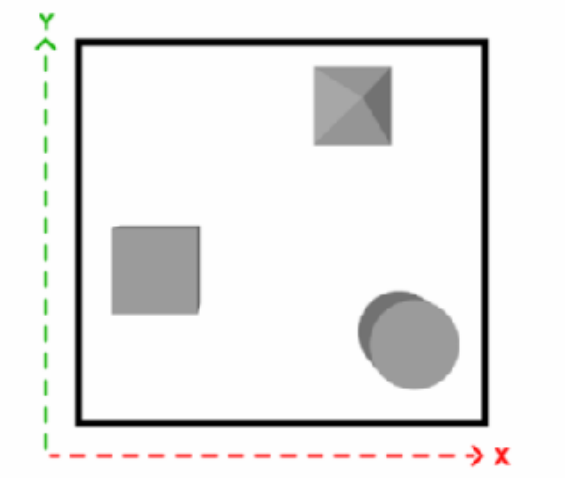
There are no built-in matrices for Clip Space, but there are some built-in functions for it:

- float4 UnityWorldToClipPos(in float3 pos), which transforms a position from World Space to Clip Space
- float4 UnityViewToClipPos(in float3 pos), which transforms a position from View Space to Clip Space
- float4 UnityObjectToClipPos(in float3 pos), which transforms a vertex position from Object Space to Clip Space

Normalized Device Coordinates (NDC)

Next up are the Normalized Device Coordinates (NDC). This is a 2D space that is independent of the specific screen or image resolution. Coordinates in NDC are obtained by diving Clip coordinates by the homogeneous coordinate (w, the 4th coordinate of the 4x4 transformation matrices), a process called perspective division. Again, NDC coordinates range from -1 to 1 in OpenGL. NDC uses three numbers instead of two, as you'd expect it to, but in this case the z coordinate is used for the depth buffer, rather than being a homogeneous coordinate.

Screen Space



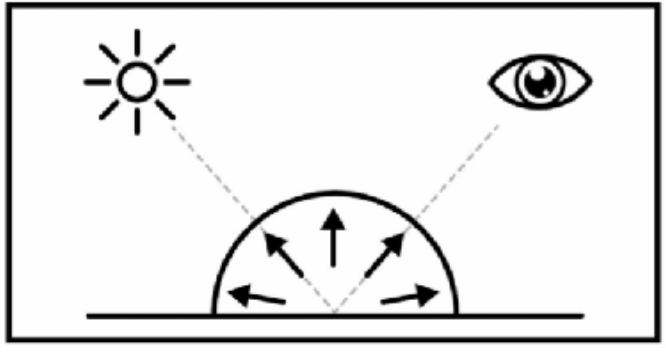
Screen Space is the coordinate space of the 2D render target. That may be a screen buffer, or a separate render target, or an image. It is obtained by transforming and scaling NDC into viewport resolution. Finally, these screen coordinates of the vertices are passed to the rasterizer, which will use them to produce fragments.

First lighting shader

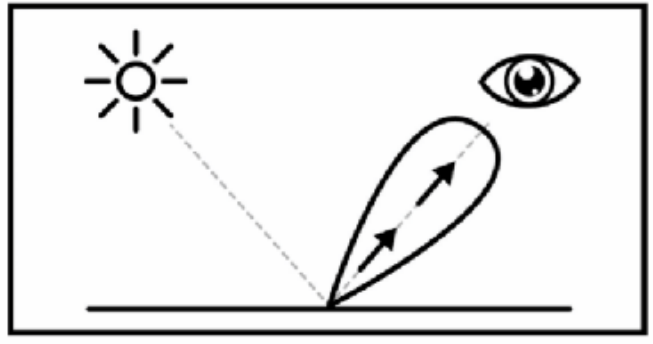
Before Physically Based Rendering

Before PBR, real time, rendering used rough approximations to simulate light behaviour. The shading used three components :

- Ambiant lighting, a color that gives the scene a non-black tone
- Diffuse lighting, where light bounces on surfaces in every possible directions
- Specular lighting, where light bounces on surfaces only in a few directions



Diffuse

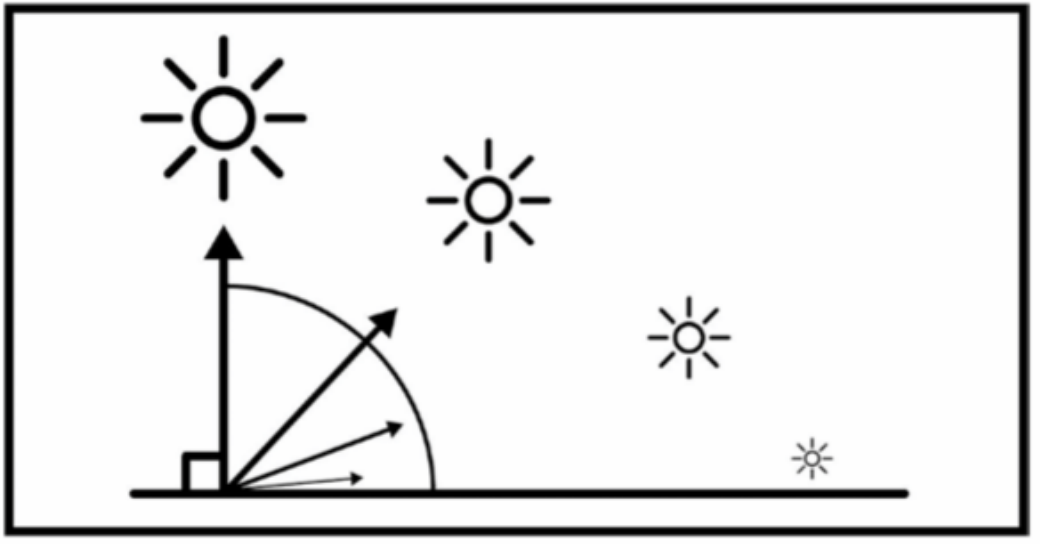


Specular

Angle of incidence and Lambert reflectance

To know how much light a surface receives, we can use the angle of incidence.

A surface will receive maximum light if the light emiter is just above its normal. It will receive no light if the light emiter is perpendicular to the normal. We can use the dot product of the light vector and the normal vector to compute brightness.



```
float brightness = dot( normal, lightDir )  //  brightness calculated from the Normal and Light directions
float3 pixelColor = brightness * lightColor * surfaceColor // final value of the surface color
```

This is the lambert approximation we have seen in the first lesson about rendering. Let's implement it in a shader.

Lambert shader

```
Shader "Custom/DiffuseShader"
{
    Properties
    {
        _Color ("Color", Color) = (1,0,0,1)
    }
    SubShader
    {
        Tags { "LightMode" = "ForwardBase" }
        LOD 100
        Pass
        {
            CGPROGRAM
            #pragma vertex vert
            #pragma fragment frag
            #include "UnityCG.cginc"
            #include "UnityLightingCommon.cginc"

            struct appdata
            {
                float4 vertex : POSITION;
                float3 normal : NORMAL;
            };

            struct v2f
            {
                float4 vertex : SV_POSITION;
                float3 worldNormal : TEXCOORD0;
            };

            float4 _Color;

            v2f vert (appdata v)
            {
                v2f o;
                o.vertex = UnityObjectToClipPos(v.vertex);
                float3 worldNormal = UnityObjectToWorldNormal(v.normal);
                o.worldNormal = worldNormal;
                return o;
            }

            float4 frag (v2f i) : SV_Target
            {
                float3 normalDirection = normalize(i.worldNormal);
                float nl = max(0.0, dot(normalDirection, _WorldSpaceLightPos0.xyz));
                float4 diffuseTerm = nl * _Color * _LightColor0;
                return diffuseTerm;
            }
            ENDCG
        }
    }
}
```

This pass will be used for the first light pass of the forward renderer

Contains functions about lighting

We need to ask the renderer what is the normal, so we add it in appdata

Output info

Calculate the normal in world coordinates

Compute the incidence, then multiply by color of the surface and color of the light

Add a texture

```
Shader "Custom/DiffuseShader"
{
    Properties
    {
        __Color ("Color", Color) = (1,0,0,1)
        __DiffuseTex ("Texture", 2D) = "white" {}
    }
    SubShader
    {
        Tags { "LightMode" = "ForwardBase" }
        LOD 100
        Pass
        {
            CGPROGRAM
            #pragma vertex vert
            #pragma fragment frag
            #include "UnityCG.cginc"
            #include "UnityLightingCommon.cginc"

            struct appdata
            {
                float4 vertex : POSITION;
                float3 normal : NORMAL;
                float2 uv : TEXCOORD0;
            };

            struct v2f
            {
                float4 vertex : SV_POSITION;
                float3 worldNormal : TEXCOORD1;
                float2 uv : TEXCOORD0;
            };

            sampler2D _DiffuseTex;
            float4 _DiffuseTex_ST;
            float4 _Color;

            v2f vert (appdata v)
            {
                v2f o;
                o.vertex = UnityObjectToClipPos(v.vertex);

                o.uv = TRANSFORM_TEX(v.uv, _DiffuseTex);

                float3 worldNormal = UnityObjectToWorldNormal(v.normal);
                o.worldNormal = worldNormal;
                return o;
            }

            float4 frag (v2f i) : SV_Target
            {
                float3 normalDirection = normalize(i.worldNormal);

                float4 tex = tex2D(_DiffuseTex, i.uv);

                float nl = max(0.0, dot(normalDirection, _WorldSpaceLightPos0.xyz));
                float4 diffuseTerm = nl * _Color * tex * _LightColor0;
                return diffuseTerm;
            }
            ENDCG
        }
    }
}
```

Add a texture property

Texture coordinates

Change to TEXCOORD1

Add UVs

Add variables for texture

Calculate the normal in world coordinates

Scale and offset texture coordinates

Use the texture with the diffuse calculation

Multiply by texture color

Add a texture in your unity assets. Chosse the texture in the material shader's properties.

Ambient light

Ambient light is a value under which the diffuse cannot drop.

```
Shader "Custom/DiffuseShader"
{
    Properties
    {
        _Color ("Color", Color) = (1,0,0,1)
        _DiffuseTex ("Texture", 2D) = "white" {}
        _Ambient ("Ambient", Range (0, 1)) = 0.25
    }
    SubShader
    {
        Tags { "LightMode" = "ForwardBase" }
        LOD 100
        Pass
        {
            CGPROGRAM
            #pragma vertex vert
            #pragma fragment frag
            #include "UnityCG.cginc"
            #include "UnityLightingCommon.cginc"

            struct appdata
            {
                float4 vertex : POSITION;
                float3 normal : NORMAL;
                float2 uv : TEXCOORD0;
            };

            struct v2f
            {
                float4 vertex : SV_POSITION;
                float3 worldNormal : TEXCOORD1;
                float2 uv : TEXCOORD0;
            };

            sampler2D _DiffuseTex;
            float4 _DiffuseTexST;
            float4 _Color;
             float _Ambient;

            v2f vert (appdata v)
            {
                v2f o;
                o.vertex = UnityObjectToClipPos(v.vertex);

                o.uv = TRANSFORM_TEX(v.uv, _DiffuseTex);

                float3 worldNormal = UnityObjectToWorldNormal(v.normal);
                o.worldNormal = worldNormal;
                return o;
            }

            float4 frag (v2f i) : SV_Target
            {
                float3 normalDirection = normalize(i.worldNormal);

                float4 tex = tex2D(_DiffuseTex, i.uv);

                float nl = max(_Ambient, dot(normalDirection, WorldSpaceLightPos0.xyz));
                float4 diffuseTerm = nl * _Color * _LightColor0;
                return diffuseTerm;
            }
            ENDCG
        }
    }
}
```

Range property

Add variable for Ambient

Replace 0 by _Ambient

Speculars with Phong

Now that we know about the diffuse approximation, we will talk about the specular approximation. Phong approximation is one of the simplest :

Reflection direction = 2 * (N . L) * N - L with N the normal to the triangle and L the light direction

The specular (= mirror) light that bounces on the surface depends of your point of view. This fonction is usually implemented in shader languages with the word "reflect".

With reflect, Phong implementation is :

```
float3 reflectionVector = reflect (-lightDir, normal);
float specDot = max(dot(reflectionVector, eyeDir), 0.0);
float spec = pow(specDot, specExponent);
```

specExponent controls the specular intensity.

Now duplicate and rename to SpecularShader your Lambert shader, create a new SpecularMaterial and assign the new shader. Don't forget to update the shader path.

Implement Phong

```
Shader "Custom/SpecularShader"
{
   Properties
   {
      ...
      _SpecColor ("Specular Material Color", Color) = (1,1,1,1)
      _Shininess ("Shininess", Float) = 10
   }
   SubShader
   {
      Tags { "LightMode" = "ForwardBase" }
      LOD 100
      Pass
      {
         ...

         struct v2f
         {
            float4 vertex : SV_POSITION;
            float3 worldNormal : TEXCOORD2;
            float4 vertexWorld : TEXCOORD1;
            float2 uv : TEXCOORD0;
         };

         sampler2D _DiffuseTex;
         float4 _DiffuseTexST;
         float4 _Color;
          float _Ambient;
          float _Shininess;

         v2f vert (appdata v)
         {
            v2f o;
            o.vertex = UnityObjectToClipPos(v.vertex);

            o.vertexWorld = mul(unity_ObjectToWorld, v.vertex);

            o.uv = TRANSFORM_TEX(v.uv, _DiffuseTex);
            float3 worldNormal = UnityObjectToWorldNormal(v.normal);
            o.worldNormal = worldNormal;
            return o;
         }

         float4 frag (v2f i) : SV_Target
         {
            float3 normalDirection = normalize(i.worldNormal);
            float3 viewDirection = normalize(UnityWorldSpaceViewDir(i.vertexWorld));
            float3 lightDirection = normalize(UnityWorldSpaceLightDir(i.vertexWorld));

            float4 tex = tex2D(_DiffuseTex, i.uv);

            // Diffuse
            float nl = max(_Ambient, dot(normalDirection, WorldSpaceLightPos0.xyz));
            float4 diffuseTerm = nl * _Color * tex * _LightColor0;

            //Specular implementation (Phong)
            float3 reflectionDirection = reflect(-lightDirection, normalDirection);
            float3 specularDot = max(0.0, dot(viewDirection, reflectionDirection));
            float3 specular = pow(specularDot, _Shininess);
            float4 specularTerm = float4(specular, 1) * _SpecColor * _LightColor0;

            // Add diffuse and specular
            float4 finalColor = diffuseTerm + specularTerm;
            return finalColor;
         }
         ENDCG
      }
   }
}
```

Color and intensity

Vertex world position
(update the numbers)

Do not forget the variable

Compute the vertexWorld

Needed for specular calculation

The computation we have seen before

The specular depends of the angle

Multiply the specular by the light color

Phong with multiple lights

Now duplicate and rename your SpecularShader to , create a new SpecularMaterial and assign the new shader. Don't forget to update the shader path.

```
Shader "Custom/SpecularShaderForwardAdd"
{
   Properties
   {
      ...
   }
   SubShader
   {
      LOD 100
      Pass
      {
         Tags { "LightMode" = "ForwardBase" }
         CGPROGRAM
        #pragma vertex vert
        #pragma fragment frag
        #pragma multi_compile_fwdbase
        ...

      }
      Pass
      {
         Tags { "LightMode" = "ForwardAdd" }
          Blend One One
          CGPROGRAM
        #pragma vertex vert
        #pragma fragment frag
        #pragma multi_compile_fwdadd

        ...

        float4 frag (v2f i) : SV_Target
        {
           ...
           // Diffuse
           float nl = max(0.0, dot(normalDirection, _WorldSpaceLightPos0.xyz));
           ...
        }

   }
}
```

For each light after the first

Blend colors additively

Don't add _Ambient several times

Surface shaders

Differences with previous shaders

Create a new Surface Shader.

Surface shaders hide a part fo the shader code. You won't have to copy and paste passes like we did just before, except if you need precise control on your shaders.

In surface shader, the vertex function is optional, and the fragment function is replaced by a surface function. You can also write optional lighting functions.

#pragma surface surf Standard fullforwardshadows

The pragma tells that the surface function will we surf, there will be a Standard lighting model and a fullforwardshadows option. To write your optional vertex function, you have to use this option : vertex:vert (vert function will be the vertex shader function)

Lighting model can be Standard, BlinnPhong, Lambert, or a custom one.

The surf function takes a Input parameter (with the texture UV inside) and a inout SurfaceOutputStandard, which will serves as a input AND a output parameter. This parameter will be sent to the lighting model. The function fills the SurfaceOutputStandard fields.

SurfaceOutputStandard type is :

```
struct SurfaceOutputStandard {
    fixed3 Albedo;      // base (diffuse or specular) color
    fixed3 Normal;      // tangent space normal, if written
    half3 Emission;
    half Metallic;      // 0=non-metal, 1=metal
    half Smoothness;    // 0=rough, 1=smooth
    half Occlusion;     // occlusion (default 1)
    fixed Alpha;        // alpha for transparencies
};
```

Lighting models

The Standard Lighting model is complex, so we will look at the Lambert lighting model :*

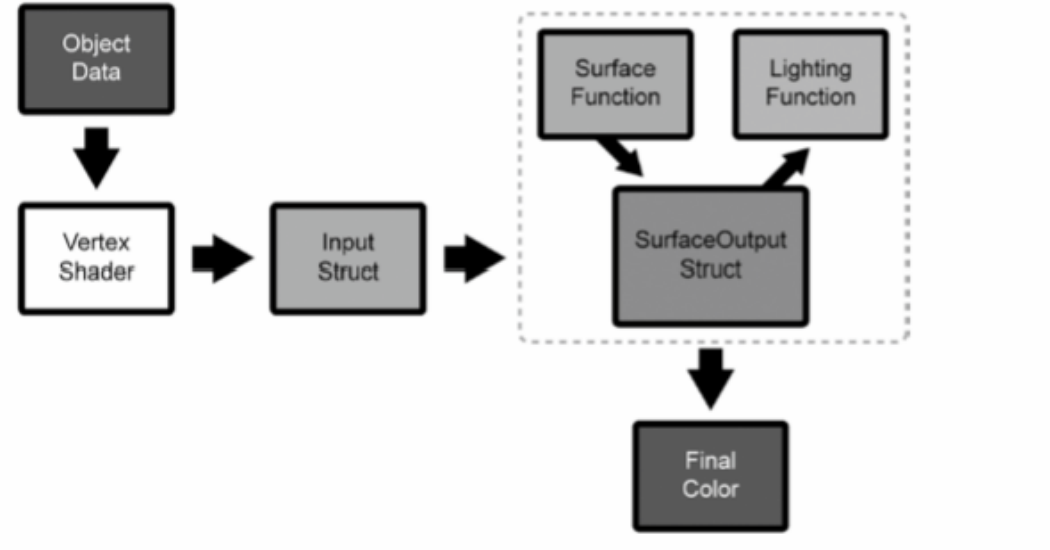
```
inline fixed4 LightingLambert (SurfaceOutput s, UnityGI gi) {
    fixed4 c;
    UnityLight light = gi.light;
    fixed diff = max (0, dot (s.Normal, light.dir));

    c.rgb = s.Albedo * light.color * diff;
    c.a = s.Alpha;

    #ifdef UNITY_LIGHT_FUNCTION_APPLY_INDIRECT
        c.rgb += s.Albedo * gi.indirect.diffuse;
    #endif
    return c;
}
```

A lighting model take a SurfaceOutput as a parameter and returns a fixed4. The UnityGI is a parameter that is passed by the Global Illumination system, which is a way to manage indirect lights. Here we only use gi.light.

You recognize the algorithm we used for Lambert's shader. If we would like to use the point of view, we would have called :

```
half4 Lighting<Name> (SurfaceOutput s, half3 viewDir, UnityGI gi)     // note the viewDir parameter
```

Surface shader pipeline



Add a second albedo

We want to add a second texture and a slider that will determine the proportion of each texture display.

```
Shader "Custom/SurfaceShader" {
	Properties {
		_Color ("Color", Color) = (1,1,1,1)
		_MainTex ("Albedo (RGB)", 2D) = "white" {}
		_SecondAlbedo ("Second Albedo (RGB)", 2D) = "white" {}
		_AlbedoLerp ("Albedo Lerp", Range(0,1)) = 0.5
		_Glossiness ("Smoothness", Range(0,1)) = 0.5
		_Metallic ("Metallic", Range(0,1)) = 0.0
	}
	SubShader {
		Tags { "RenderType"="Opaque" }
		LOD 200

		CGPROGRAM
		// Physically based Standard lighting model, and enable shadows on all light types
		#pragma surface surf Standard fullforwardshadows

		// Use shader model 3.0 target, to get nicer looking lighting
		#pragma target 3.0

		sampler2D _MainTex;
		sampler2D _SecondAlbedo;
		half _AlbedoLerp;

		struct Input {
			float2 uv_MainTex;
		};

		half _Glossiness;
		half _Metallic;
		fixed4 _Color;

		// Add instancing support for this shader. You need to check 'Enable Instancing' on
materials that use the shader.
		// See https://docs.unity3d.com/Manual/GPUInstancing.html for more information about
instancing.
		// #pragma instancing_options assumeuniformscaling
		UNITY_INSTANCING_BUFFER_START(Props)
			// put more per-instance properties here
		UNITY_INSTANCING_BUFFER_END(Props)

		void surf (Input IN, inout SurfaceOutputStandard o) {
			// Albedo comes from a texture tinted by color
			fixed4 c = tex2D (MainTex, IN.uvMainTex); //* _Color;
			fixed4 secondAlbedo = tex2D (SecondAlbedo, IN.uvMainTex);
			o.Albedo = lerp(c, secondAlbedo, AlbedoLerp)  * Color;
			// Metallic and smoothness come from slider variables
			o.Metallic = _Metallic;
			o.Smoothness = _Glossiness;
			o.Alpha = c.a;
		}
		ENDCG
	}
	FallBack "Diffuse"
}
```

New properties

New variables

Load the second texture color

Mix with the first texture