
CodeGear
Join us for <Dev Days of Summer> 2024!
August 12-16 | 19-23, 2024
Two full weeks of live and on-demand
developer content, all for free!
RAD
C++
UE
Visual Assist
Yellowfin


Program the
Rainbow
Working with Colors in Delphi
Slides and samples
github.com/jimmckeeth/Programming-the-Rainbow

Jim McKeeth

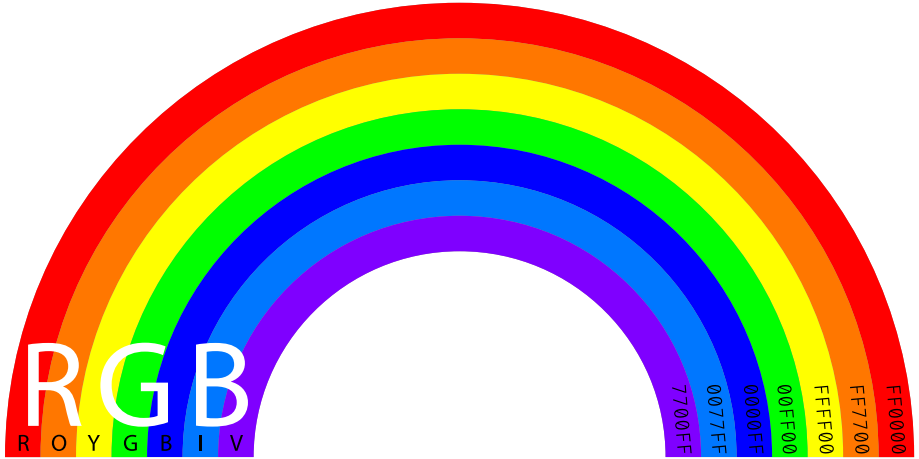
GDK Software

Embarcadero Delphi MVP
Director of Consulting
jim@gdksoftware.com
gdksoftware.com

GDK software

INTERFACE

- Color theory
- TAlphaColor vs TColor
- RGB, HSL, & CMYK
- Complementary colors
- Palettes & Blending
- Gradients, shades, tints, tones
- Color names

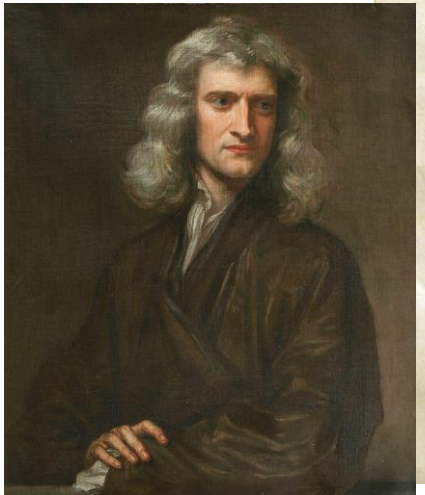


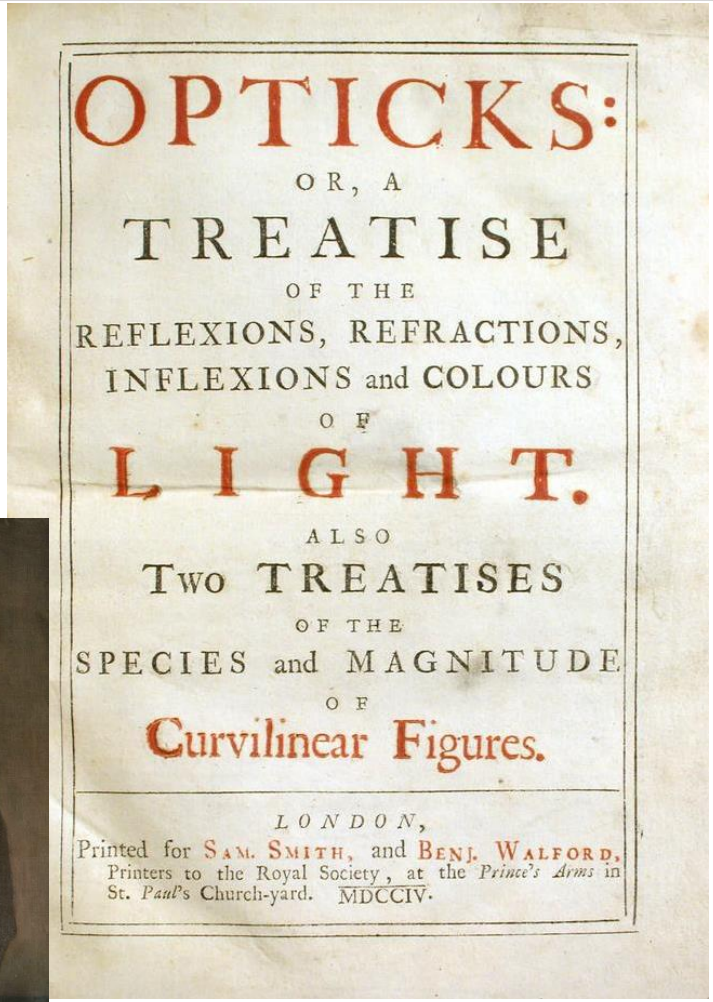
Slides and samples
github.com/jimmckeeth/Programming-the-Rainbow

IMPLEMENTATION

Early Color Theory

- 322 BCE: Early musings on color in Aristotle's *On Colors*
- 1800s: formalized "color theory" with Isaac Newton's *Opticks*



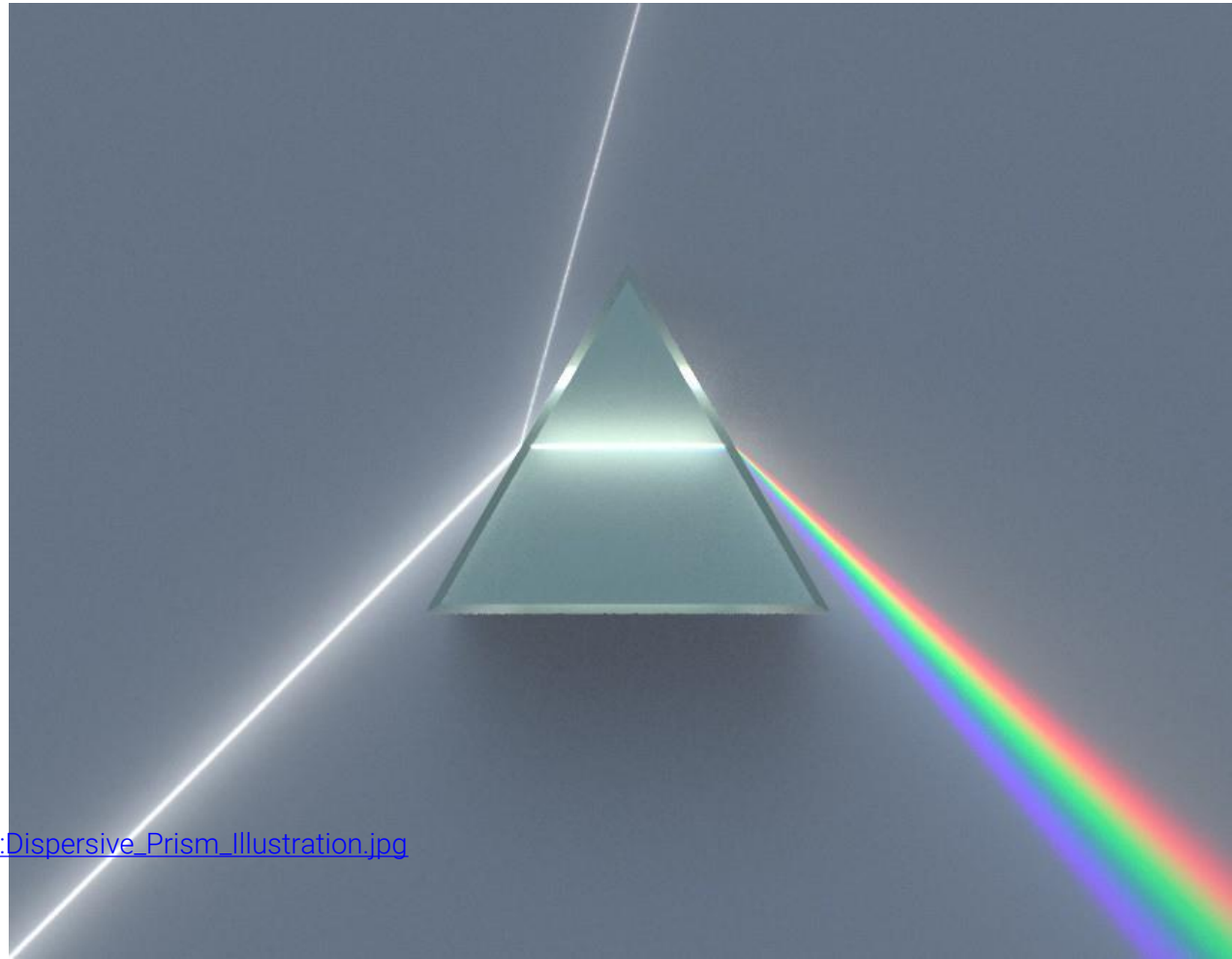


OPTICKS:
OR, A
TREATISE
OF THE
REFLEXIONS, REFRACTIONS,
INFLEXIONS and COLOURS
OF
LIGHT.
ALSO
Two TREATISES
OF THE
SPECIES and MAGNITUDE
OF
Curvilinear Figures.

LONDON,
Printed for SAM. SMITH, and BENJ. WALFORD,
Printers to the Royal Society, at the *Prince's Arms* in
St. *Paul's* Church-yard. MDCCIV.

Visible Light

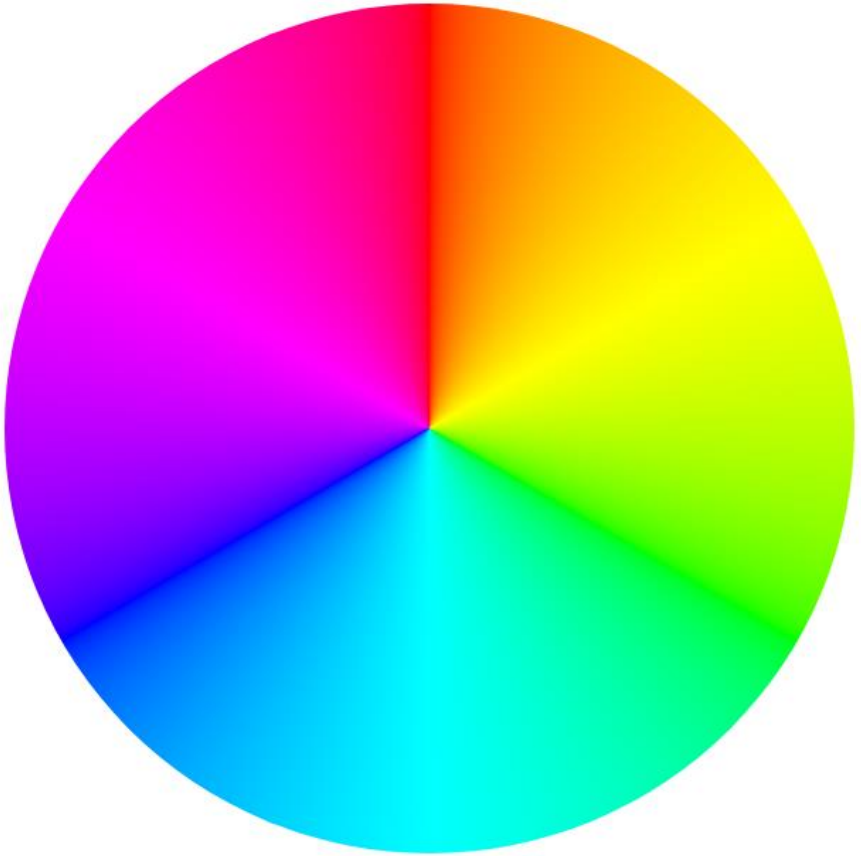
- Newton showed a prism separates white sunlight into the visible spectrum



https://commons.wikimedia.org/wiki/File:Dispersive_Prism_Illustration.jpg
by Cepheiden, CC BY-SA 3.0

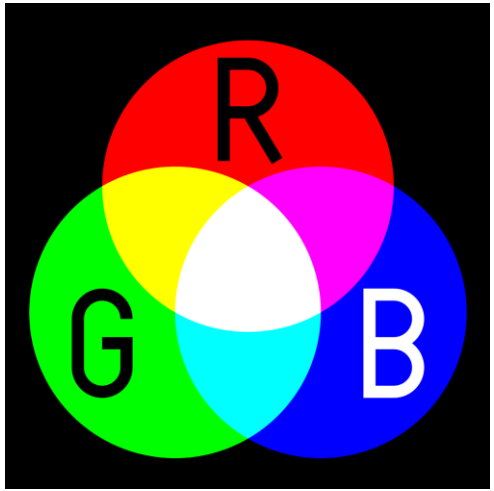
Color Wheel

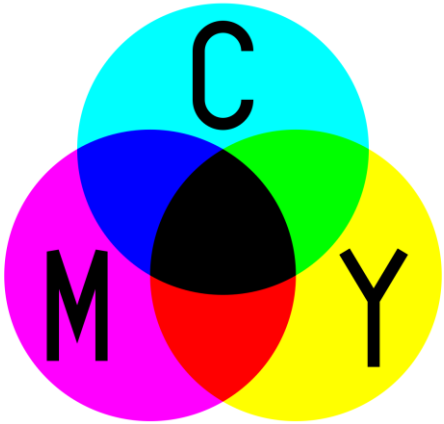
- Illustrative organization of color hues around a circle (360°)
- Shows the relationships of colors
- 0° and 360° are red



Gradient RGB/CMY color wheel

Primary Colors

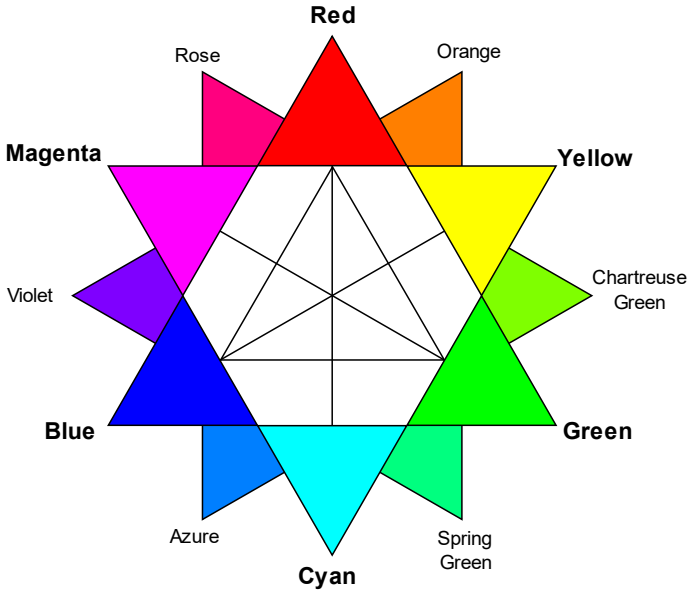




- Additive primary colors
  - Red, Green, Blue (RGB)
  - When mixing light
  - All three create white
- Subtractive primary colors
  - Cyan, Magenta, & Yellow (CMY)
  - When mixing pigments on white
  - All three create black

Color Science

- Scientific study of color: lighting; optics; measurement; physiology; psychophysics; modeling of color vision; and color reproduction
- The modern evolution of *Color Theory*

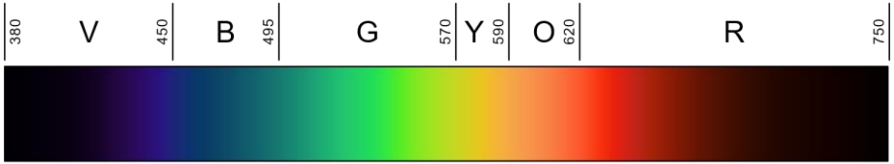


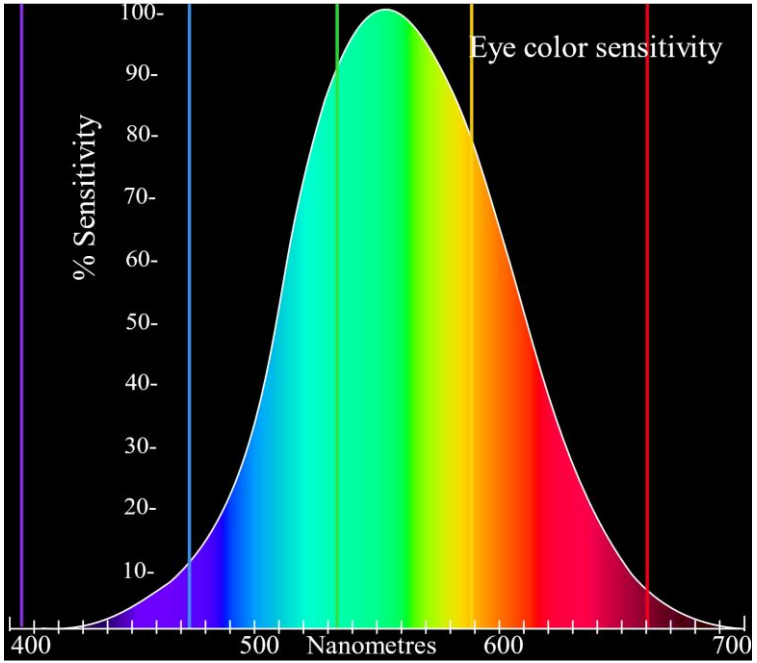
https://en.wikipedia.org/wiki/Color_theory

https://en.wikipedia.org/wiki/Color_science

Human Color Vision Sensitivity

- Relative brightness sensitivity as a function of wavelength →
- A linear representation of the visible light spectrum ↓






BEGIN
Show me the code!

TColor vs TAlphaColor = *Incompatible*

See more in QP Issue RSS-1432

```
unit System.UITypes;
```

```
TColor = -$7FFFFFFF-1..$7FFFFFFF;
TColorRec = record
 // TColor constants
  class var ColorToRGB:
      function (Color: TColor): Longint;
  case Cardinal of
    0: (Color: TColor);
    2: (HiWord, LoWord: Word);
    3: (R, G, B, A: System.Byte);
end;
```

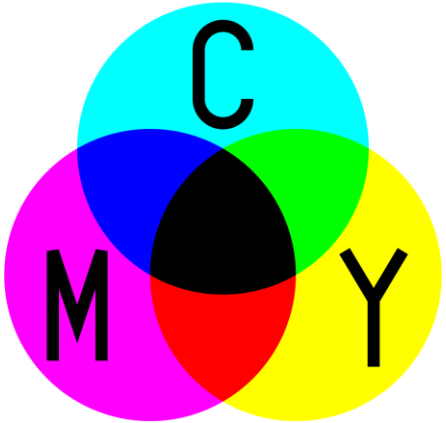
```
TAlphaColor = type Cardinal;
TAlphaColorRec = record
    // TAlphaColor constants
    class var ColorToRGB:
      function (Color: TAlphaColor): Longint;
    case Cardinal of
      0: (Color: TAlphaColor);
      2: (HiWord, LoWord: Word);
      3: (B, G, R, A: System.Byte);
end;
```

- TColor is an integer (+ & -) subrange, while TAlphaColor is a full cardinal (+ only).
- TColor orders the bytes R, G, B, A and TAlphaColor orders them B, G, R, A
- They are incompatible, but the compiler implicitly converts them

Working with CMYK

- **C**yan, **M**agenta, **Y**ellow & Blac**k** (or **K**ey)
- The subtractive primary colors
- CMYK, by its nature, is not native for a display screen
- Converting an approximation and frequently makes use of color management systems (color space or color profile).

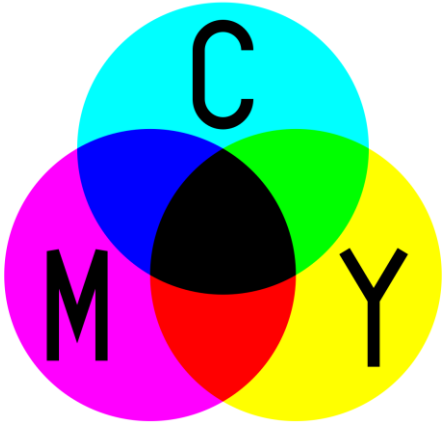
RGBToCMYK




```
uses System.Math;
// Handle black manually
var r := 1 - (Red   / 255);
var g := 1 - (Green / 255);
var b := 1 - (Blue  / 255);
var k := Min(r, Min(g, b));
Cyan    := (r - k) / (1 - k);
Magenta := (g - k) / (1 - k);
Yellow  := (b - k) / (1 - k);
Key     := k;
```

CMYKtoRGB

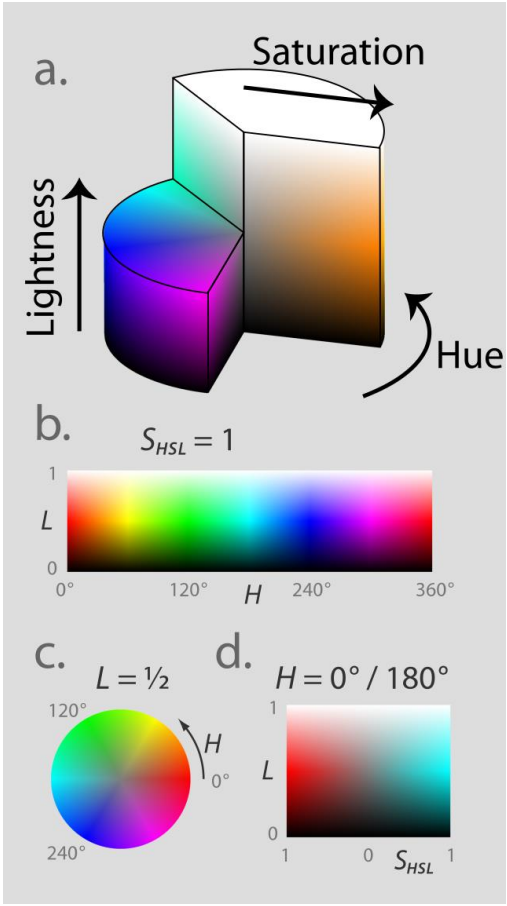
Going back is relatively easy




```
Red   := Round(255 * (1-Cyan)    * (1-Key));
Green := Round(255 * (1-Magenta) * (1-Key));
Blue  := Round(255 * (1-Yellow)  * (1-Key));
```

HSL

- Each is a **`Single`** with a range of 0 to 1
- **H**ue is the color in 0° to 360°
- **S**aturation is amount of color
  - 0% = Grey; 100% = Pure color
- **L**ightness
  - 0% = White
  - 50% = Pure color
  - 100% = Black



https://en.wikipedia.org/wiki/HSL_and_HSV

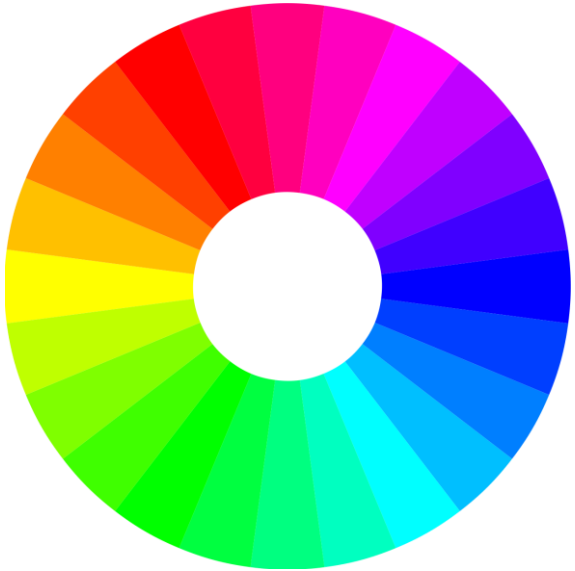
Working with HSL

```
unit System.UIConsts;

// Create TAlphaColor from HSL
function HSLtoRGB(H, S, L: Single): TAlphaColor;

// Convert TAlphaColor to HSL
procedure RGBtoHSL(RGB: TAlphaColor;
                   out H, S, L: Single);

// Changes the TAlphaColor by the HSL delta provided
function ChangeHSL(const C: TAlphaColor;
                   dH, dS, dL: Single): TAlphaColor;
```



Making a Rainbow Gradient

Newton's

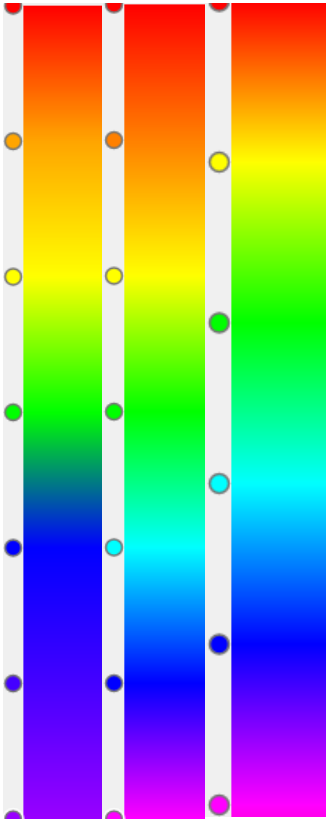
Color	Hex
Red	FF0000
Orange	FFA500
Yellow	FFFF00
Green	00FF00
Blue	0000FF
Indigo	4400FF
Violet	9900FF

Modern

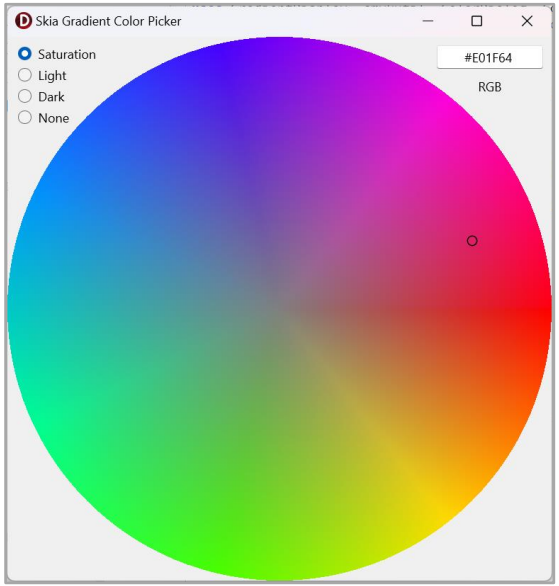
Color	Hex
Red	FF0000
Orange	FF8000
Yellow	FFFF00
Green	00FF00
Cyan	00FFFF
Blue	0000FF
Magenta	FF00FF

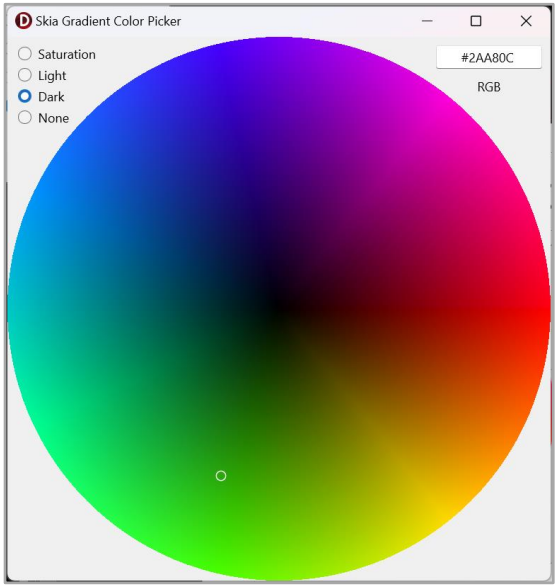
Hue

Color	Hex	Hue
Red	FF0000	0°
Yellow	FFFF00	60°
Green	00FF00	120°
Cyan	00FFFF	180°
Blue	0000FF	240°
Magenta	FF00FF	300°



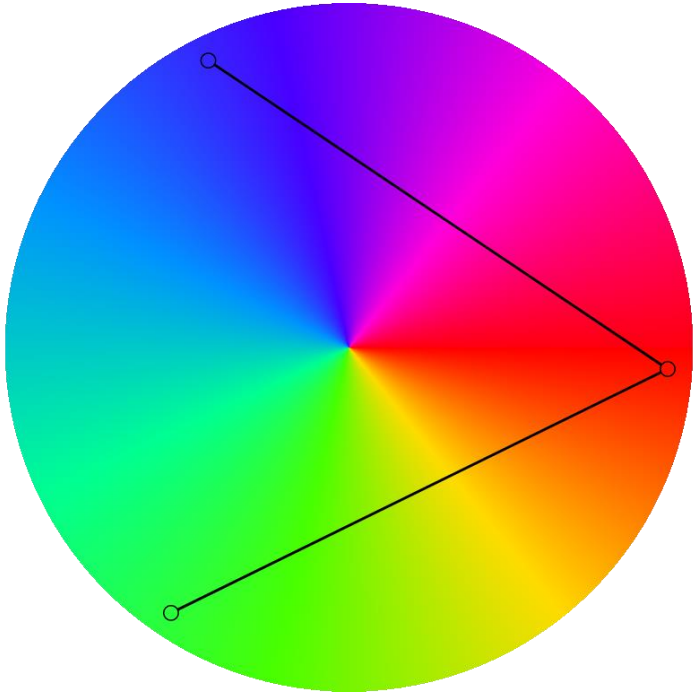
Gradient Color Picker (with Skia)





Palates & Complementary Colors

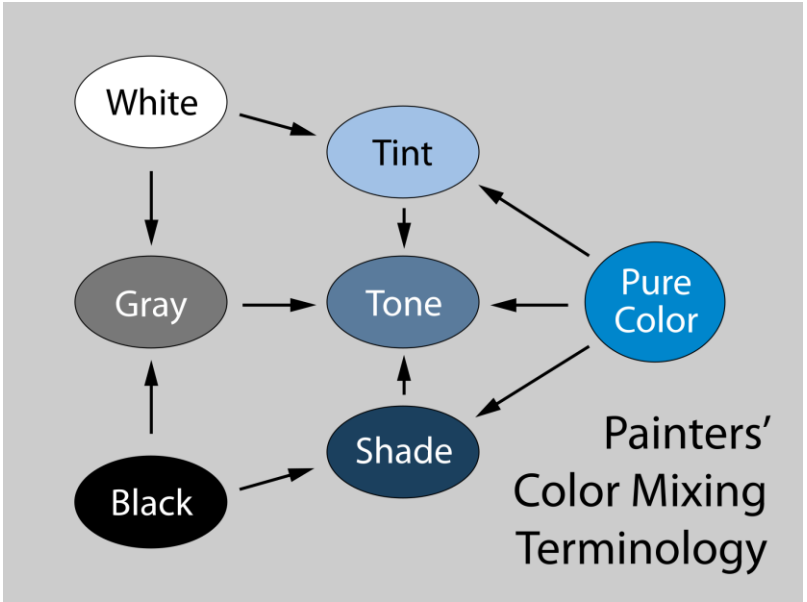
- Its easy with HSL, just modify the hue
  - Complementary: 0°, 180°
  - Split-complementary: 0°, 150°, 210°
  - Analogous: 0°, 30°, 330°
  - Triadic: 0°, 120°, 240°
  - Tetradic: 0°, 60°, 180°, 240°
  - Hexadic: 0°, 60°, 120°, 180°, 240° and 300°



https://en.wikipedia.org/wiki/Color_scheme

Shades, Tints, and Tones

- Start with a pure color (hue)
- Tint
  - Lightness from 1 to 0.5
- Shade
  - Lightness from 0 to 0.5
- Tone
  - Saturation from 0 to 1

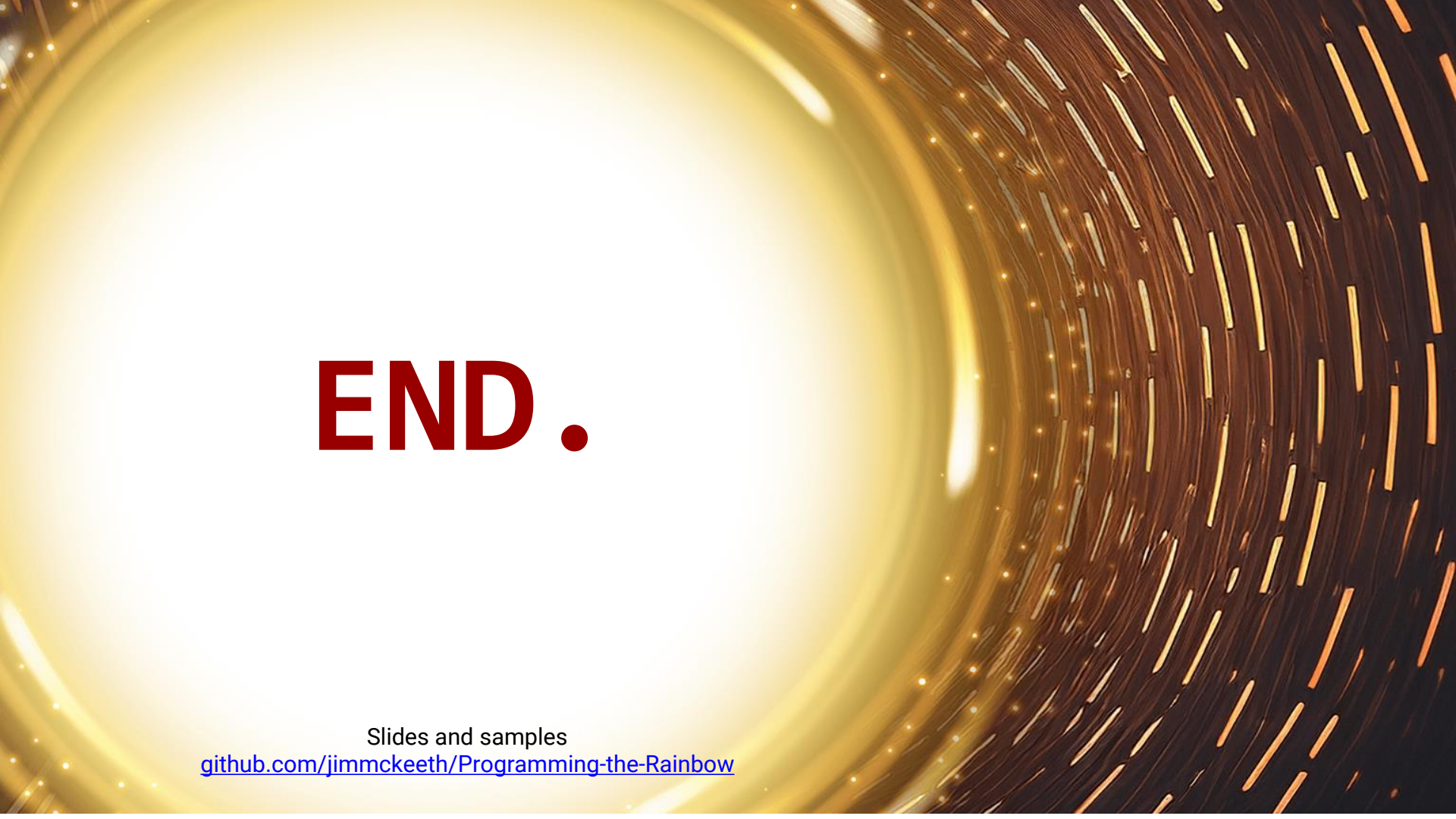


FINALIZATION

Slides and samples
github.com/jimmckeeth/Programming-the-Rainbow

Resources

- Slides
  - github.com/jimmckeeth/Programming-the-Rainbow
- Samples (and a whole lot more)
  - github.com/jimmckeeth/FMXColorDialog



Slides and samples
github.com/jimmckeeth/Programming-the-Rainbow


CodeGear
<Dev Days of Summer> 2024!
Thanks for Watching
RAD
C++
UE
Visual Assist
Yellowfin