Matrices

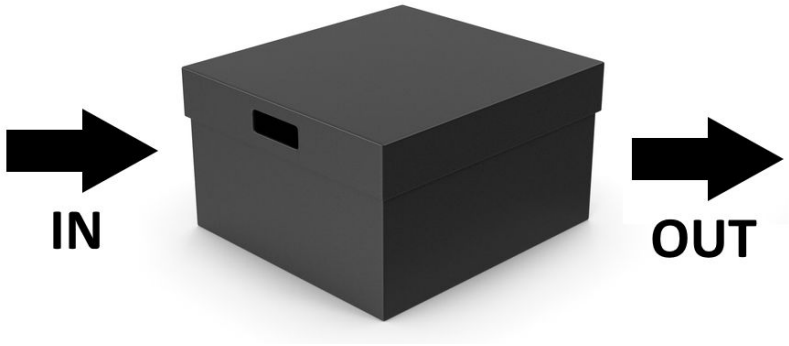
Why do they work?

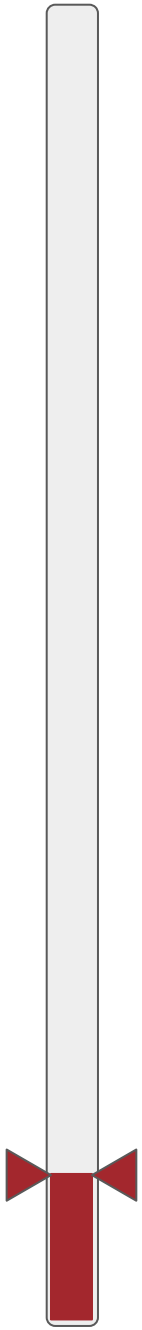
*Screenshot from
Insane Clown Posse - Miracles

Aw jeez, not this again

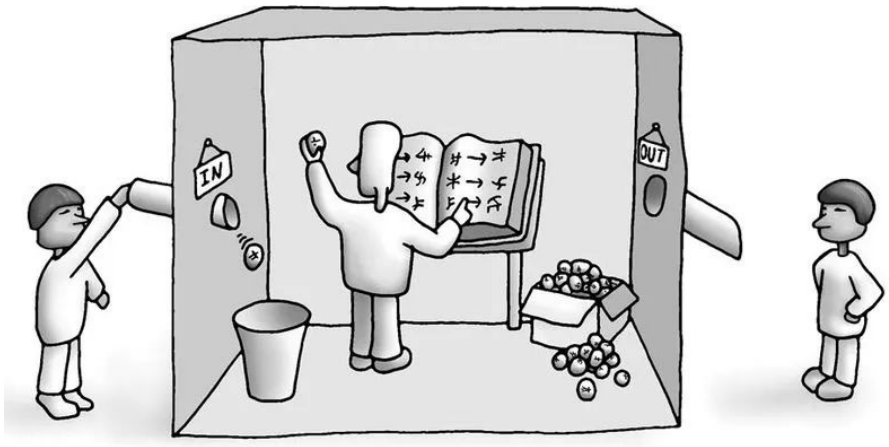
Aw jeez, not this again

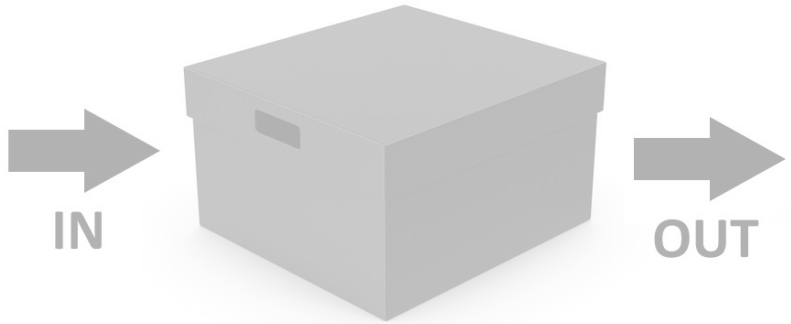
Oh, really?
Tell me more



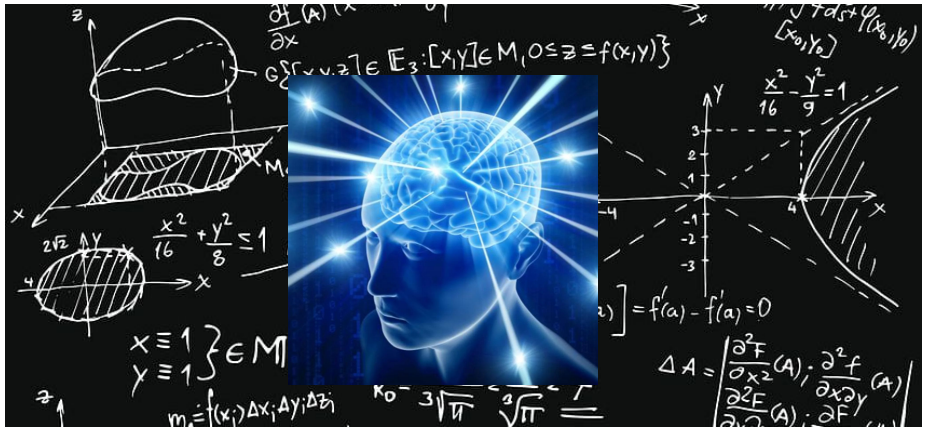


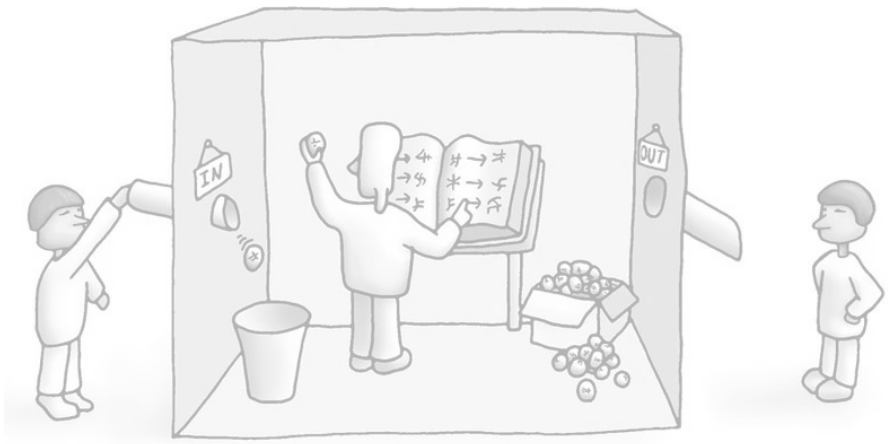
- Use as black box
- What but not How

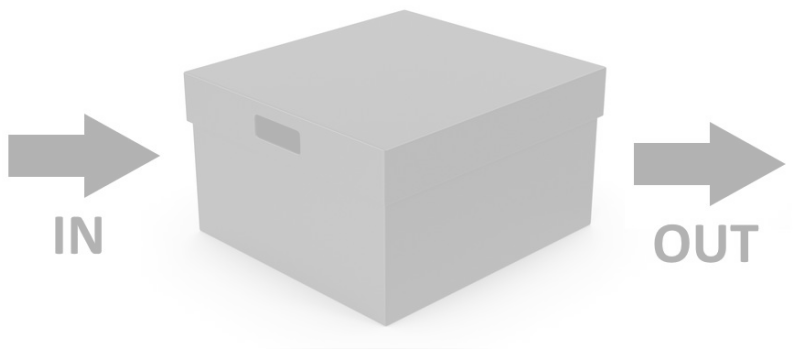




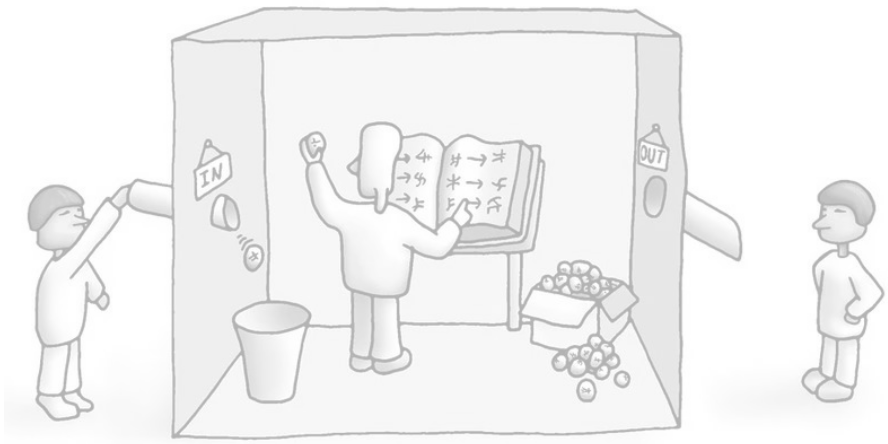
- Know what inside
- Can implement
- Know performance
- How but not Why

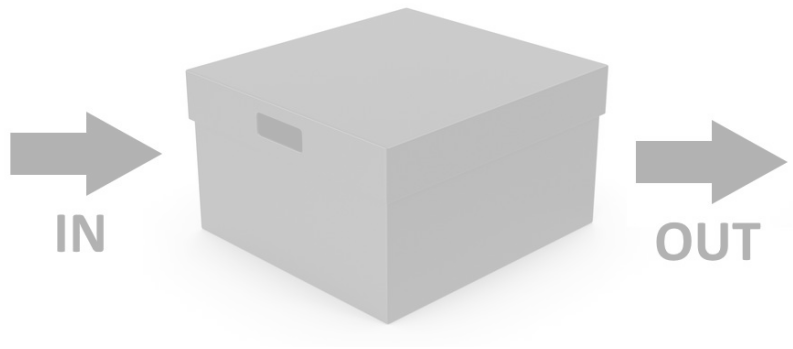




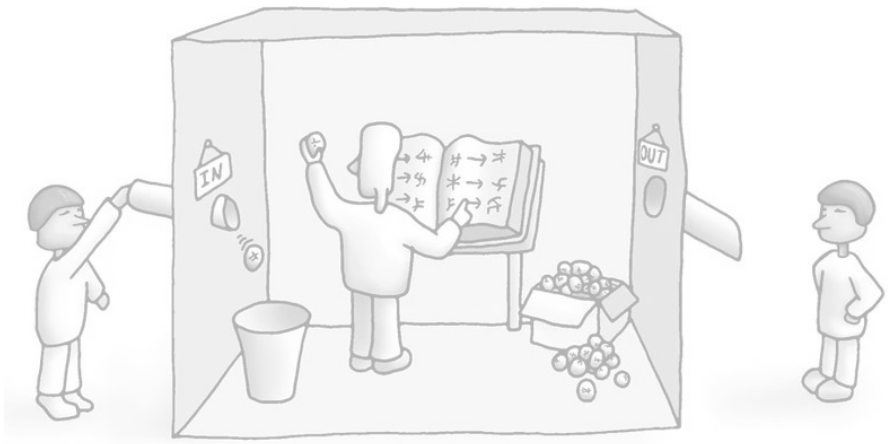


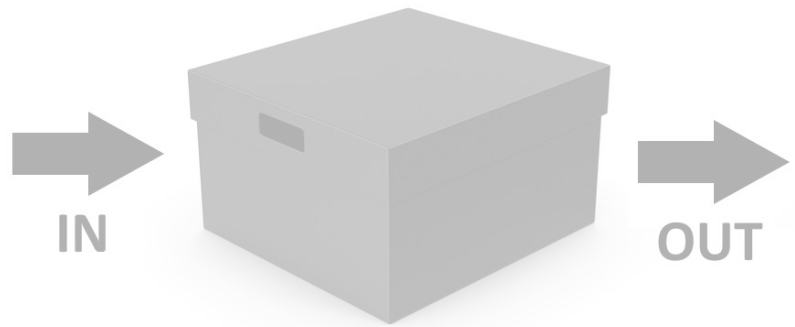
- Big Brain Math
- Academic way
- Algebraic form
- Still no geometric intuition



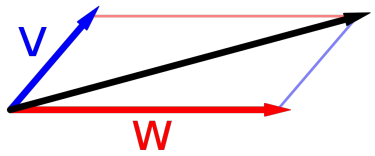


- **Easy & intuitive way**
- **Geometric meaning**





- **Easy & intuitive way**
- **Geometric meaning**



- **Vector arithmetic is enough**

No such article

Basics

Conventions

Geometry meaning

3	34	6	1
5	4	2.9	0
2.3	19	0	34
17	3	4.4	5

Basics

Conventions

Geometry meaning

Basics

Conventions

Geometry meaning


X Y Z

- **RUF** - Unity
- **FRU** - Unreal
- **RUB** - Godot, XNA
- **RFU** - O3DE, Blender
- **LUF** - PyTorch3D
- **RDF** - Vulkan NDC

RUF - Unity

FRU - Unreal

RUB - Godot, XNA

RFU - O3DE, Blender

LUF - PyTorch3D

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~~**RUB** - Godot, XNA~~

RFU - O3DE, Blender

~~**LUF** - PyTorch3D~~

~~**RDF** - Vulkan NDC~~

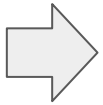
Tim Sweeney
@TimSweeneyEpic

Sorry y’all I was young and this coordinate system stuff was confusing

RUF - Unity

~~FRU - Unreal~~

~~RUB - Godot, XNA~~



RFU - O3DE, Blender

~~LUF - PyTorch3D~~

~~RDF - Vulkan NDC~~

RUFF

PERFUME

… X Y Z X Y Z X Y Z …

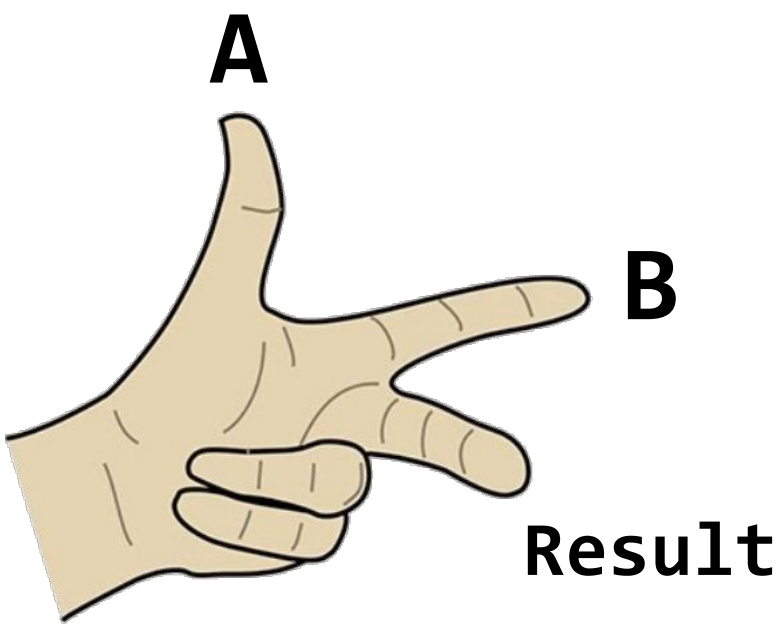

… X Y Z X x Y Z X Y Z …

… X Y Z **X x Y = Z** X Y Z …

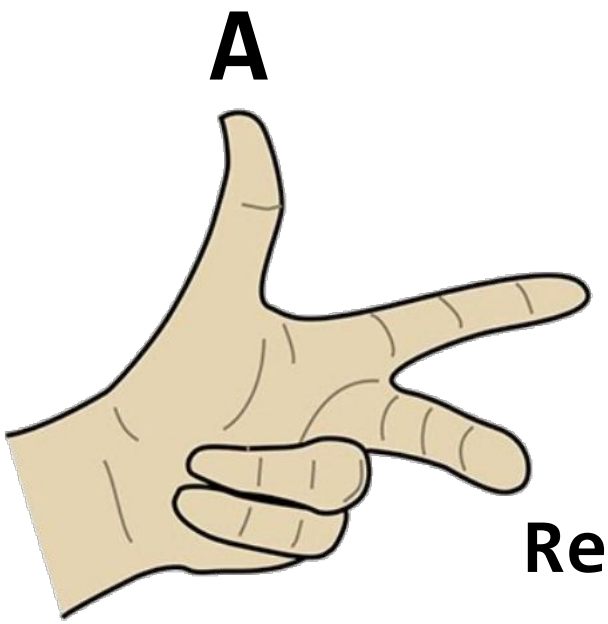
… X Y Z X $Y \times Z = X$ Y Z …

… X Y Z X Y Z × X = Y Z …

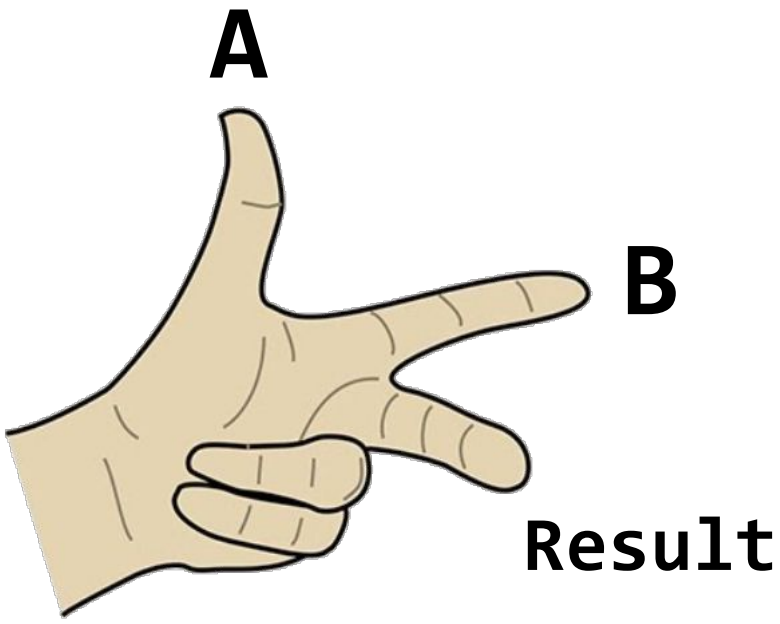
… X Y Z X Y Z x X = Y Z …

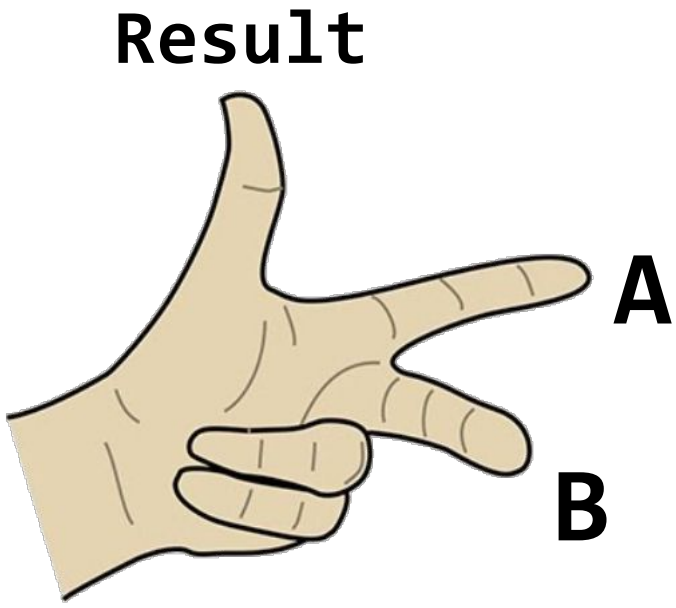


… X Y Z X **Y = Z x X = Y** Z …

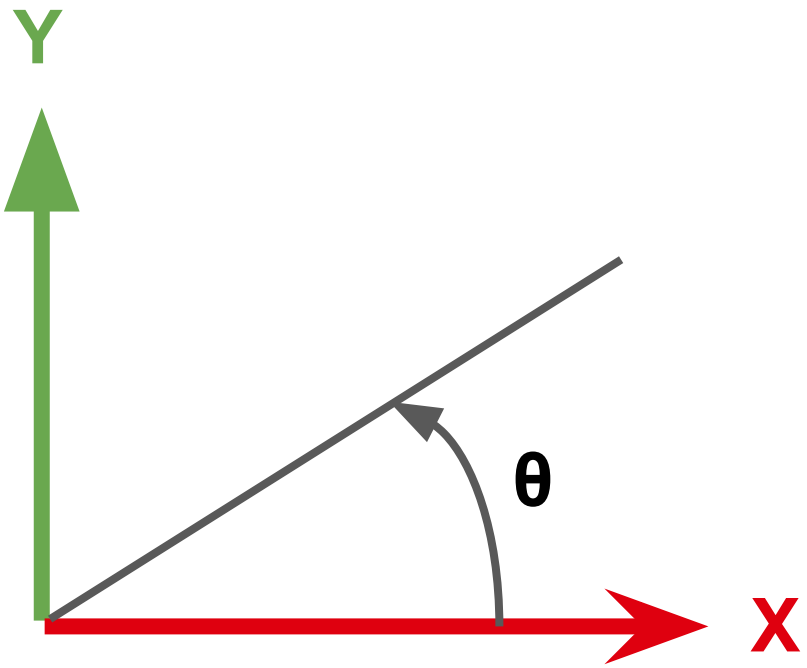


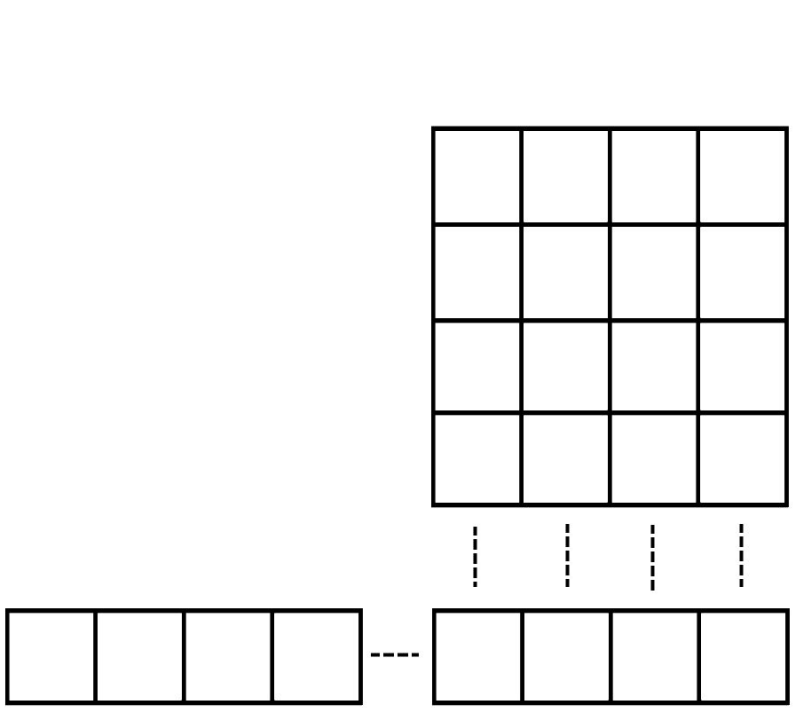
… X Y Z X **Y = Z x X = Y** Z …



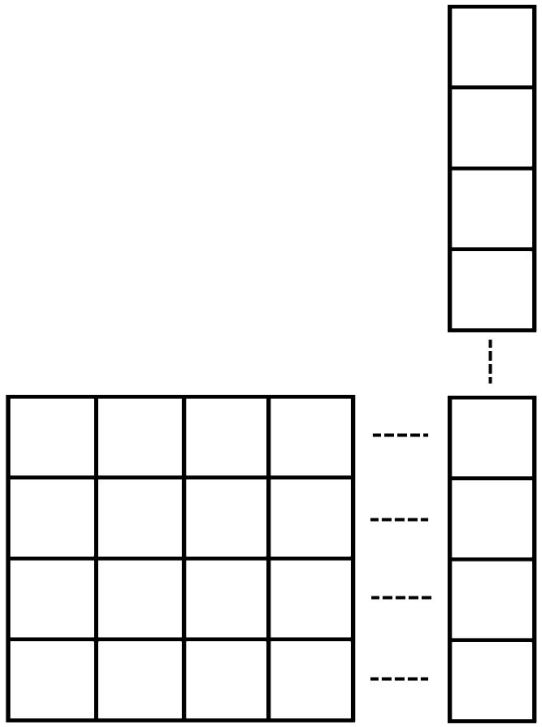


… X Y **Z = X ⇨ Y** Z X Y Z …



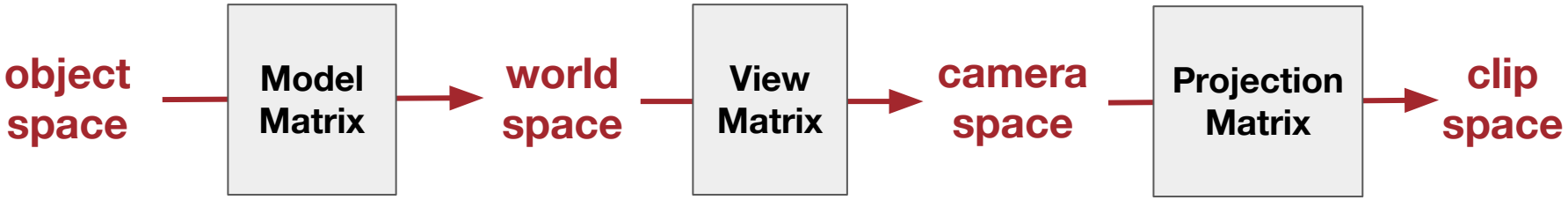


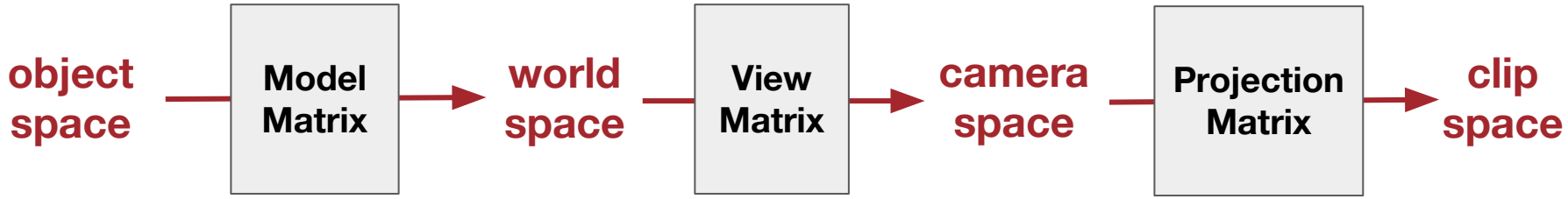
vs



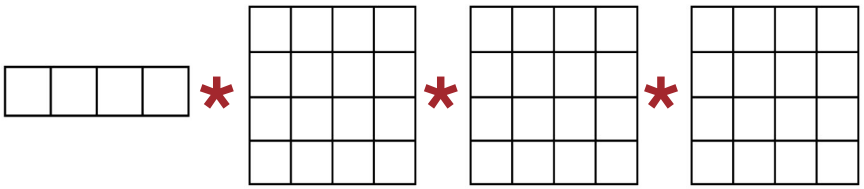
Row-vector

Column-vector

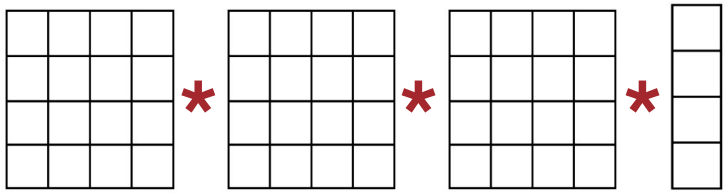

object space
Model Matrix
world space
View Matrix
camera space
Projection Matrix
clip space

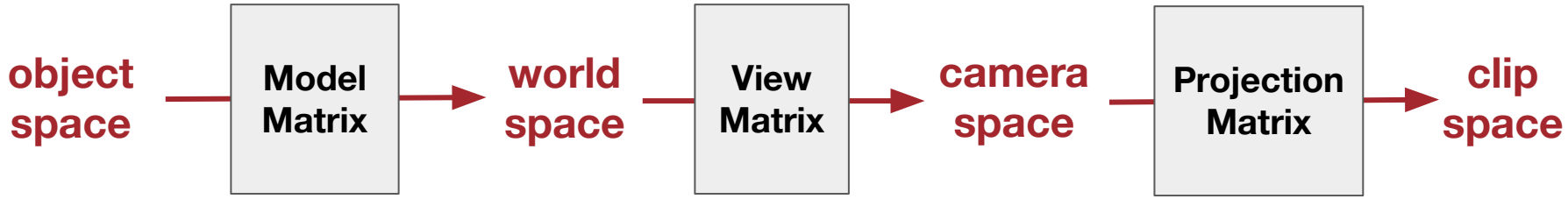

object space
Model Matrix
world space
View Matrix
camera space
Projection Matrix
clip space

x * M * V * P



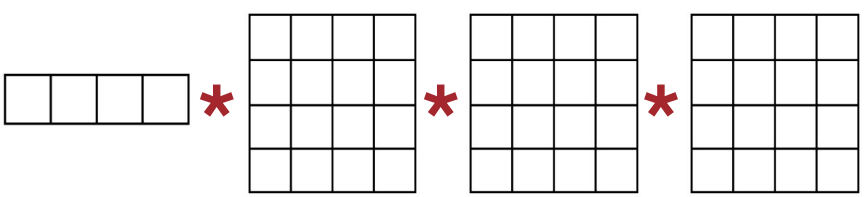
P * V * M * x

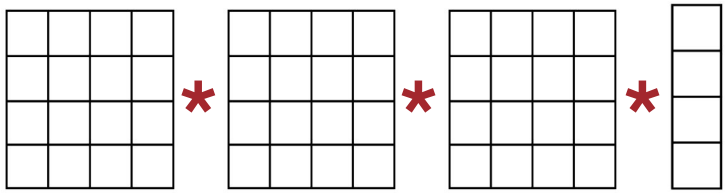



object space
Model Matrix
world space
View Matrix
camera space
Projection Matrix
clip space

$$x * M * V * P$$

$$P(V(M(x)))$$





Row-vector == row-major

Column-vector == column-major

Row-vector

Colu column-major

English is row major.

English is row major.

```
float m11, m12, m13, m14;
float m21, m22, m23, m24;
float m31, m32, m33, m34;
float m41, m42, m43, m44;
```

```
float Matrix[4][4] = {
    { 1, 0, 0, 0 },
    { 0, 1, 0, 0 },
    { 0, 0, 1, 0 },
    { 0, 0, 0, 1 }
};

Matrix[3][2];
```

English is row major.

```
float m11, m12, m13, m14;
float m21, m22, m23, m24;
float m31, m32, m33, m34;
float m41, m42, m43, m44;
```

```
float Matrix[4][4] = {
    { 1, 0, 0, 0 },
    { 0, 1, 0, 0 },
    { 0, 0, 1, 0 },
    { 0, 0, 0, 1 }
};

Matrix[3][2];
```

Column major is also very convinient.

Basics

Conventions

Geometry meaning

What's next?

Interactive guide to homogeneous coordinates

https://wordsandbuttons.online/interactive_guide_to_homogeneous_coordinates.html

by Oleksandr Kaleniuk

Let's remove Quaternions from every 3D Engine

https://marctenbosch.com/quaternions/

by Marc ten Bosch