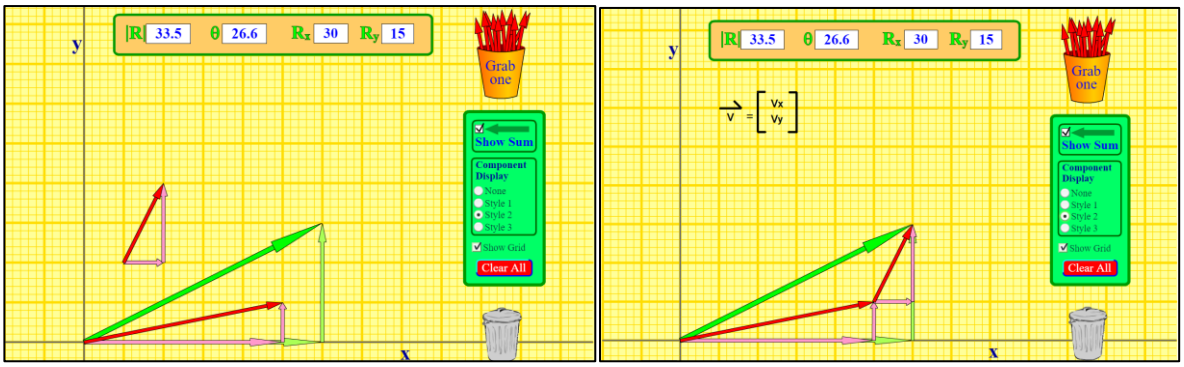
1. 2D Vectors (20.05.17, 20)

① What is Vector?

A quantity having direction as well as magnitude, -> the starting point is meaningless

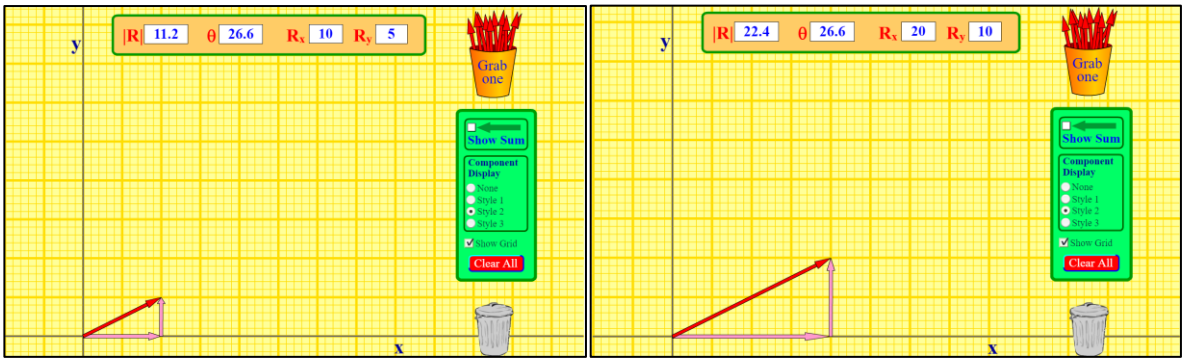
escpecially as ***determining the position of one point space relative to anaother.***

② Sum of vectors



$$\overrightarrow{\text{End position}} = \overrightarrow{\text{Starting position}} + \overrightarrow{\text{Delta position}} = \begin{bmatrix}25\\5\end{bmatrix} + \begin{bmatrix}5\\10\end{bmatrix} = \begin{bmatrix}30\\15\end{bmatrix}$$

③ Vector scalar



Scale the vector

K $\overset{\star}{\underset{V}{\rightarrow}} = \begin{bmatrix}K & * & Vx\\K & * & Vy\end{bmatrix}$ (K is the scalar value)

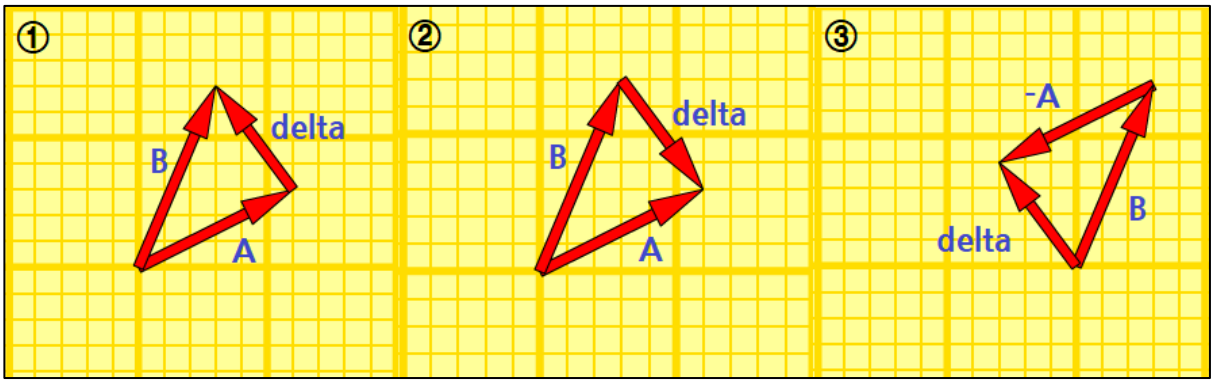
Double x and y => Double the length

④ Update position function by using 2D vector

Earlier code	Modified code
posX += velX * dt (delta time)	pos += vel * dt
posY += velY * dt	(pos is starting position vector, vel is velocity vector)

⑤ Subtraction of vectors

$\underset{b}{\rightarrow} - \underset{a}{\rightarrow}$ means what is the **delta** from $\underset{a}{\rightarrow}$to $\underset{b}{\rightarrow}$ (how do I get to $\underset{b}{\rightarrow}$from$\underset{a}{\rightarrow}$)



① B - A = delta from A to B ② A - B = delta from B to A

③ $\underset{b}{\rightarrow} - \underset{a}{\rightarrow} = \underset{b}{\rightarrow} + (\underset{a}{\rightarrow} * -1)$ So, the delta in ① is same as in ③

⑥ The length of vector

Legnth of $\underset{v}{\rightarrow} = |\underset{v}{\rightarrow}|$ $\quad |\underset{v}{\rightarrow}|^2 = x^2 + y^2$ so, $|\underset{v}{\rightarrow}| = \sqrt{x^2 + y^2}$

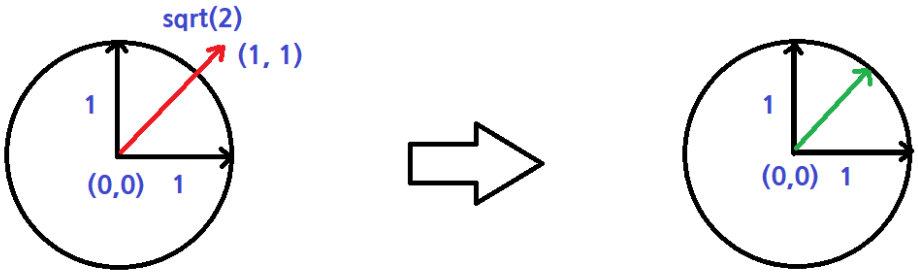
⑦ Normalize the vector

Scale the length of vector to 1. so, it just describes a direction and don't care about the length.

normalized $\underset{v}{\rightarrow} = \underset{v}{\rightarrow} * \frac{1}{|\underset{v}{\rightarrow}|}$

Sum of vectors	Vector scalar	Subtraction of vectors	Length of vectors
$\underset{V1}{\rightarrow} +$ $\underset{V2}{\rightarrow} = \begin{bmatrix} V1x + V2x \\ V1y + V2Y \end{bmatrix}$	K $\star \underset{V}{\rightarrow} = \begin{bmatrix} K * Vx \\ K * Vy \end{bmatrix}$	$\underset{V2}{\rightarrow} -$ $\underset{V1}{\rightarrow} = \begin{bmatrix} V2x - V1x \\ V2y - V1y \end{bmatrix}$	$\|\underset{V}{\rightarrow}\| = \sqrt{Vx^2 + Vy^2}$
Normalized vector			
$\hat{V} = \underset{v}{\rightarrow} * \frac{1}{\|\underset{v}{\rightarrow}\|}$			

⑧ How to make the object move at same velocity?



We want to move the object in x, y space at same velocity.

But, if we pressed both up and right arrow (up = y, right = x), the object gets a speed boost.

So, just get the direction of the velocity vector by normalizing it, and multiply the direction, speed and delta time and add the result to position vector.

Dude.cpp;af3363e1

```
350 void Dude::Update( const Keyboard& kbd,float
351 {
352     if( kbd.KeyIsPressed( VK_RIGHT ) )
353     {
354         pos.x += speed * dt;
355     }
356     if( kbd.KeyIsPressed( VK_LEFT ) )
357     {
358         pos.x -= speed * dt;
359     }
360     if( kbd.KeyIsPressed( VK_DOWN ) )
361     {
362         pos.y += speed * dt;
363     }
364     if( kbd.KeyIsPressed( VK_UP ) )
365     {
366         pos.y -= speed * dt;
367     }
368 }
```

Dude.cpp;e27e084a

```
350 void Dude::Update( const Keyboard& kbd,float
351 {
352     Vec2 vel( 0.0f,0.0f );
353     if( kbd.KeyIsPressed( VK_RIGHT ) )
354     {
355         vel.x += 1.0f;
356     }
357     if( kbd.KeyIsPressed( VK_LEFT ) )
358     {
359         vel.x -= 1.0f;
360     }
361     if( kbd.KeyIsPressed( VK_DOWN ) )
362     {
363         vel.y += 1.0f;
364     }
365     if( kbd.KeyIsPressed( VK_UP ) )
366     {
367         vel.y -= 1.0f;
368     }
369     pos += vel.GetNormalized() * speed * dt;
370 }
```

▲ example code by ChiliTomatoNoodle