CPSC 314
Computer Graphics

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Geometry 1: vertices, points, vectors, coordinates

Announcements

- Preliminaries
  - Assignment 1 progress
  - Office hour Sep 21 2-3pm X853
  - You can visit any of the scheduled labs to meet with TAs too
  - Earliest example of use of vertex shaders for physics
    http://sensorimotor.cs.ubc.ca/2002/07/01/dyrt/
    https://youtu.be/V-GUxcktw2Q
- Today:
  - Essential math for graphics
    (read Textbook Chapter 2)

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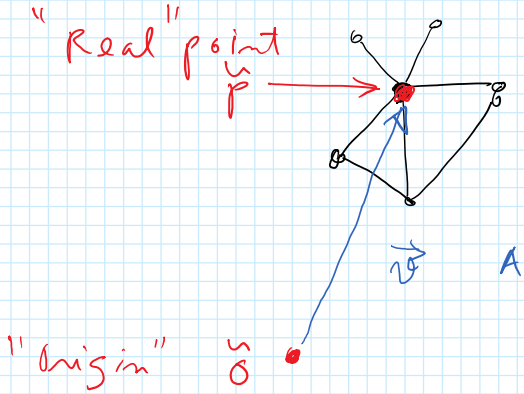
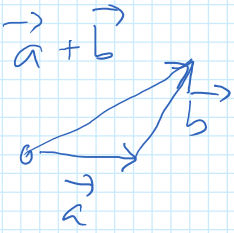
L4. Points and Vectors

September 13, 2017 9:45 AM

Objective: What's the difference between points & vectors
Why "4" dimensions in graphics
How to represent geometry in a program.



Vector $\Rightarrow$
$\vec{a} + \vec{b}$ = vector
$\alpha \vec{a}$, $2.75\,\vec{a}$
$\vec{a} + \vec{0} = \vec{a}$



By fixing an origin, I can represent points with vectors.

§ Vector Space

$V = \{ \vec{v}, \vec{a}, \vec{b}, \dots \}$

$\vec{a} + \vec{b} \in V$ if $\vec{a}, \vec{b} \in V$

$\alpha \vec{a} \in V$ for $\alpha \in \mathbb{R}$ real numbers.

+ fine print

§ Basis $\vec{b}_1, \vec{b}_2, \dots$ (linearly independent)

such that ANY vector $\vec{v} \in V$

$\vec{v} = v_1 \vec{b}_1 + v_2 \vec{b}_2$

v_1, v_2: coordinates of $\vec{v}$

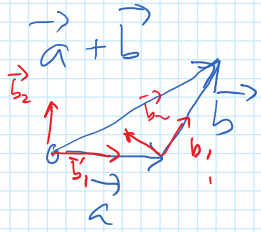
Coordinates of $\vec{v}$ in basis $\{\vec{b}_1, \vec{b}_2\}$

This can be a representation of a vector

$\vec{v} \rightsquigarrow \begin{pmatrix} v_1 \\ v_2 \end{pmatrix} \overset{\text{def.}}{=} \underline{v}$

known $\vec{b}_1, \vec{b}_2$

You can add two vectors by adding their coordinates only if they use the same basis

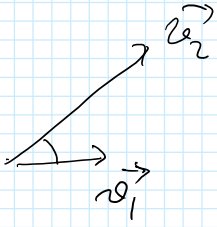


$a = \begin{pmatrix} 2 \\ 0 \end{pmatrix}$ $b = \begin{pmatrix} 2 \\ 0 \end{pmatrix}$

§ Orthonormal basis

A dot product

$\vec{v}_1 \cdot \vec{v}_2 = \text{scalar}$



A norm

$\|\vec{a}\| = \sqrt{\vec{a} \cdot \vec{a}}$

If $\vec{b}_1$ is perpendicular to $\vec{b}_2$

$\vec{b}_1 \cdot \vec{b}_2 = 0$

A dot product is simple if

⚠ dot product is simple if and only if the basis orthonormal

§ Notation Difference

	Pai	Bak
Point	$\underset{\sim}{p}$	$\underset{\sim}{p}$ ✓
Vector	$\vec{v}$	$\vec{v}$ ✓
column matrix	$\bar{a}$	**a** ← bold a