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)
4. Points and Vectors

Objective:

- What's the difference between points & vectors?
- Why do we use vectors in graphics?
- How to represent geometry in a program.

"Real" point

$$\vec{v}$$

"Origin" $$\vec{0}$$

A displacement vector

$$\vec{v} + \vec{b} = \text{vector}$$

$$\lambda \vec{a}, \lambda \geq 1$$

$$\vec{a}^2 + \vec{b}^2 = \vec{c}$$

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

$$\mathbb{R}$$ Vector Space

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

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

$$\lambda \vec{a} \in V \text{ for } \lambda \in \mathbb{R}$$

A finite point

$$\mathbb{R}$$ Basis

$$\vec{b}_1, \vec{b}_2, \ldots$$ (linearly independent)

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

$$\vec{v} = \lambda_1 \vec{b}_1 + \lambda_2 \vec{b}_2$$

$$\text{coordinates of } \vec{v}$$

$$\lambda_1, \lambda_2$$
This can be a representation of a vector:

\[ \overrightarrow{v} \quad \text{in basis } \{ \overrightarrow{b_1}, \overrightarrow{b_2} \} \]

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

\[ \overrightarrow{a} + \overrightarrow{b} \]

- Out of normal basis

A dot product:

\[ \overrightarrow{a} \cdot \overrightarrow{b} = \text{Scalar} \]

A norm:

\[ ||\overrightarrow{a}|| = \sqrt{\overrightarrow{a} \cdot \overrightarrow{a}} \]

If \( \overrightarrow{b_1} \) is perpendicular to \( \overrightarrow{b_2} \):

\[ \overrightarrow{b_1} \cdot \overrightarrow{b_2} = 0 \]

A dot product is simple if...
A dot product is simple if and only if the basis is orthonormal.

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<tr>
<th>Notation</th>
<th>Difference</th>
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<tbody>
<tr>
<td>Point</td>
<td>( \vec{p} )</td>
</tr>
<tr>
<td>Vector</td>
<td>( \vec{v} )</td>
</tr>
<tr>
<td>Column matrix</td>
<td>( \vec{a} )</td>
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