CPSC 314
Computer Graphics

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Geometry 1: Points, Vectors and Coordinates

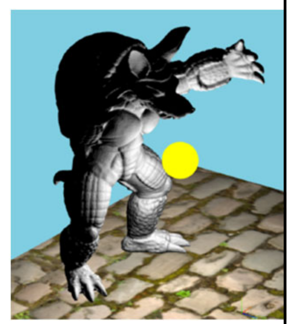
NOTICE:
Recordings of the lecture are provided to students enrolled in the course for self-study only. Any other use, including reproduction and sharing of links to materials, is strictly prohibited.

Preliminaries

- Announcements
  - A1 is out! Please get started. Any questions so far?
  - Labs start this week. Zoom links posted on Canvas.
- Today: Theory (review Chapter 2 of text)
  - Points and Vectors
  - Basis and Coordinates (vec3). Orthonormal Basis.
  - Linear transformations and matrices (mat3 or mat3x3)

Assignment 1 notes

- Many of you have already made great progress! Congratulations!
- Note that there are many things in the provided code (e.g., "modelMatrix"), that you haven't learned yet. Don't panic! You don't need to understand them deeply for this assignment. We'll cover them later this week.
- For Part 1(c) the exact brightness is not important and can be adjusted by a scale factor.
  As long as you get shading that varies with the cosine of the angle between normal and light position, its fine for this assignment. Later we'll look at diffuse shading more accurately.



Today

- Learning objectives
  - Linear algebra review, with some new notation
  - **Points ≠ Vectors ≠ Arrays of numbers**
  - Basis and Coordinates
  - Operations: dot, norm, etc.(built into GLSL)
  - Coordinate transformations, matrices
- Switch to tablet

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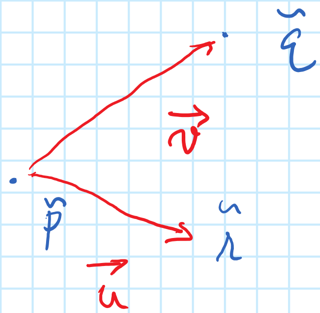


Point is a physical/real location in space

Displacement vector between two points

$$\breve{q} = \breve{p} + \vec{v}$$

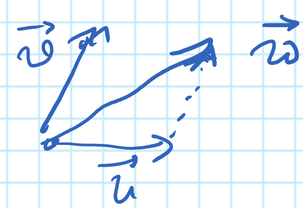
§ Vectors and linear algebra

A set of objects : vectors

Operations : + vectors, multiply with scalars

(1) Add 2 vectors & get another vector

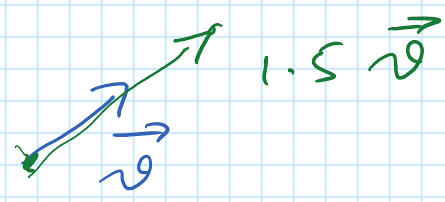
$$\vec{u} + \vec{v} = \vec{w}$$



(2) Scale a vector

$a\vec{v}$ is also a vector

a number



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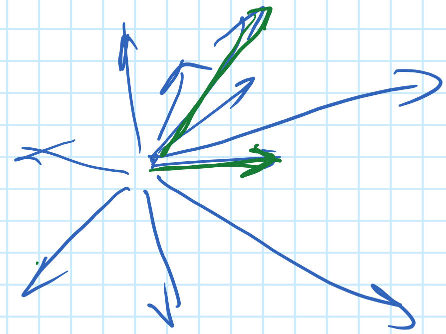
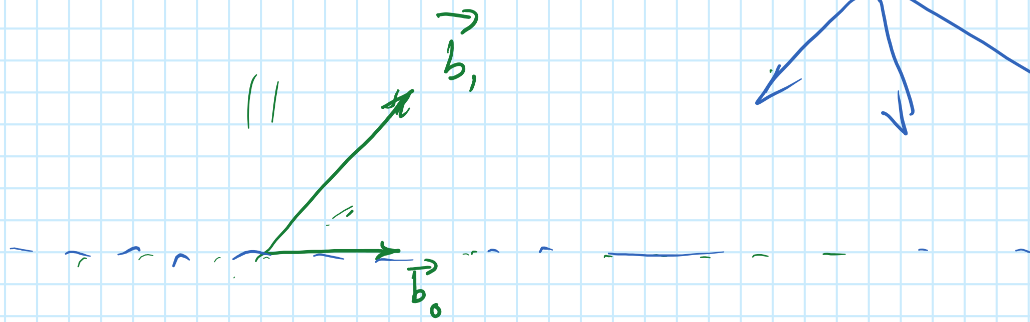
§ Basis





Linearly independent set of vectors, that can generate, via linear combination, all the vectors in the space

The size of the basis set is the <u>dimension</u> of the space. Eg. that is 2D

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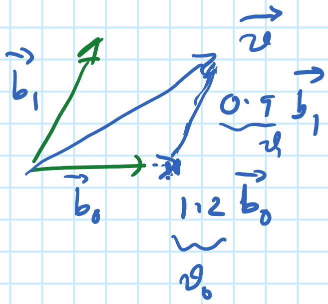
§ Coordinates in a basis $\underline{\vec{b}}$

Can write any vector $\vec{v}$ as

$$\boxed{\vec{v} = \vec{b}_0 v_0 + \vec{b}_1 v_1} \quad (1)$$



Scalars, can represent in an array, in column matrix

$\begin{pmatrix} v_0 \\ v_1 \end{pmatrix}$ are the coordinates of $\vec{v}$

$$\underbrace{\vec{v}}_{\text{vector}} \xrightarrow[\underline{\vec{b}}]{\text{in basis}} \underbrace{\begin{pmatrix} v_0 \\ v_1 \end{pmatrix} = \bar{v}}_{\text{column matrix of numbers}}$$

Note: we will denote a row of items

$$\underline{a} = \begin{pmatrix} a_0 & a_1 \end{pmatrix}$$

Rewrite Eqn (1) using the notation

$$\boxed{\vec{v} = \underbrace{\begin{pmatrix} \vec{b}_0 & \vec{b}_1 \end{pmatrix}}_{\underline{\vec{b}}} \underbrace{\begin{pmatrix} v_0 \\ v_1 \end{pmatrix}}_{\bar{v}} = \underline{\vec{b}}\,\bar{v}}$$

For next class

- Review Chapter 3 and 4 of textbook.
- This is a key step: you’ll solve the mystery of 4-vectors!