CPSC 314
Computer Graphics

Dinesh K. Pai

Geometry 1 continued:
transforms, frames

Announcements

- Quiz 1preparation tips
- Assignments
  - Please do not miss your face-to-face grading time! If you need to reschedule, do it at least a day in advance. No-show Policy: unless you have a documented excuse, 15% deduction from the max grade for that assignment.
  - Lateness policy: up to **three days in the entire term** Submit well before your grading time slot
- Today:
  - Essential math for graphics

  (read Textbook Chapter 3)

2

Quiz 1 Preparation

- CAREFULLY review lecture notes, and assignment 1
- Textbook. Read all of these, except as noted. But use class notation (see L4 and today for differences).
  - Ch 1
  - Ch 2: skip Eq. 2.5
  - Ch 3: skip Section 3.6

4

Quiz Format

- The Quiz is closed book, closed electronic device (laptops, phones, etc. should be out of sight).
- 45 marks (in 45 minutes. Please be on time, will start at 10!)
- Three types of questions
  - small questions (fill in the blank, many choices given)
    "Can you recognize the concepts?"
  - direct questions (write down short answer)
    "Do you understand the concepts?"
  - problem solving questions
    "Can you use your knowledge in a new situation?"

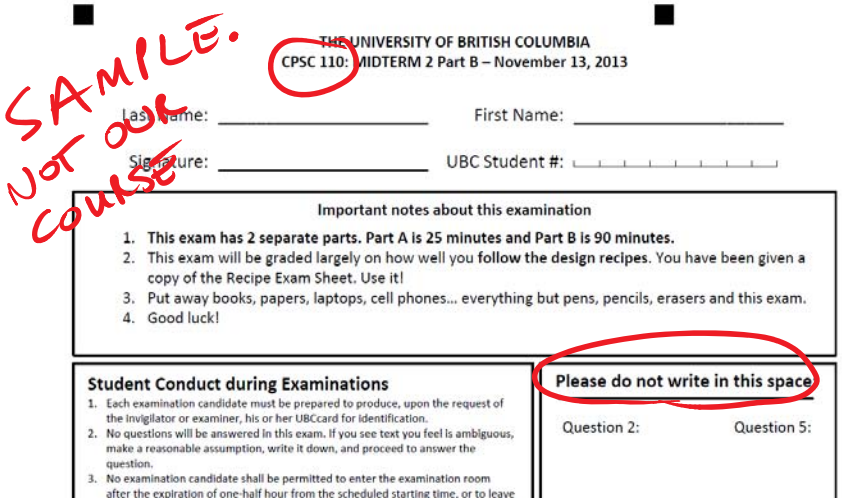
5

Quiz Format

- The first two question types are meant to be easy. Try to go through them quickly, so that you have time to think about the problem solving questions at the end.
- Some questions may have multiple parts that build on one another. Answer for part (a) is used in part (b), etc. Even if the answer for (a) is incorrect, you can get credit for later parts if you show your steps (i.e., later parts will be graded on the subsequent logic).

6

Quizzes will be scanned and returned electronically


SAMPLE. NOT OUR COURSE

THE UNIVERSITY OF BRITISH COLUMBIA
CPSC 110: MIDTERM 2 Part B – November 13, 2013

Last Name: _____ First Name: _____

Signature: _____ UBC Student #: _____

Important notes about this examination

1. **This exam has 2 separate parts. Part A is 25 minutes and Part B is 90 minutes.**
2. This exam will be graded largely on how well you **follow the design recipes**. You have been given a copy of the Recipe Exam Sheet. Use it!
3. Put away books, papers, laptops, cell phones... everything but pens, pencils, erasers and this exam.
4. Good luck!

Student Conduct during Examinations

1. Each examination candidate must be prepared to produce, upon the request of the invigilator or examiner, his or her UBCcard for identification.
2. No questions will be answered in this exam. If you see text you feel is ambiguous, make a reasonable assumption, write it down, and proceed to answer the question.
3. No examination candidate shall be permitted to enter the examination room after the expiration of one-half hour from the scheduled starting time, or to leave

Please do not write in this space

Question 2: Question 5:

7

September 18, 2017 9:54 AM

Recap

Important Notation

Us	Book	
$\tilde{p}$	$\tilde{p}$	Point
$\vec{v}$	$\vec{v}$	Vector
$\bar{a}$	$\mathbf{a}$	Column matrix $\begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix}$ vec3
$\underline{a}$	$\mathbf{a}^t$	Row matrix: $(a_1\ a_2\ a_3)$ vec3
$\underline{\vec{b}}$	$\vec{\mathbf{b}}^t$	Row of vectors $(\vec{b}_1\ \vec{b}_2\ \vec{b}_3)$
$\underline{\bar{b}}$	?	Coordinate matrix $(\bar{b}_1\ \bar{b}_2\ \bar{b}_3)$

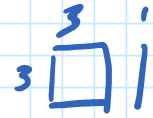
$$= \begin{pmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{pmatrix}$$ mat3

★ This is also how GLSL represents matrices

```
mat3 b;
```

b[0] ⟶ First column of b

```
vec3 a;
```

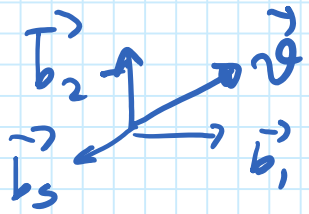



```
b * a
a * b;
```

Examples

September 18, 2017 10:27 AM

§ Scaling



$$\vec{v} = \underline{b} \begin{pmatrix} v_1 \\ v_2 \\ v_3 \end{pmatrix}$$

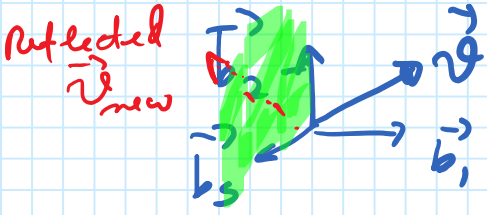
Uniform $\alpha \begin{bmatrix} 1 & & \\ & 1 & \\ & & 1 \end{bmatrix}$ or $\begin{bmatrix} \alpha & & \\ & \alpha & \\ & & \alpha \end{bmatrix}$

Notation $\begin{bmatrix} \text{Blank means '0'} \\ * \quad \text{means non-zero} \end{bmatrix}$

Non-uniform $\begin{bmatrix} 3 & & \\ & 2 & \\ & & -5 \end{bmatrix}$

§ Reflection

Eg in the $(\vec{b}_2, \vec{b}_3)$ plane



$$R = \begin{bmatrix} -1 & & \\ & 1 & \\ & & 1 \end{bmatrix}$$

$$v_{new} = R \cdot v = \begin{pmatrix} -v_1 \\ v_2 \\ v_3 \end{pmatrix}$$

§ Rotation

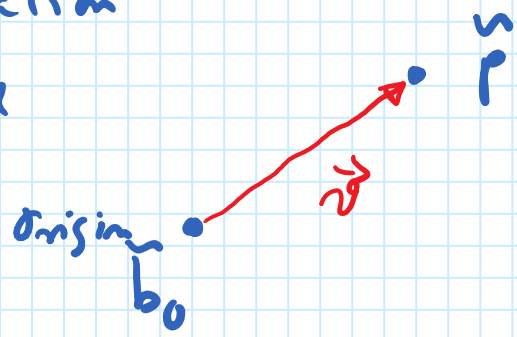
(Next class?)

Affine Space (Read Ch. 3)

September 18, 2017 10:35 AM

§ Translation

Recall



Extend our algebra to allow adding a vector to a point!

$$\tilde{p} = \tilde{b}_0 + \vec{v}$$

Using a basis for the vector space

$$\tilde{p} = \underbrace{\vec{b}_1 v_1 + \vec{b}_2 v_2 + \vec{b}_3 v_3}_{\vec{v}} + \underbrace{\tilde{b}_0 1}_{\tilde{b}_0}$$

$$= \begin{pmatrix} \vec{b}_1 & \vec{b}_2 & \vec{b}_3 & \tilde{b}_0 \end{pmatrix} \begin{pmatrix} v_1 \\ v_2 \\ v_3 \\ 1 \end{pmatrix}$$

"Frame" or "Affine frame"

$$\tilde{p} = \underline{b} \; \vec{v}$$

"Homogeneous" coordinates of a point

Can also allow

$\tilde{a} - \tilde{b} \overset{\text{def}}{=} \vec{v}$ such that $\tilde{b} + \vec{v} = \tilde{a}$

Similarly

$1\tilde{a} = \tilde{a}$

Not yet

$3\tilde{a}$ or $\tilde{a} + \tilde{b}$