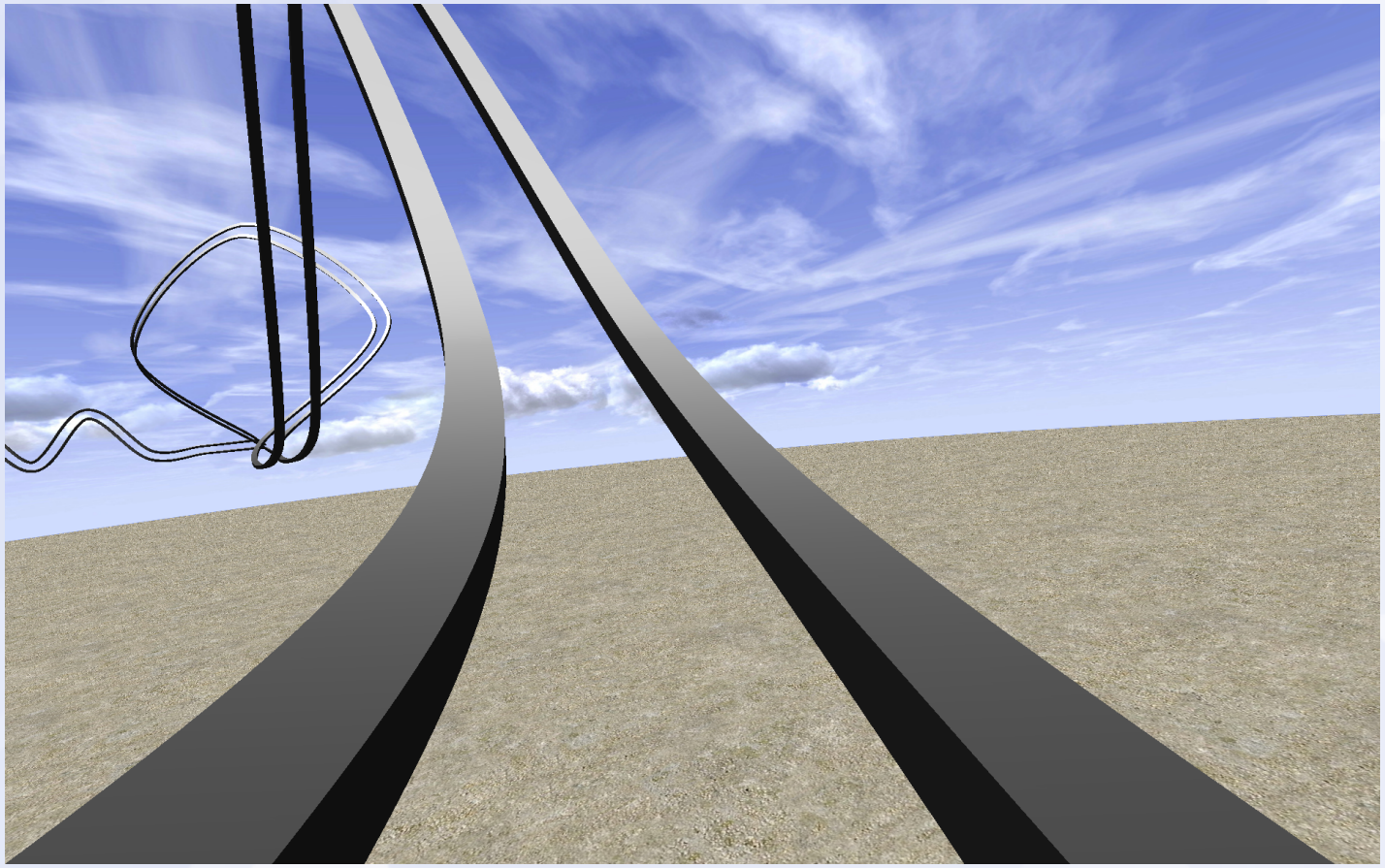
CS420 Assignment 2 Hints

Simulating a Roller Coaster



Spline

Catmull-Rom Spline Matrix

$$\begin{bmatrix} x & y & z \end{bmatrix} = \begin{bmatrix} u^3 & u^2 & u & 1 \end{bmatrix} \begin{bmatrix} -s & 2-s & s-2 & s \\ 2s & s-3 & 3-2s & -s \\ -s & 0 & s & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ x_3 & y_3 & z_3 \\ x_4 & y_4 & z_4 \end{bmatrix}$$

basis

control matrix

Display splines in OpenGL

- Method 1(basic): brute force
  - u = 0, 0.01, 0.02, 0.03, ... ,1
  - Fixed even steps of u does not mean even steps of x
  - Line length will vary over the curve
- Method 2(extra): recursive subdivision

Recursive Subdivision

- Method 2: recursive subdivision - vary step size to draw short lines

```
Subdivide(u0,u1,maxlinelength)
    umid = (u0 + u1)/2
    x0 = F(u0)
    x1 = F(u1)
    if |x1 - x0| > maxlinelength
       Subdivide(u0,umid,maxlinelength)
       Subdivide(umid,u1,maxlinelength)
    else drawline(x0,x1)
```

- Variant on Method 2 - subdivide based on curvature
  - replace condition in “if” statement with straightness criterion
  - draws fewer lines in flatter regions of the curve

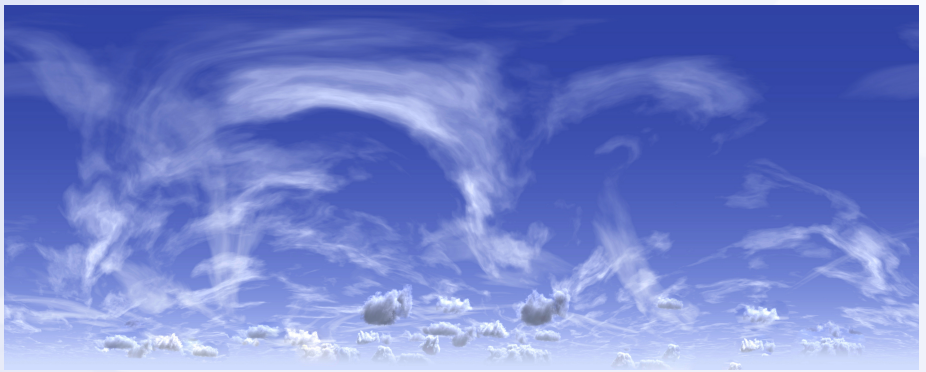
Ground

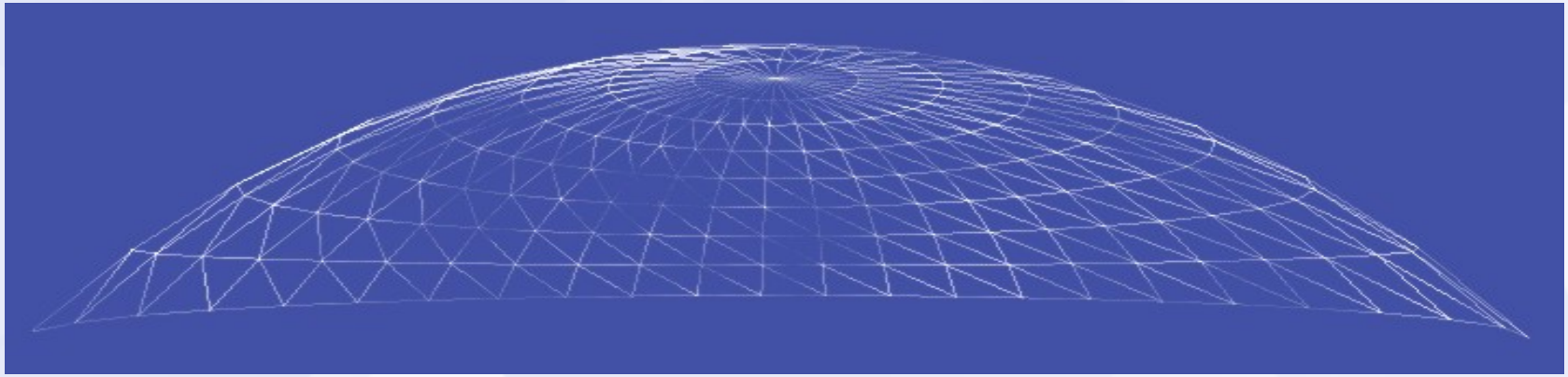
- A large plane
- Texture-mapped

  ImageIO library can load texture images

Sky

- Texture-mapped
- Basic: Use a cube
  - Not realistic
- Extra: e.g. A dome





http://www.flipcode.com/archives/Sky_Domes.shtml

Move Camera

- Camera points along the tangent vector of the curve
  - t(u) =unit(p'(u)) = unit([3u^2 2u 1 0] M C).
- How to find an “up” vector for the camera?
  - Camera orientation should be continuous

Coordinate Transitions

- Establish a local coordinate system for each point on the curve
  - T, N, B
- Initialization: T0, N0, B0
  - u = 0 => T0
  - Pick an arbitrary V. N0 = unit(T0 x V) and B0 = unit(T0 x N0). This guarantees T0, N0, B0 perpendicular to each other.

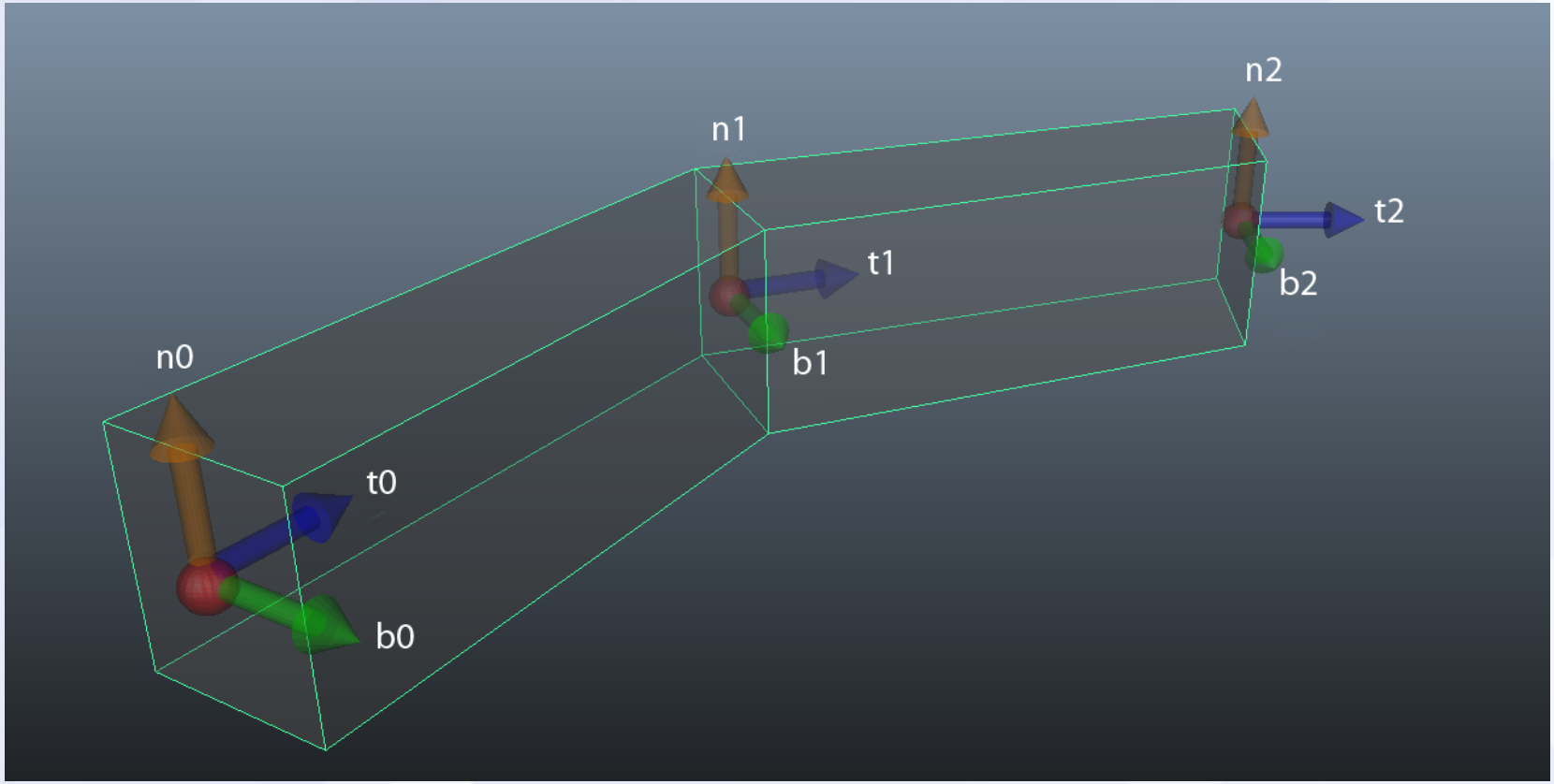
Coordinate Transitions

- Next view: T1, N1, B1
  - Move u or x ahead, compute T1 based on new u
  - N1 = unit(B0 x T1) and B1 = unit(T1 x N1)
- T2, N2, B2, ...
- Make camera “up” vector to be N or B
- Guarantee camera orientation changes continuously

Speed of the camera

- Basic: fixed steps of u
- Extra: realistic in terms of gravity
  - $$u_{new} = u_{current} + (\Delta t) \frac{\sqrt{2g(h_{max} - h)}}{\left\| \frac{dp}{du} \right\|}$$
  - Derive the equation above for extra credit

Rail Cross-section



Other shapes are also allowed. e.g. A circle or ellipse.

Animation Requirement

- Do not exceed 1000 frames
- Frame rate: 15fps

- Start as soon as possible
- Have fun!

Thanks!