

Finding edge intersections in a directed graph

Shortcomings of the Shortest Path Problem

Background

“The shortest path”

“The current status calculates the shortest path using the navigation lines as a graph and Dijkstra algorithm to obtain the path”

ESRI

ESRI

65.5

39.9

ESRI

65.5

39.9

65° 30' 00"

39° 52' 45"

ESRI

65.5

39.9



ESRI

65.5

39.9



ESRI

65.5

39.9



ESRI

65.5
39.9

65° 30' 00"
39° 52' 45"

Java

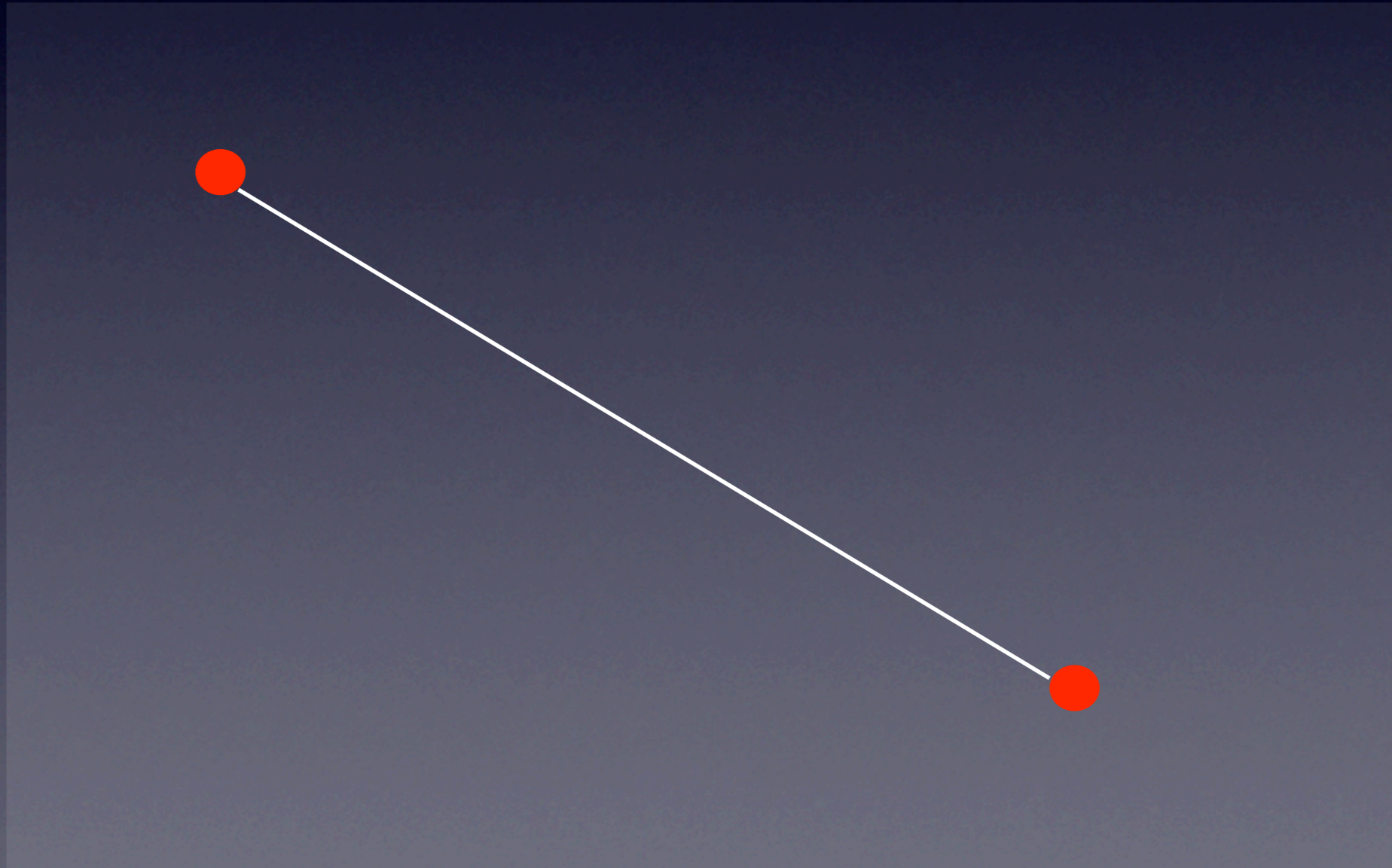


12.43px
33.3 px

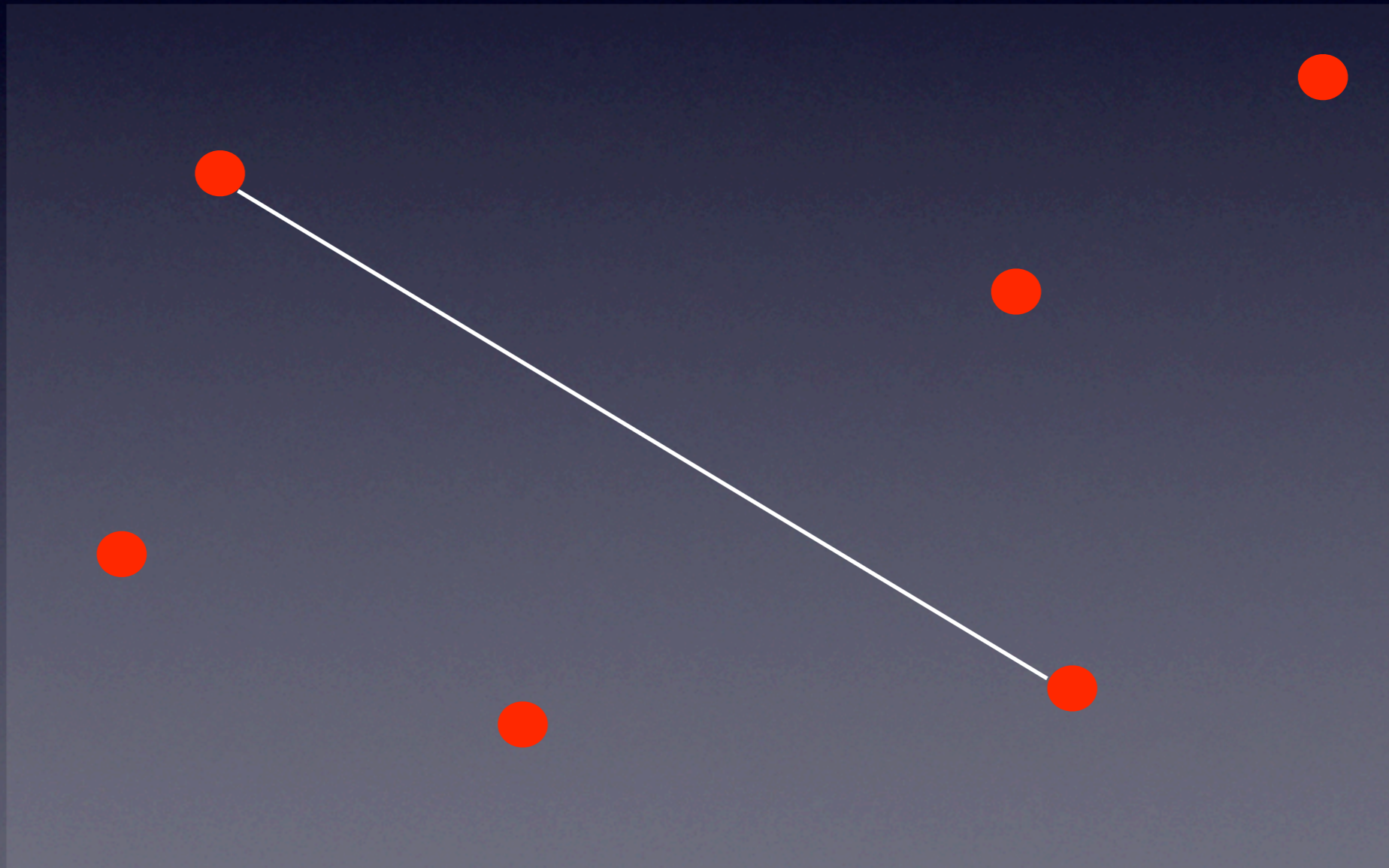
Navigation Line



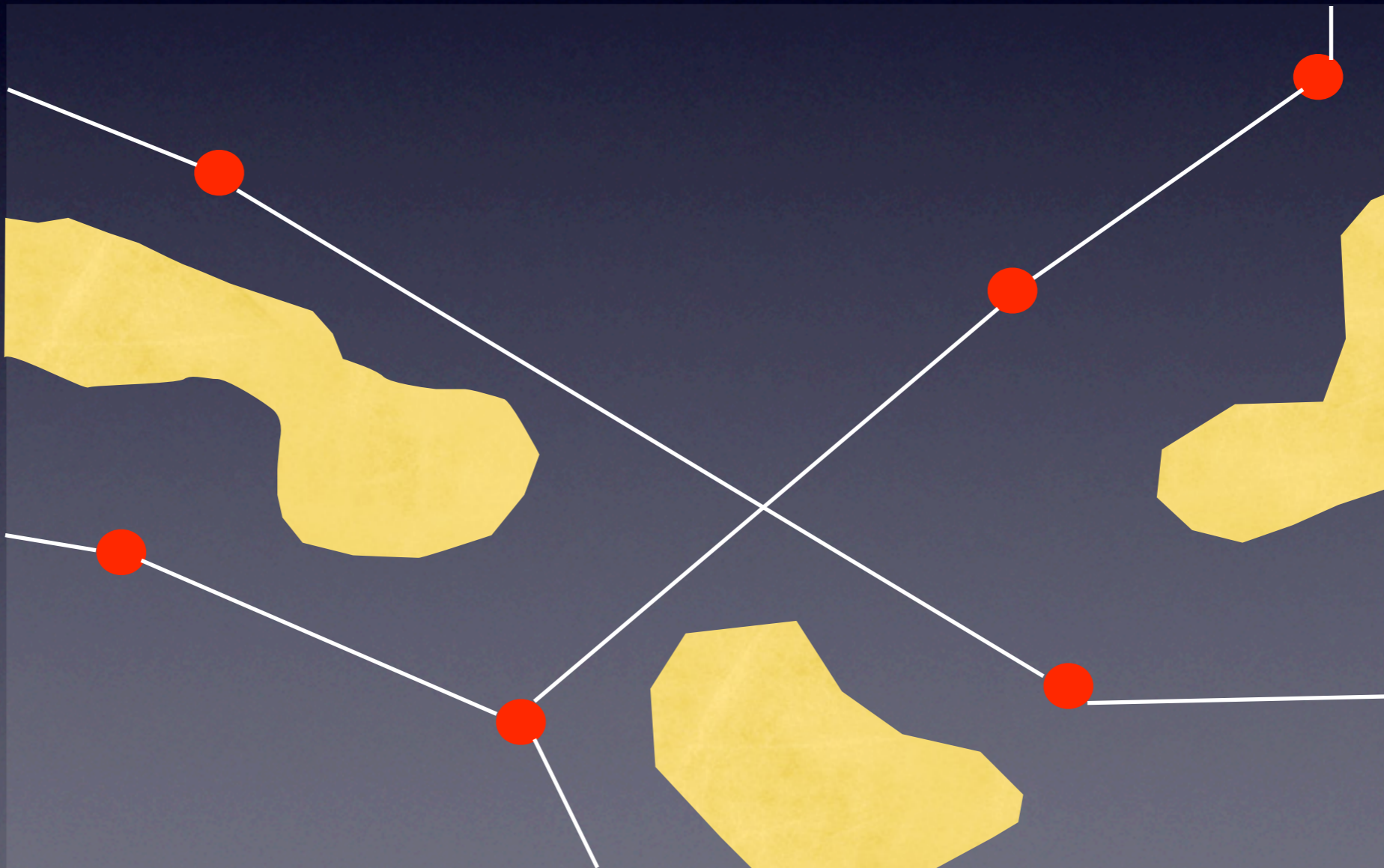
Navigation Line



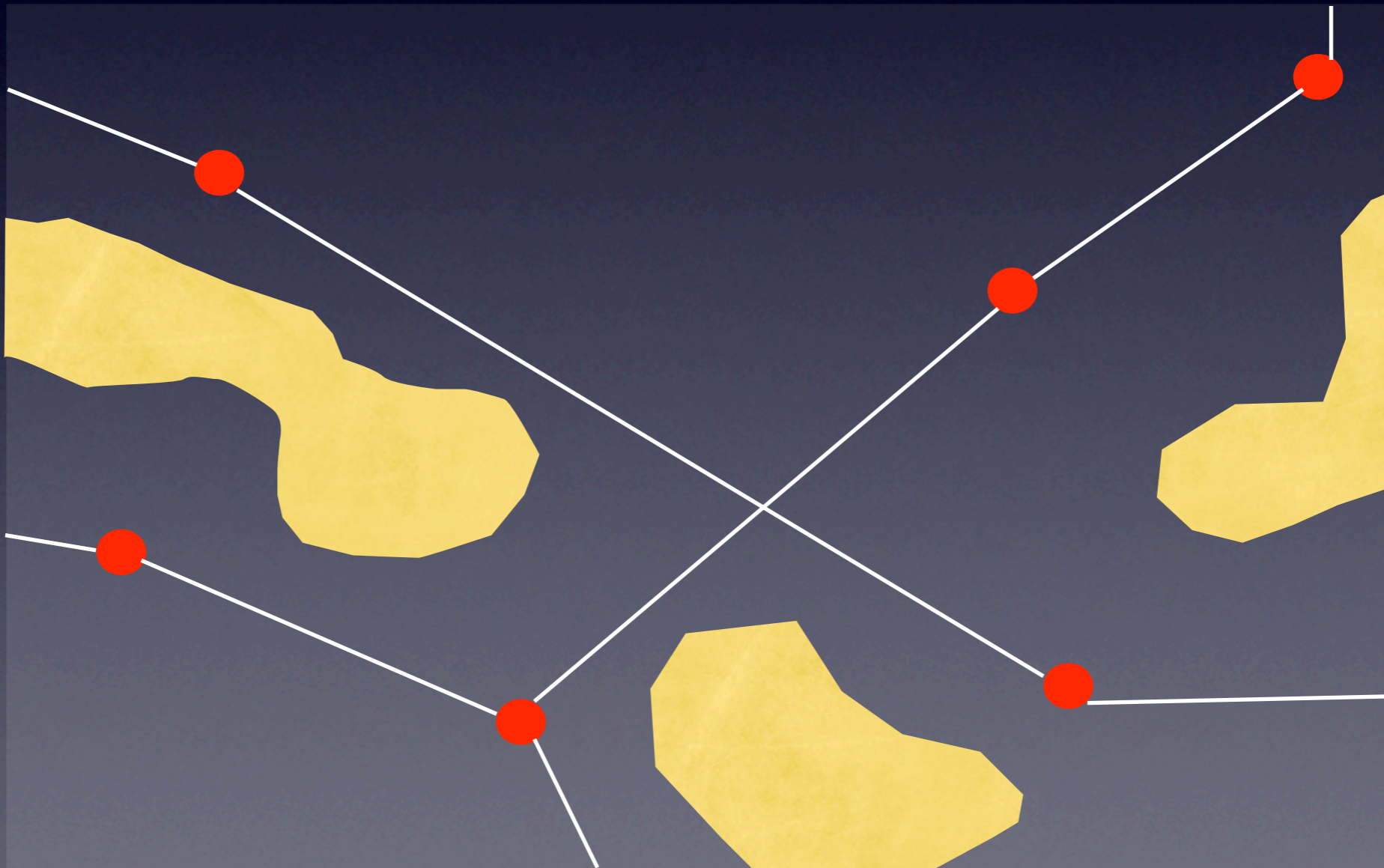
Navigation Line



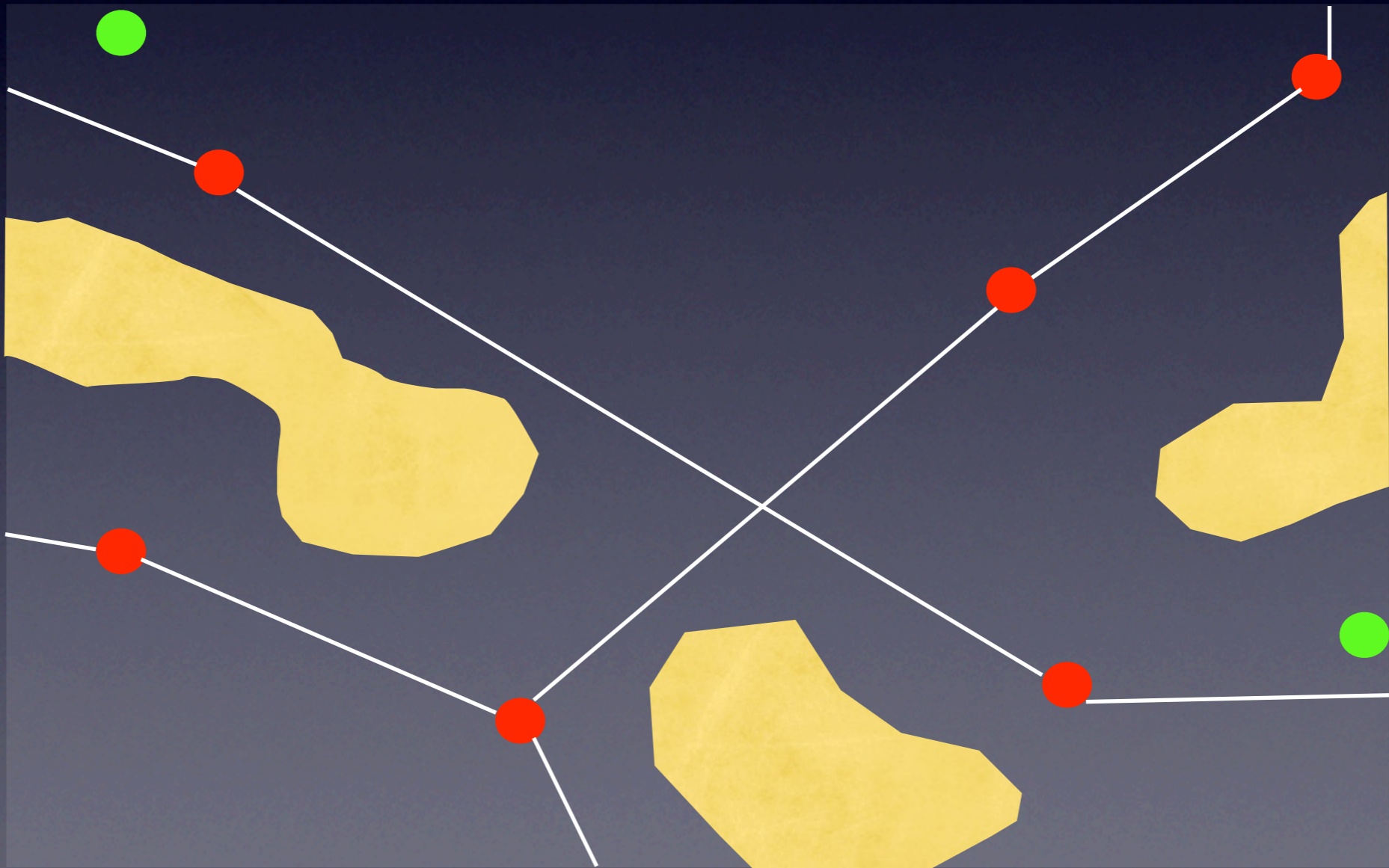
Navigation Lines



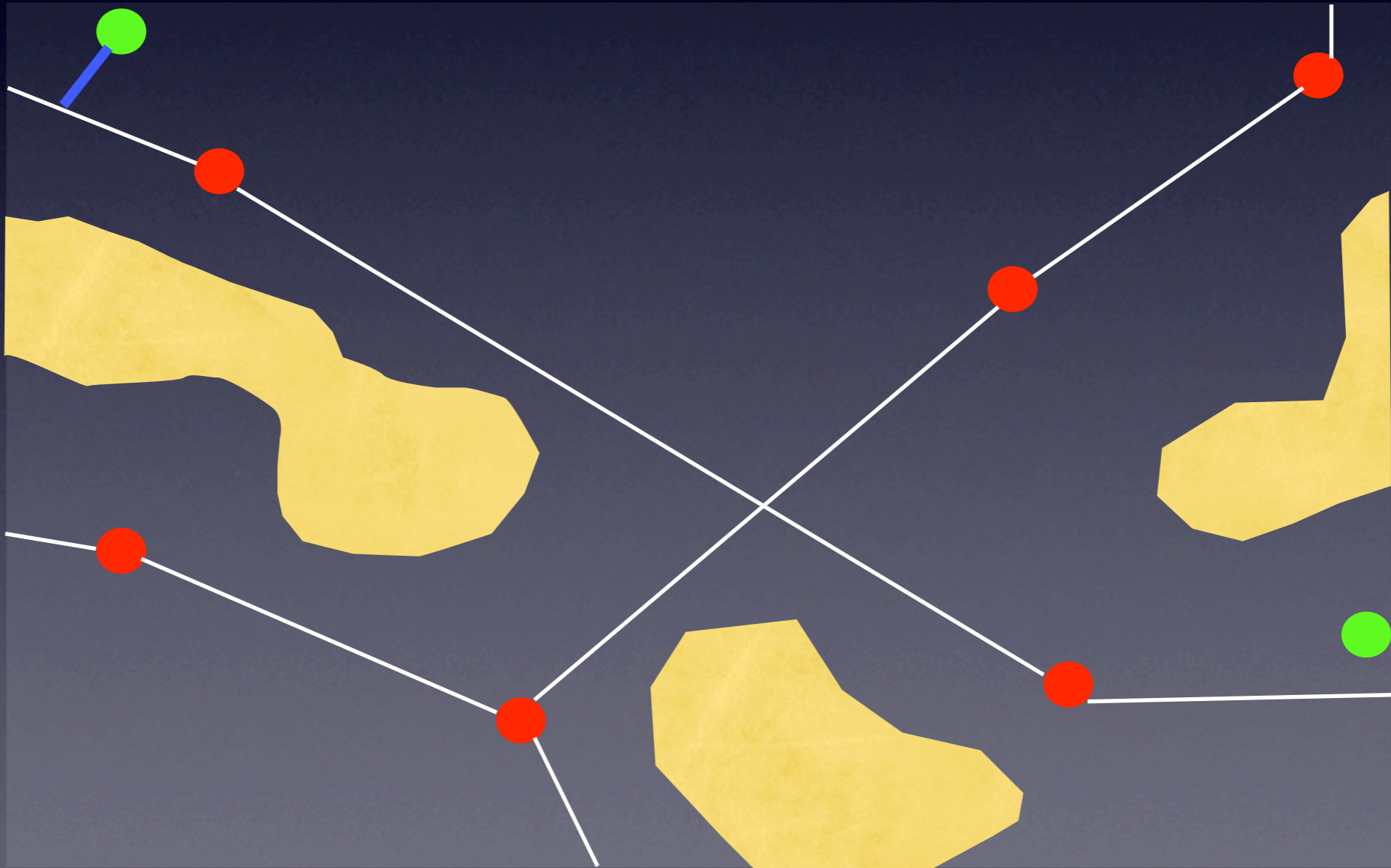
Navigation Lines



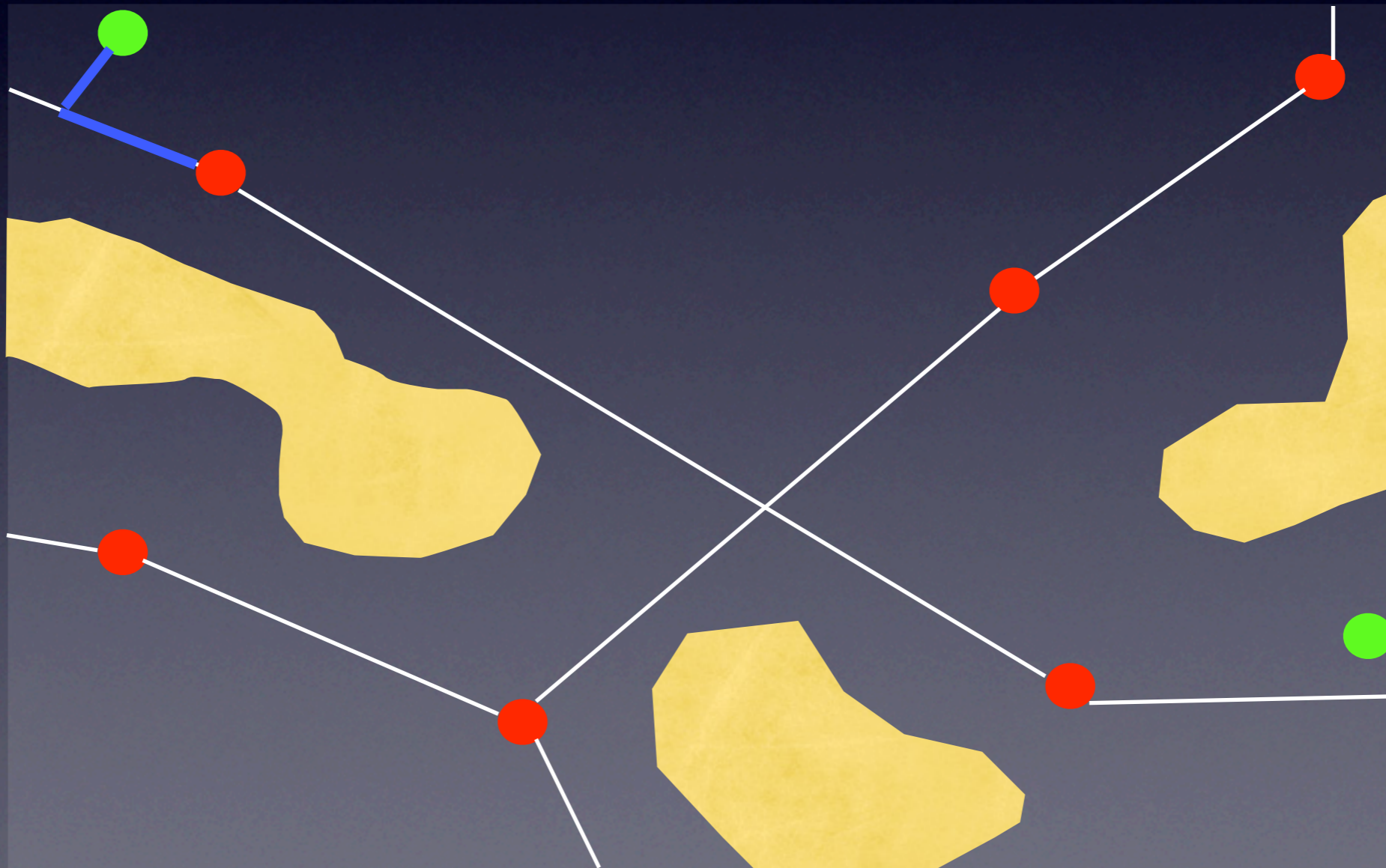
Shortest path



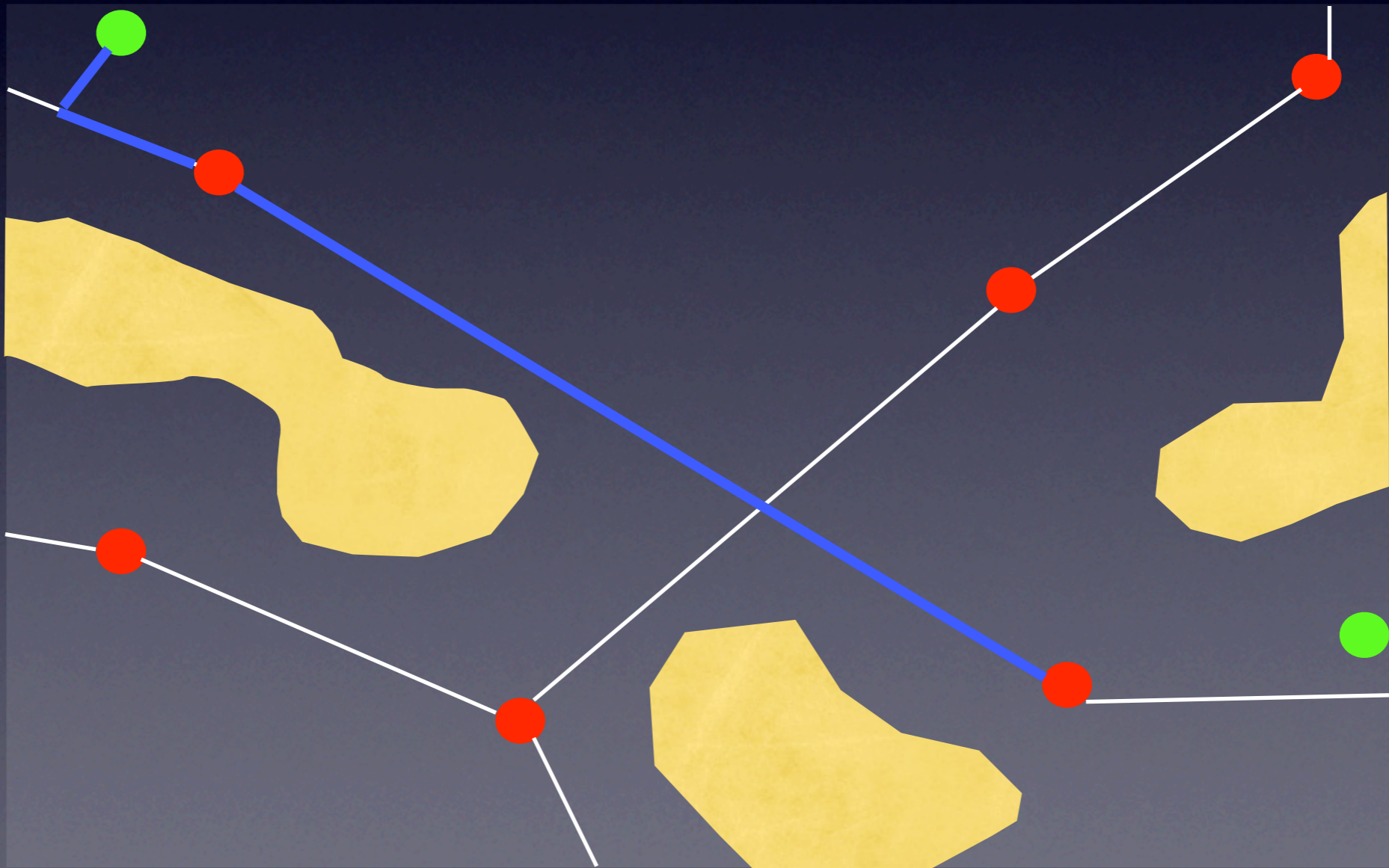
Shortest path



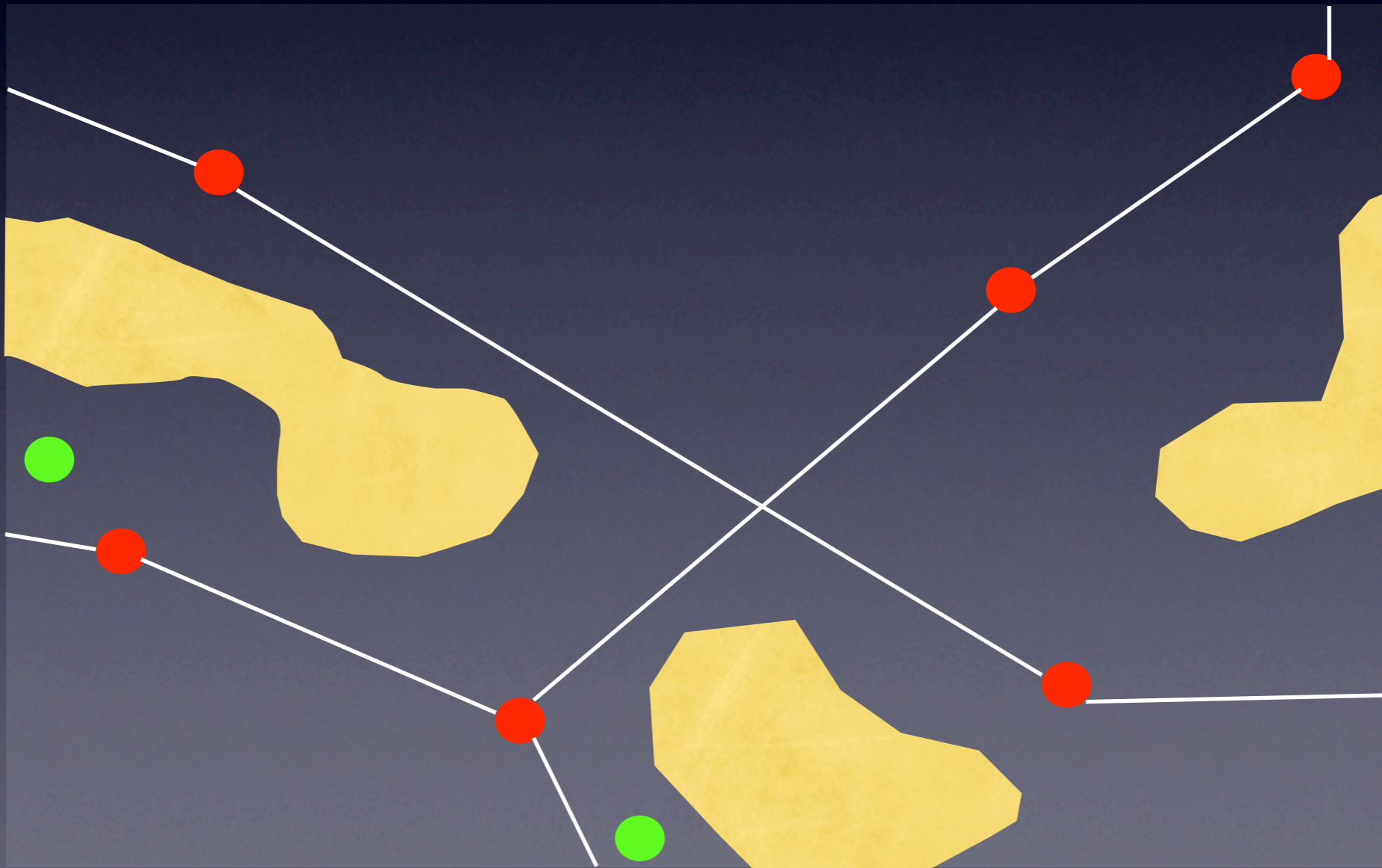
Shortest path



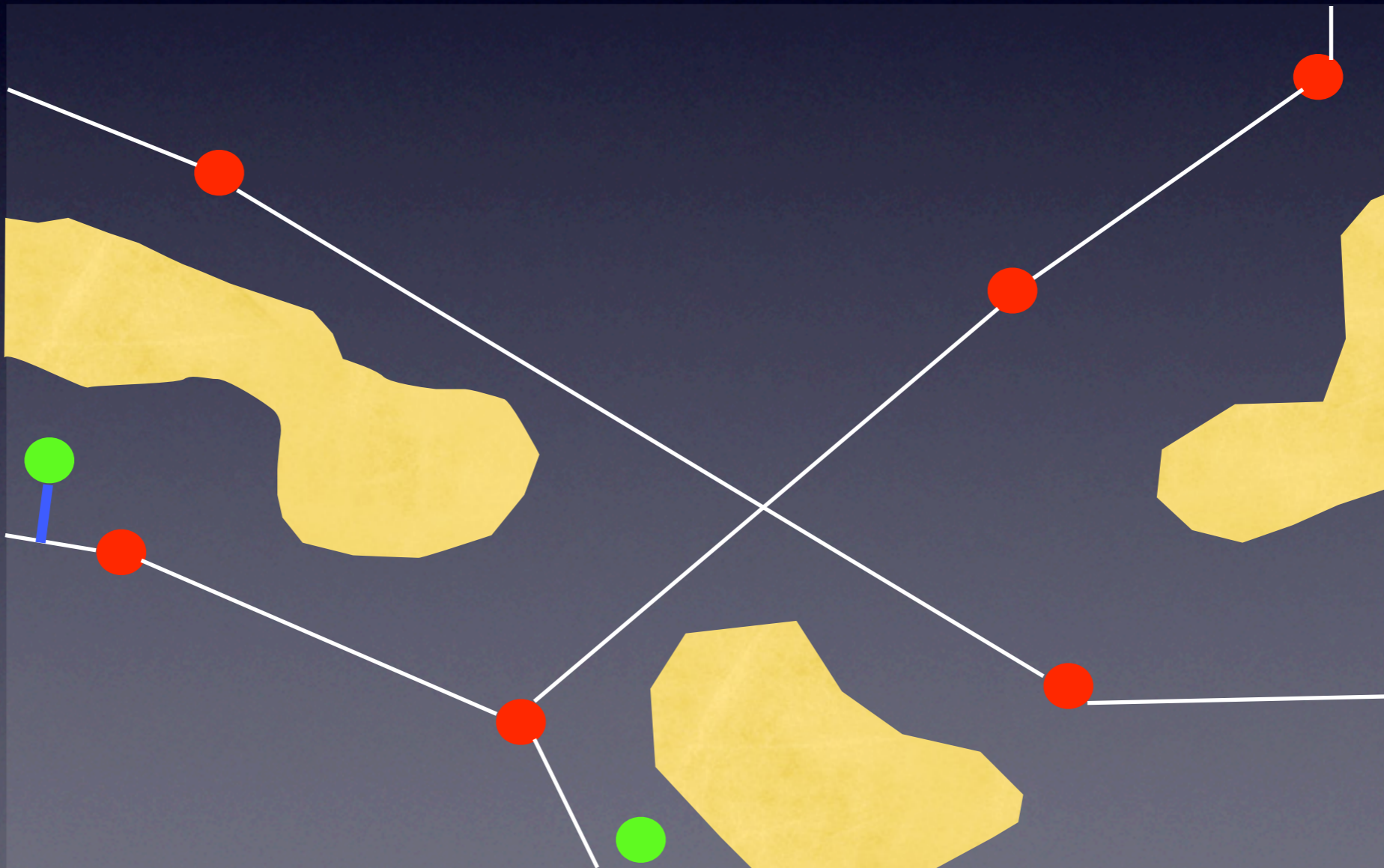
Shortest path



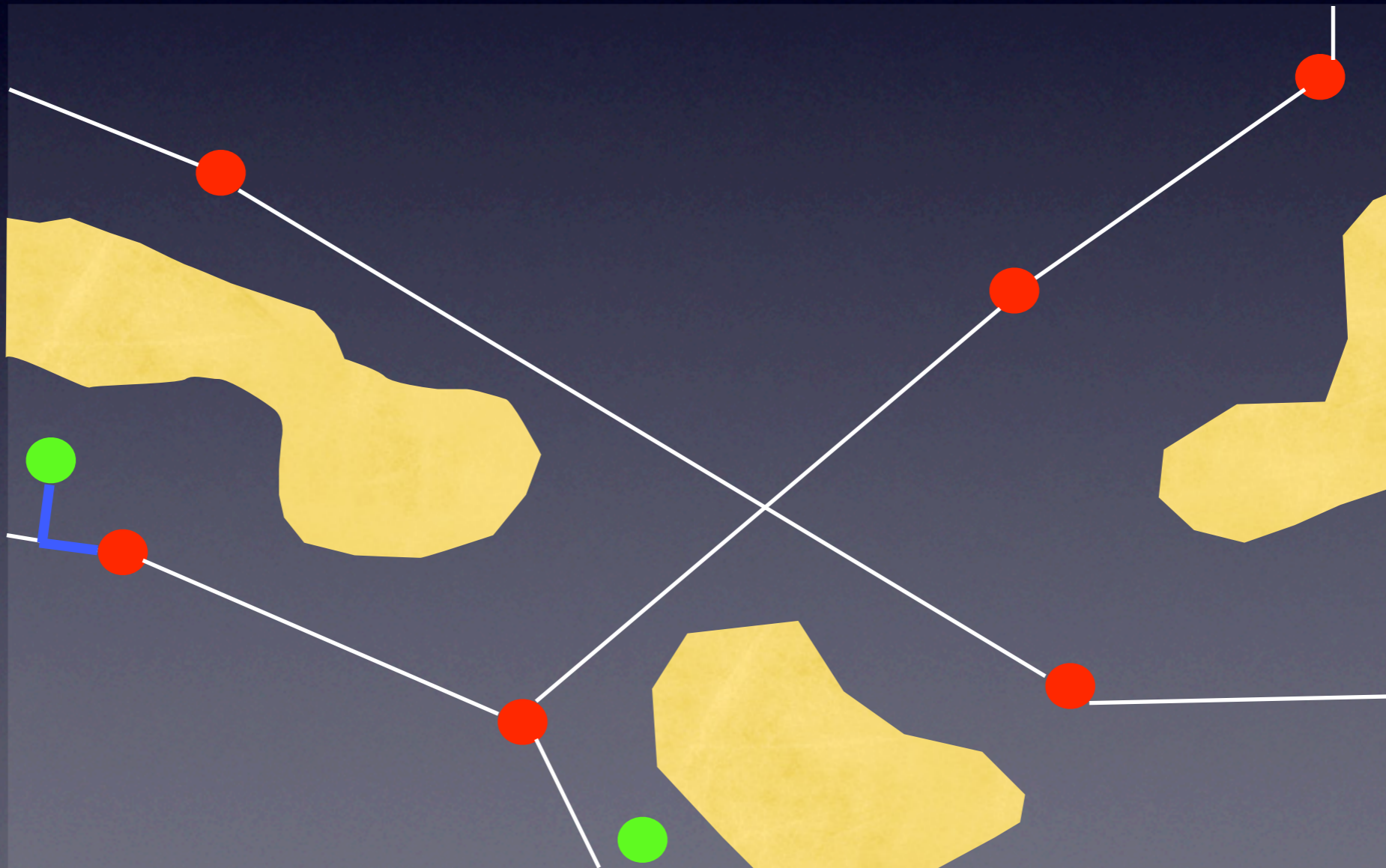
Shortest path



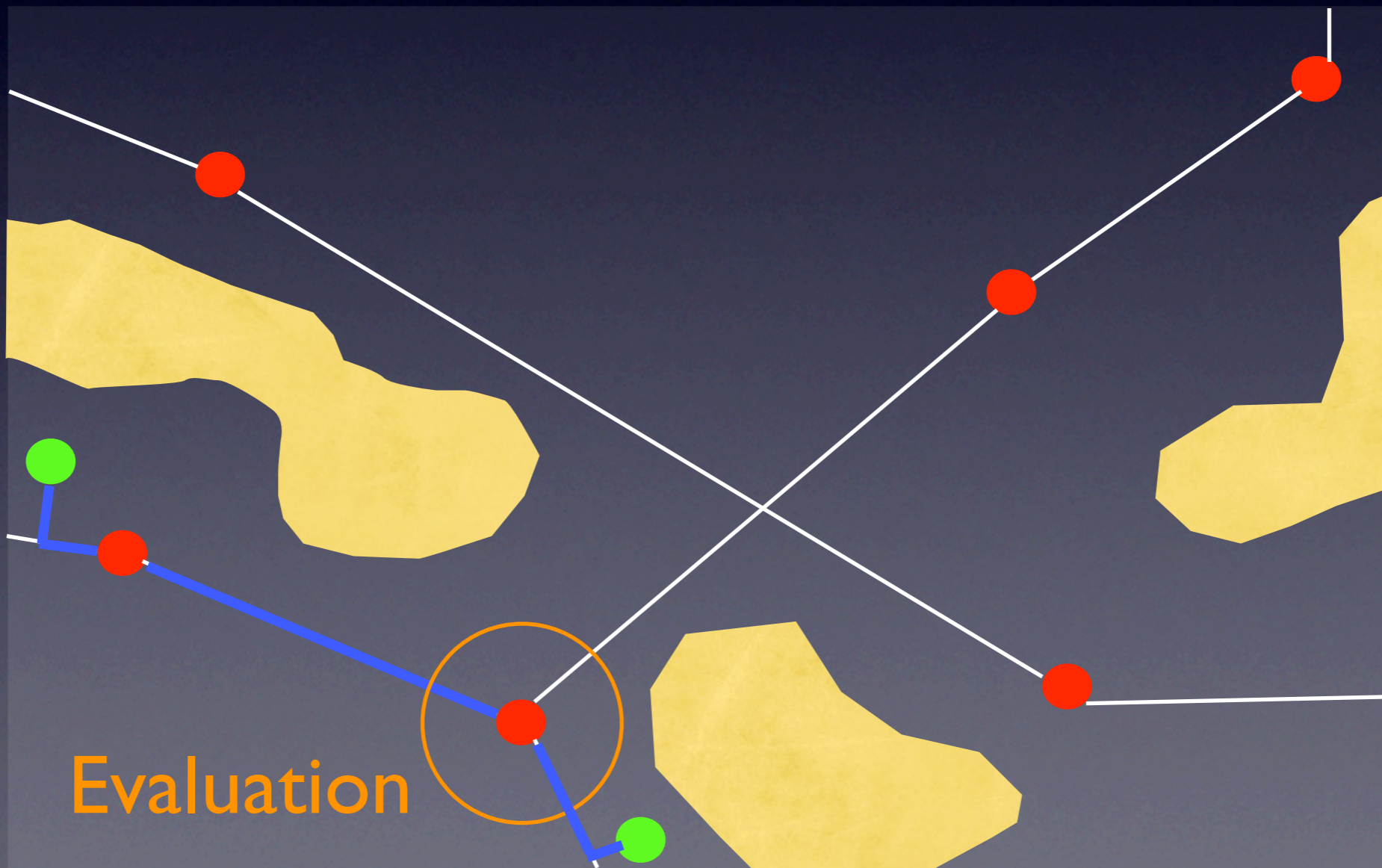
Shortest path



Shortest path

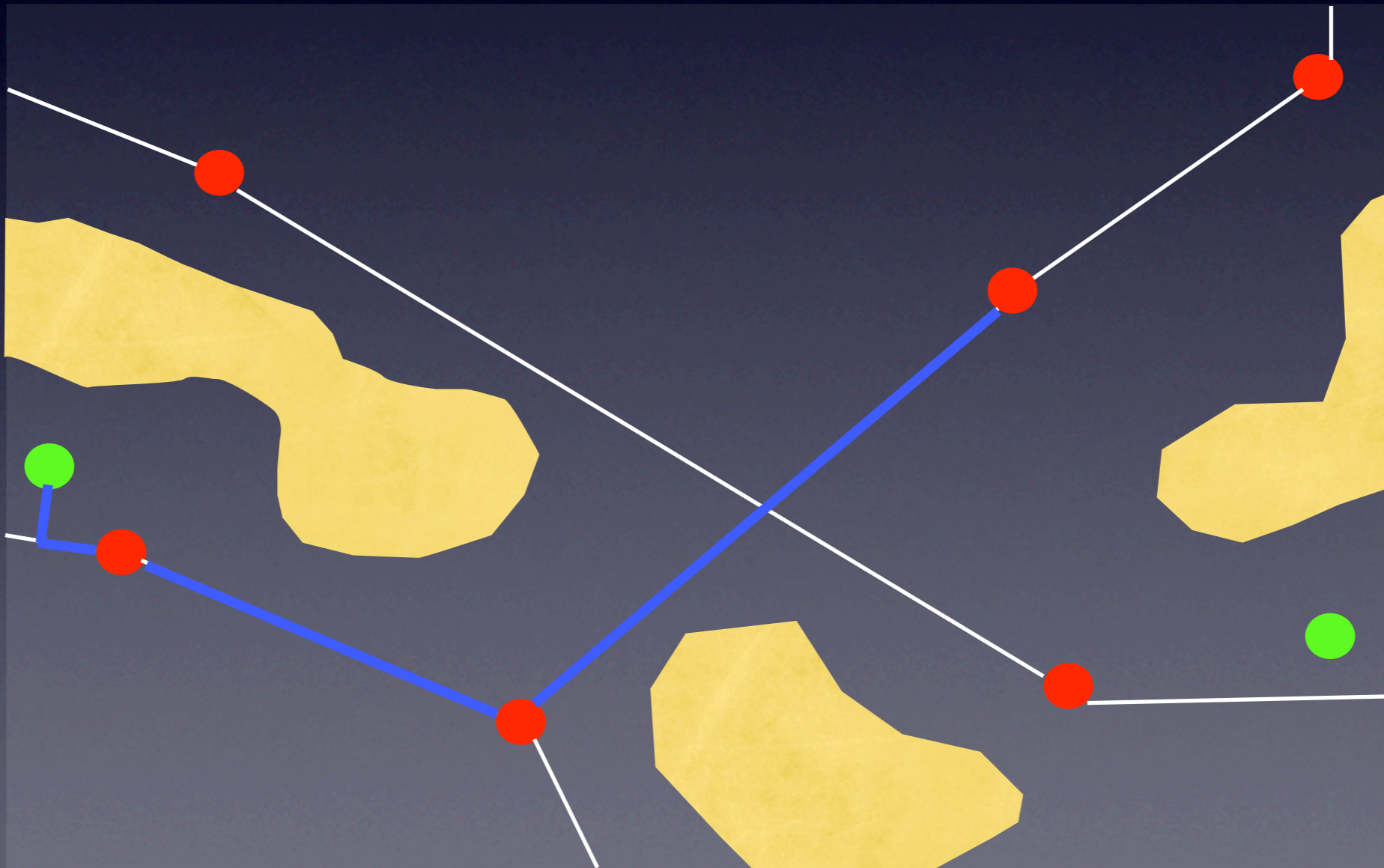


Shortest path

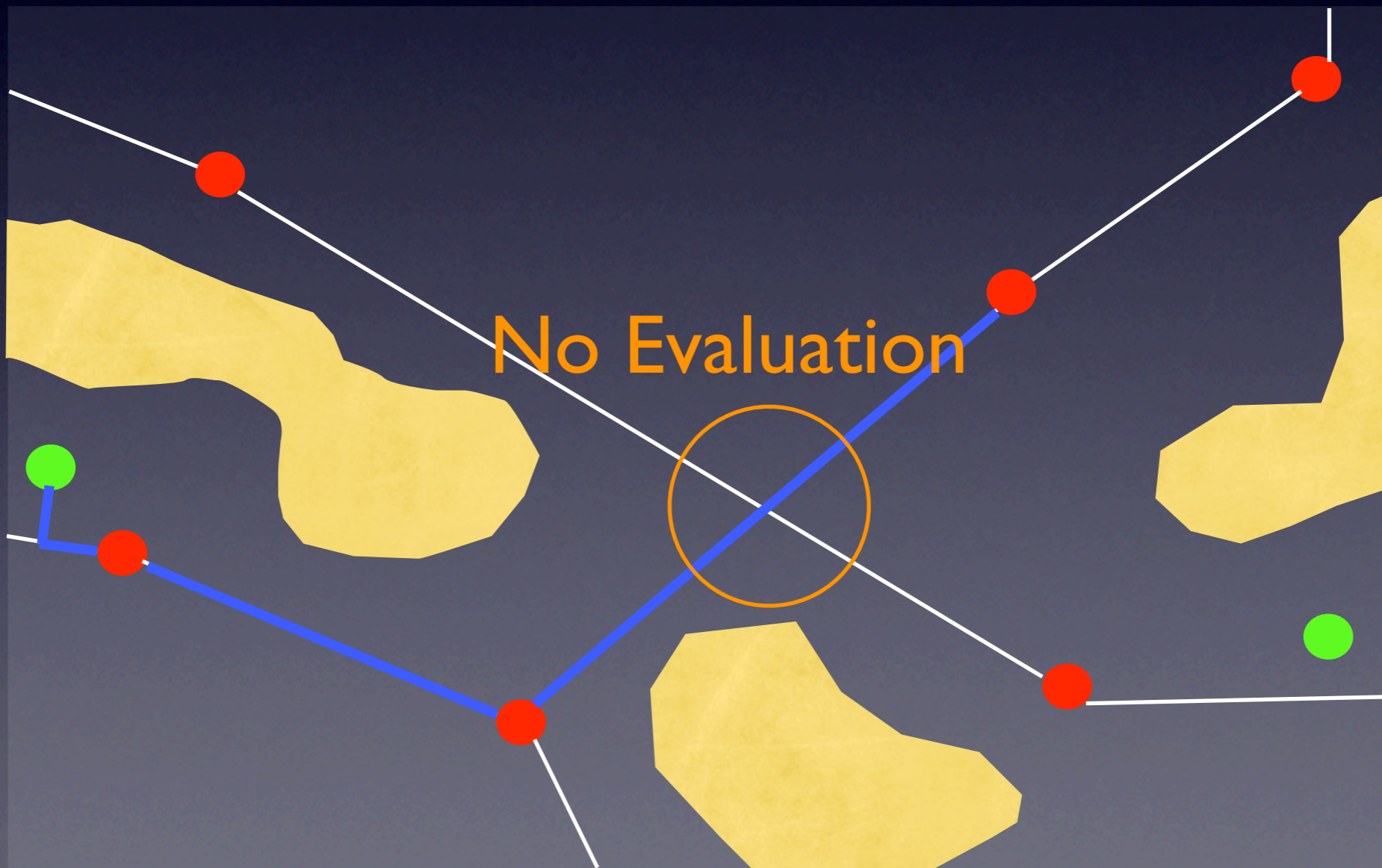


Shortcomings

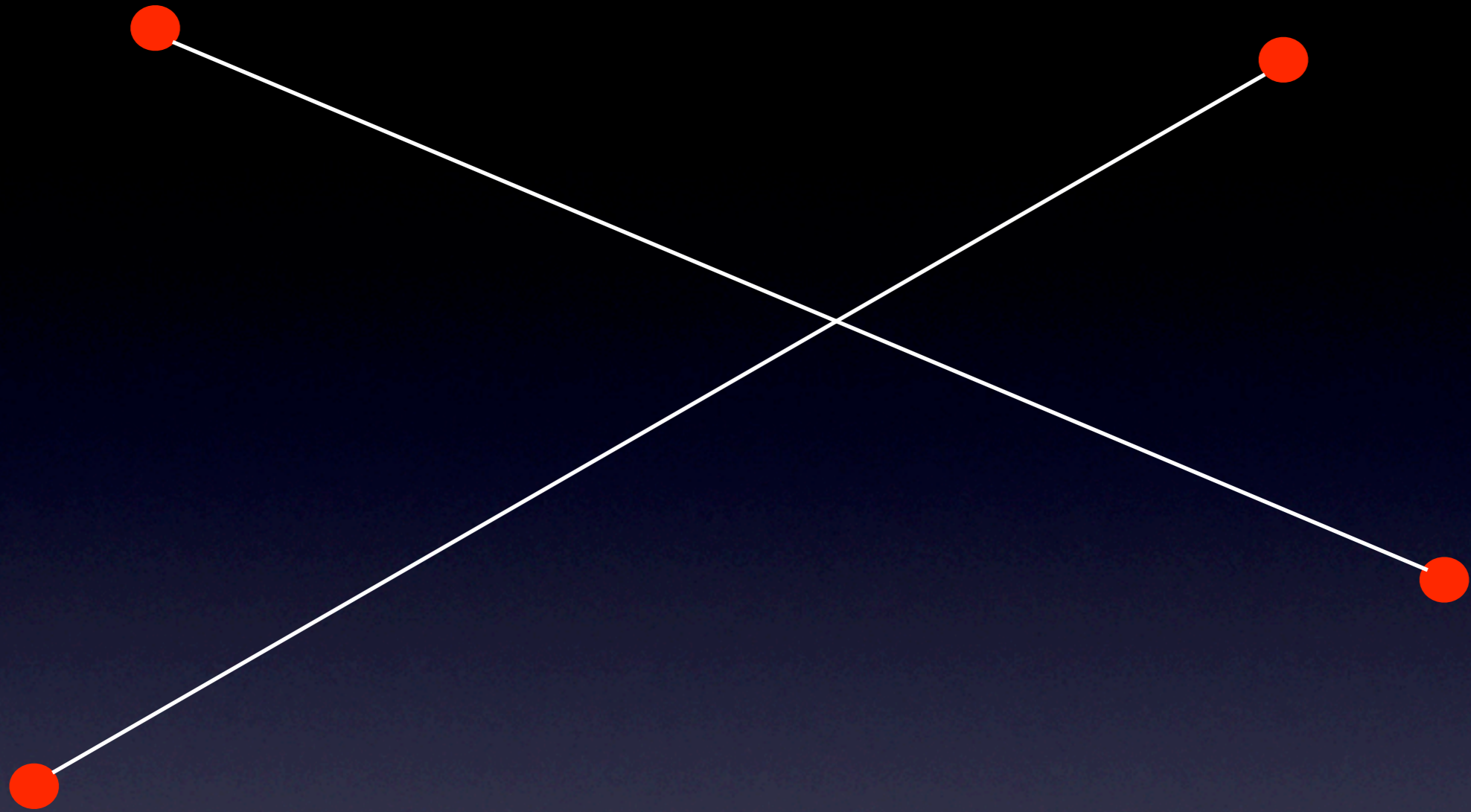
Navigation Lines



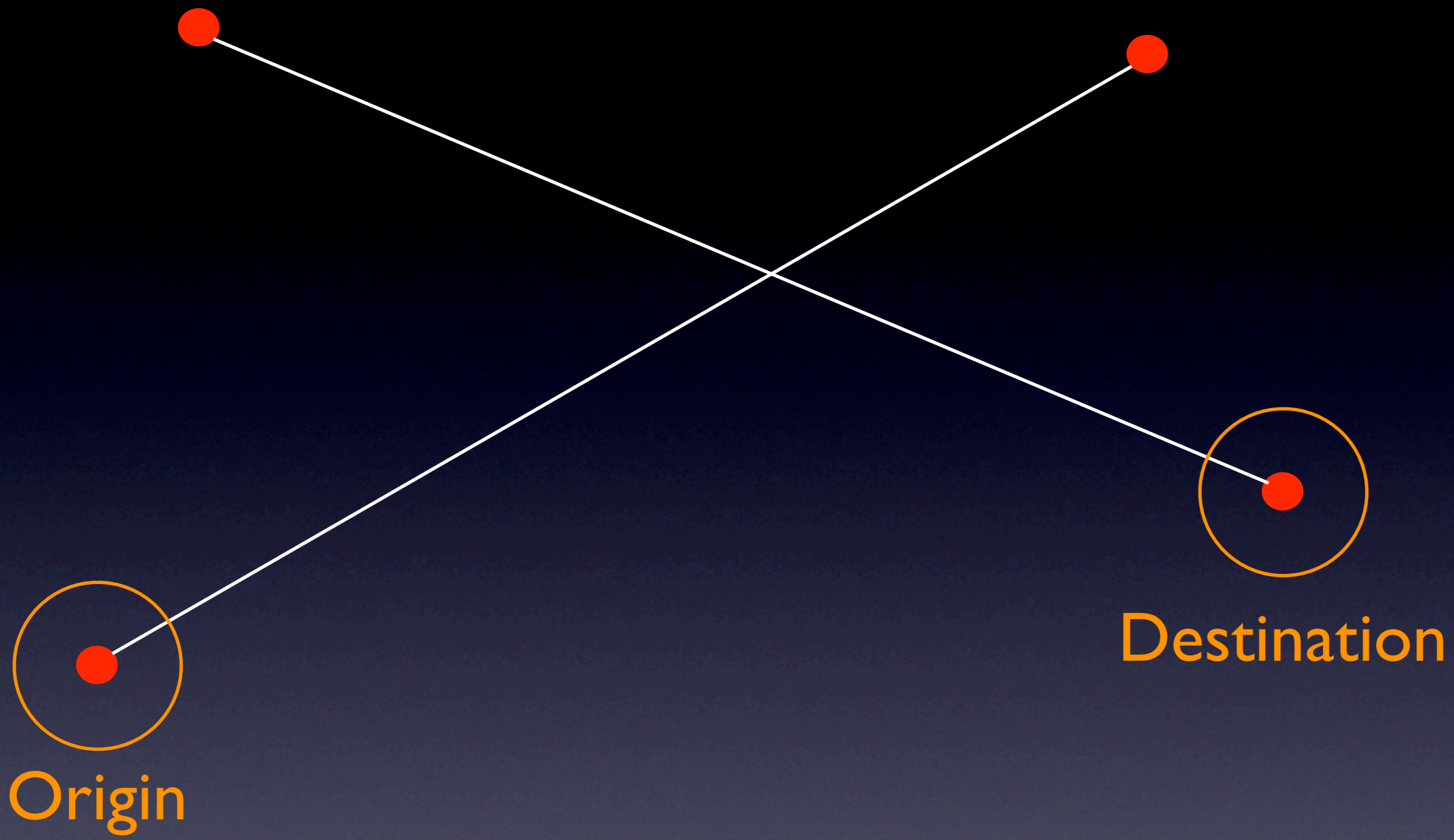
Navigation Lines



Problem: Finding the intersections

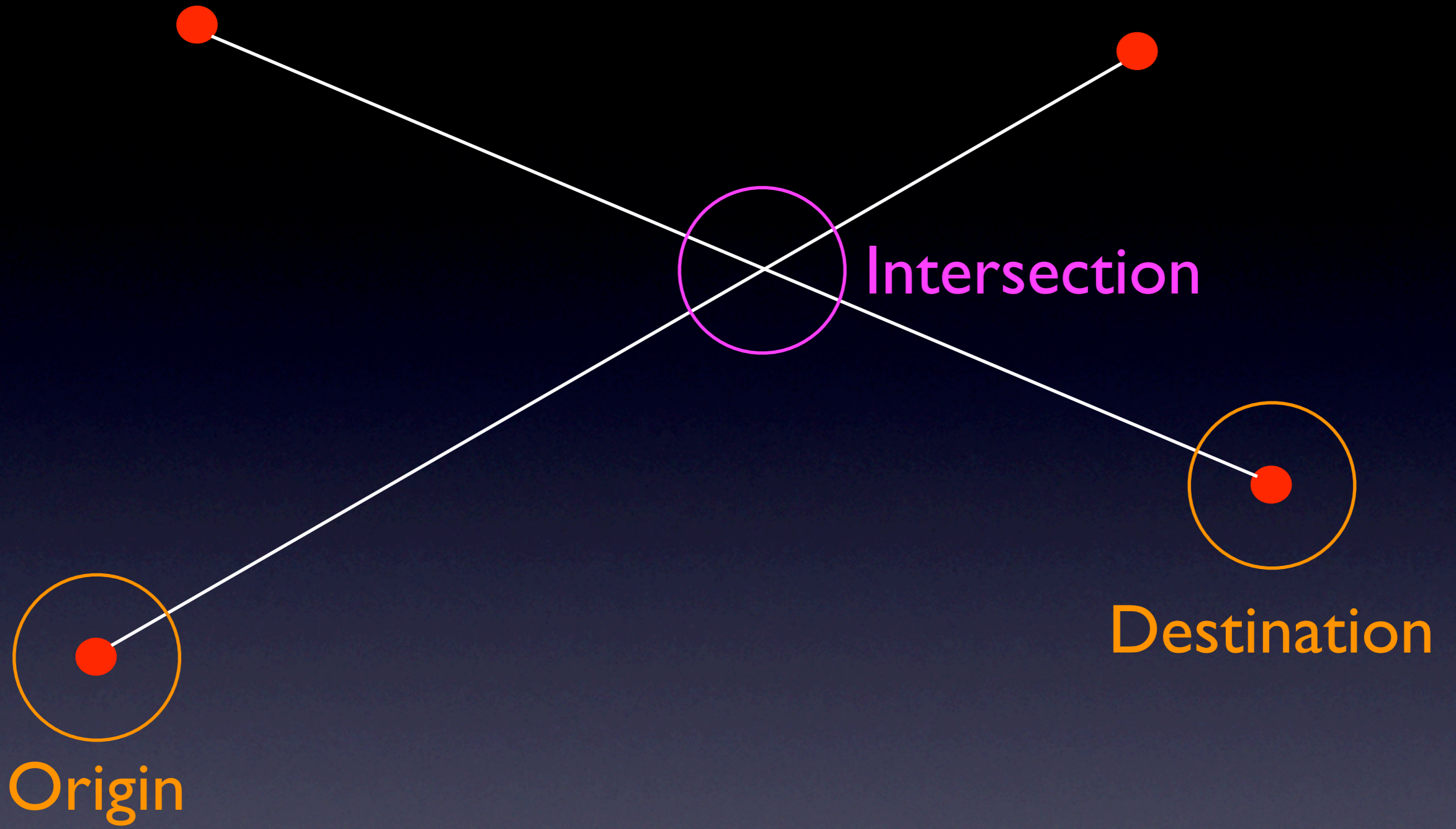


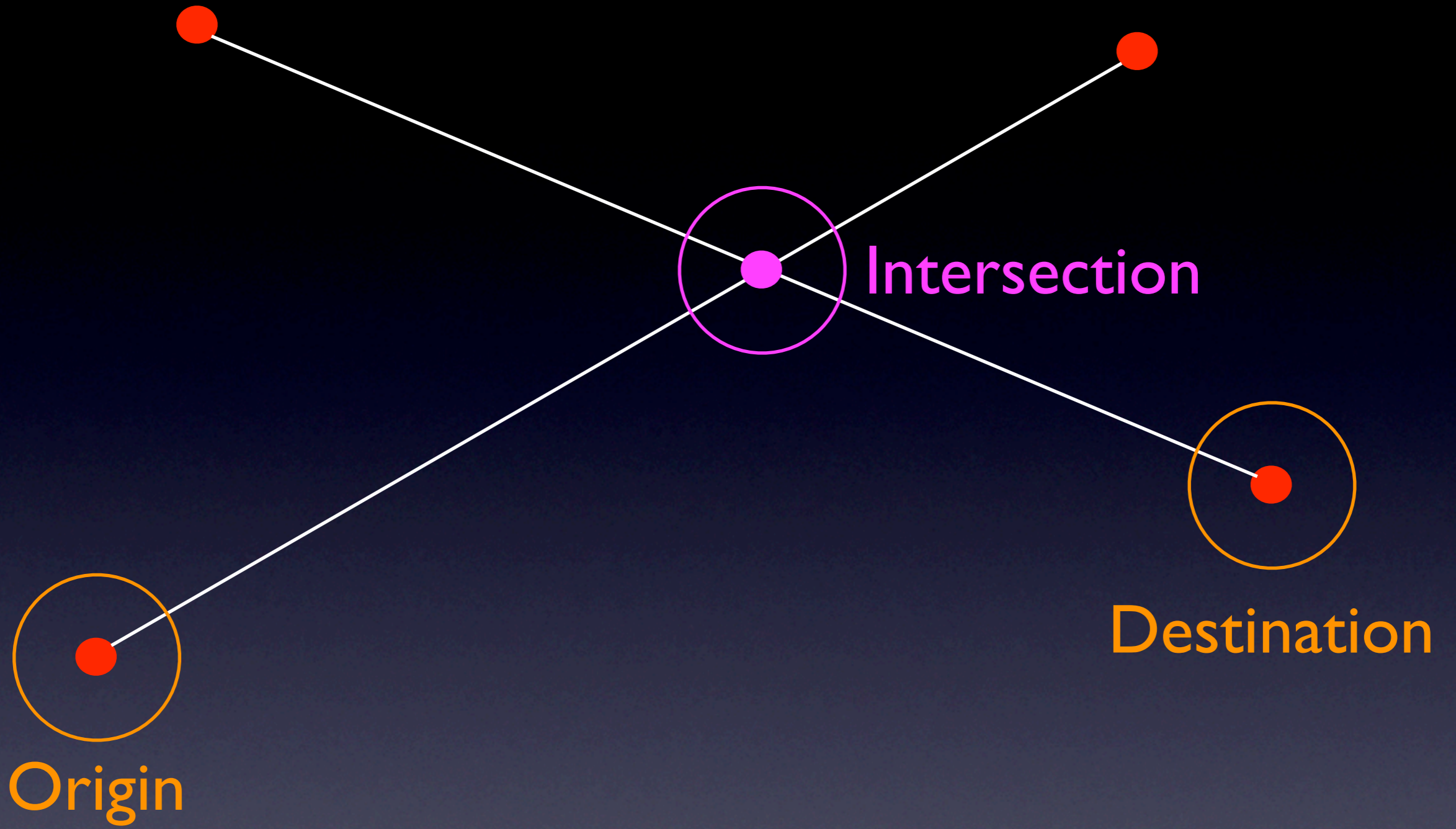
Case scenario

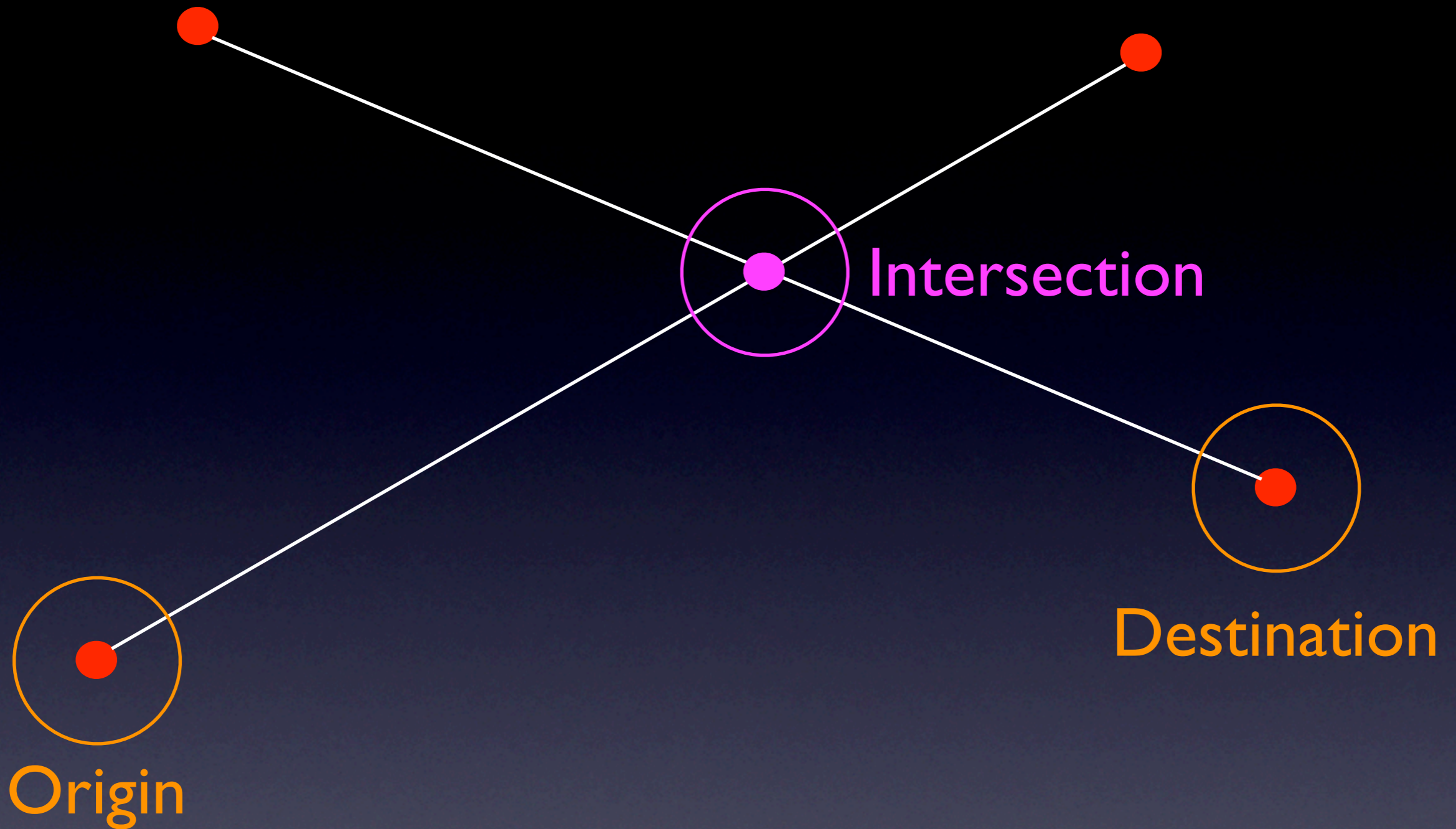


Origin

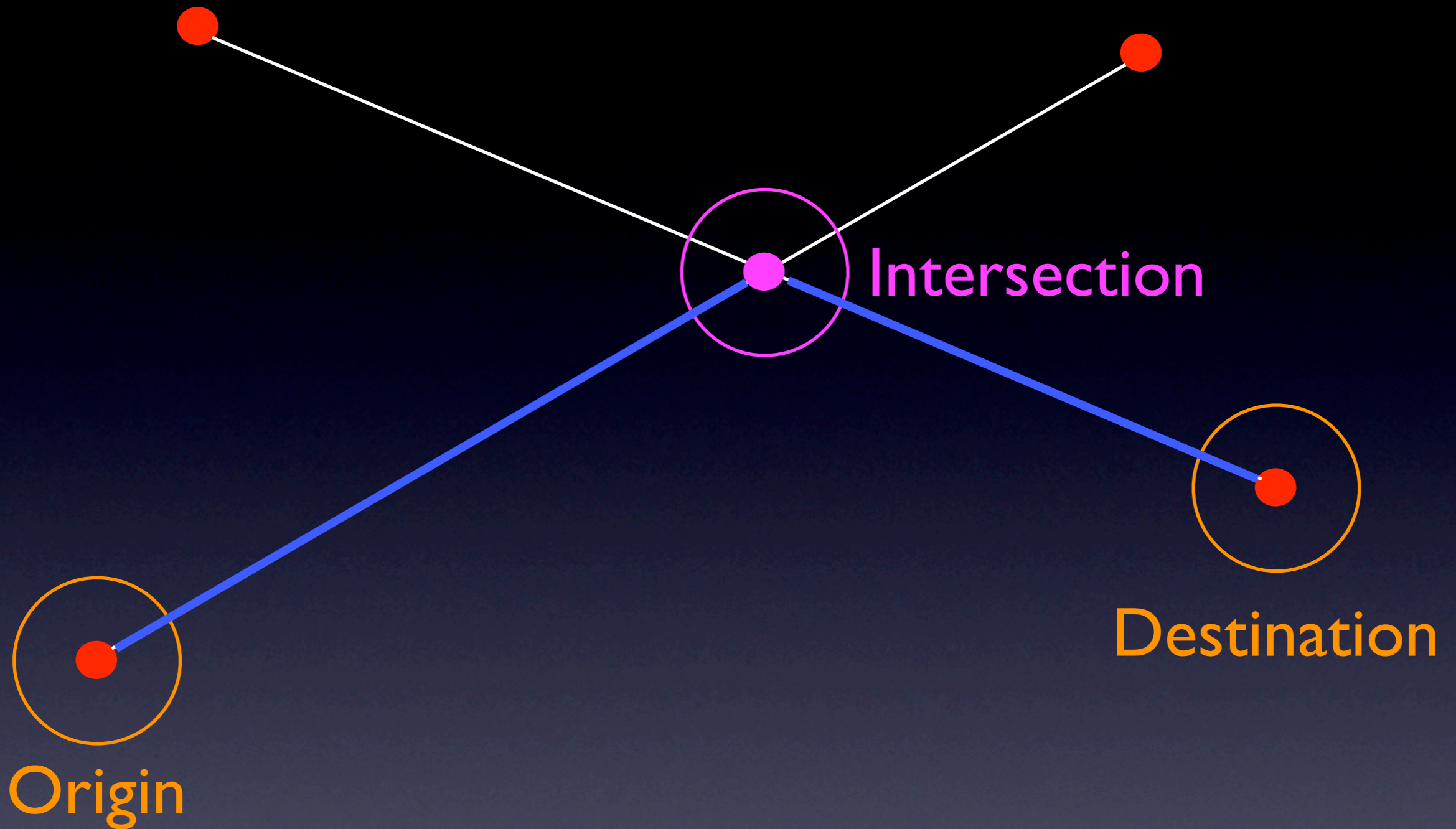
Destination



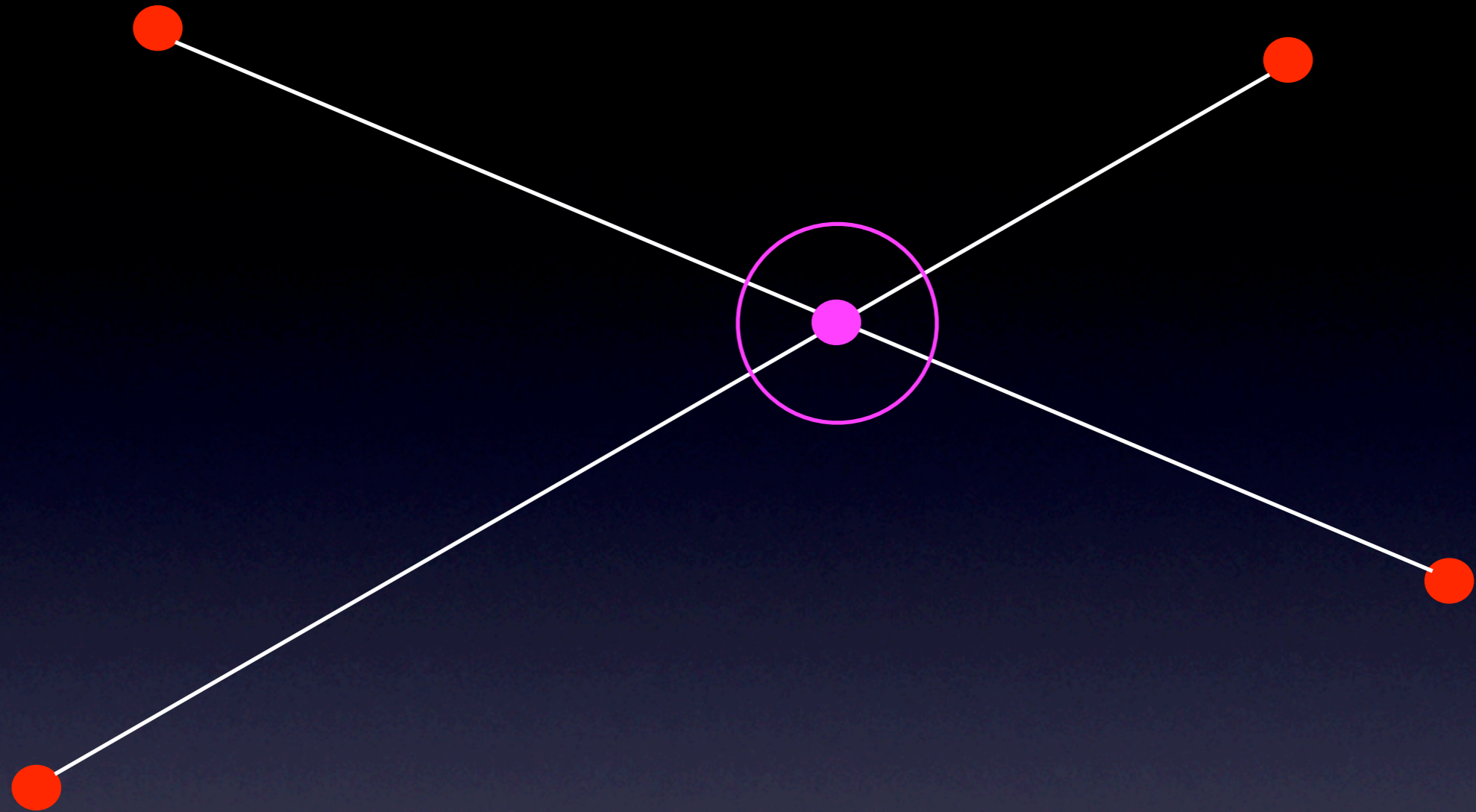




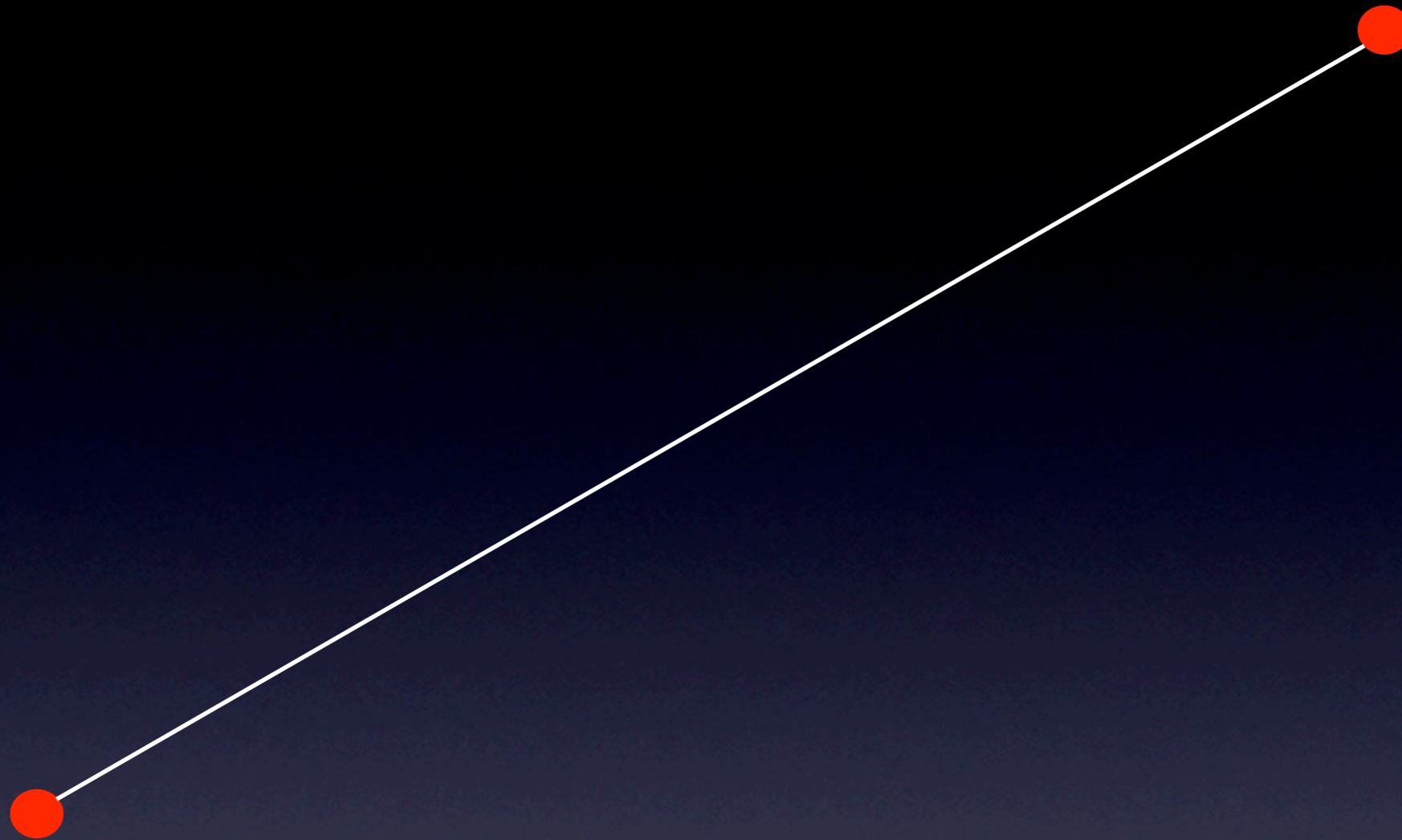
Intersections should be calculated BEFORE
applying the shortest path algorithm



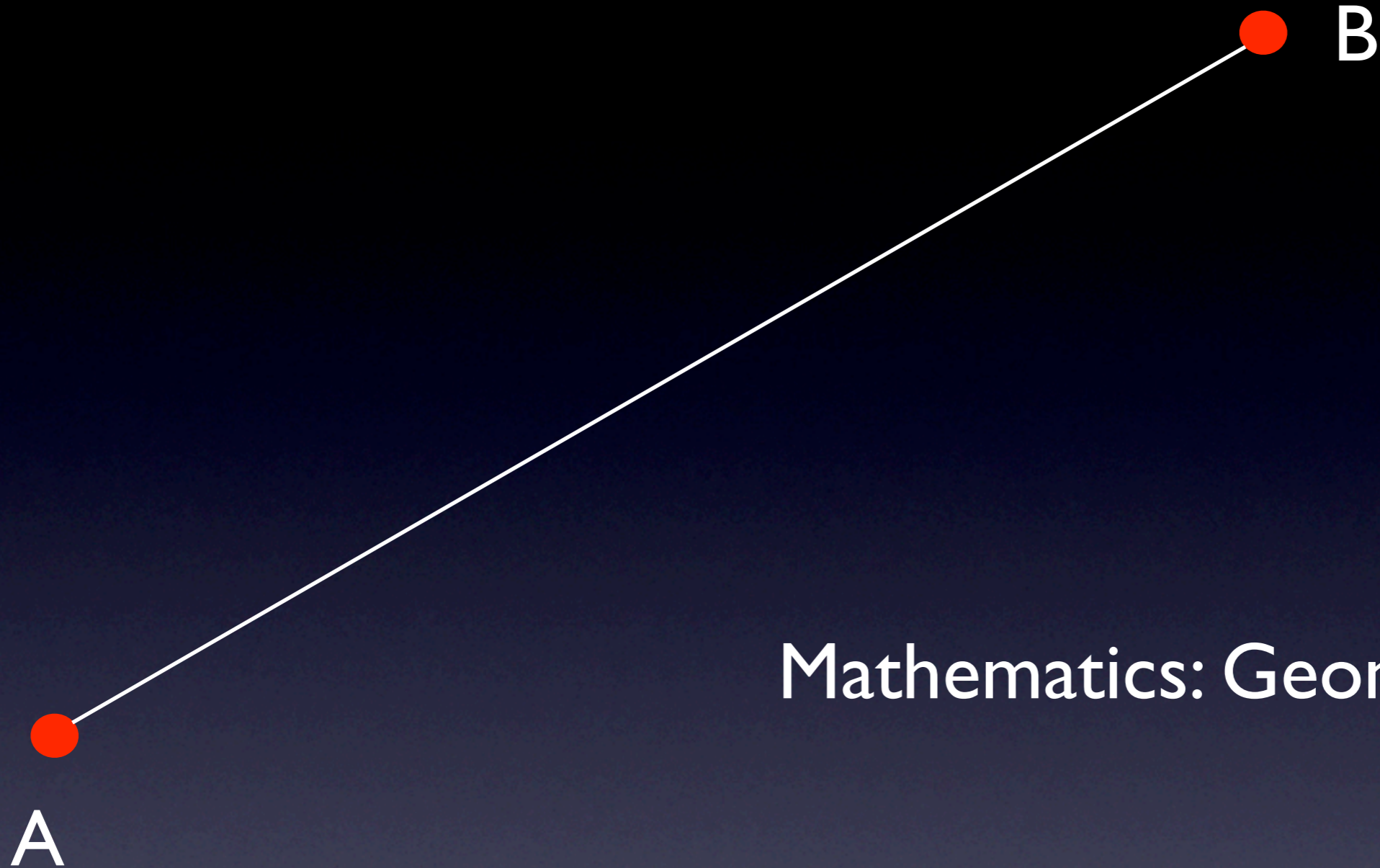
Intersections should be calculated BEFORE
applying the shortest path algorithm



How can we calculate them?



Mathematics: Geometry

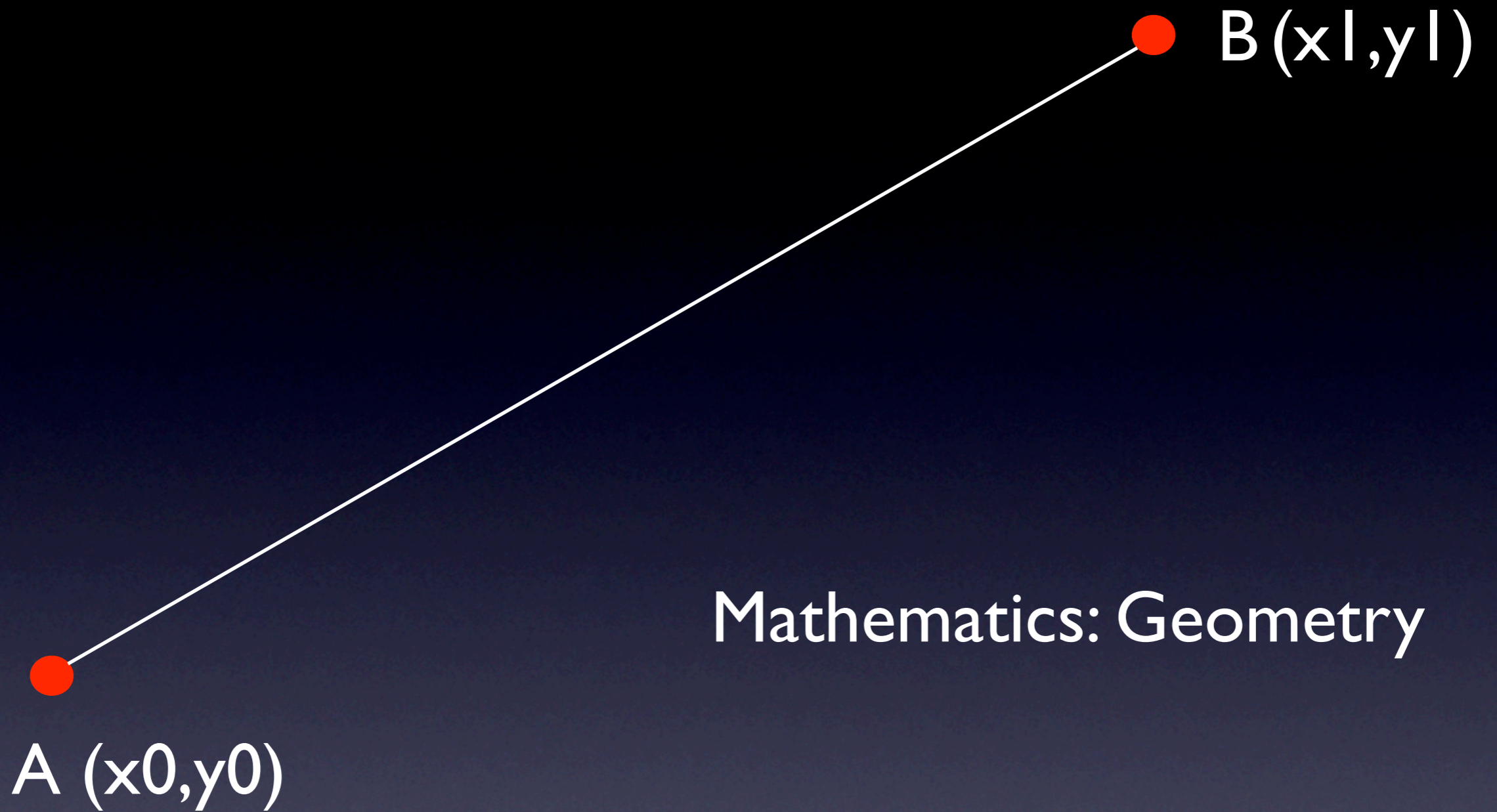


Mathematics: Geometry

Ecuation of the straight-line

A(x₀,y₀) & B(x₁,y₁)

$$\frac{x - x_0}{x_1 - x_0} = \frac{y - y_0}{y_1 - y_0}$$

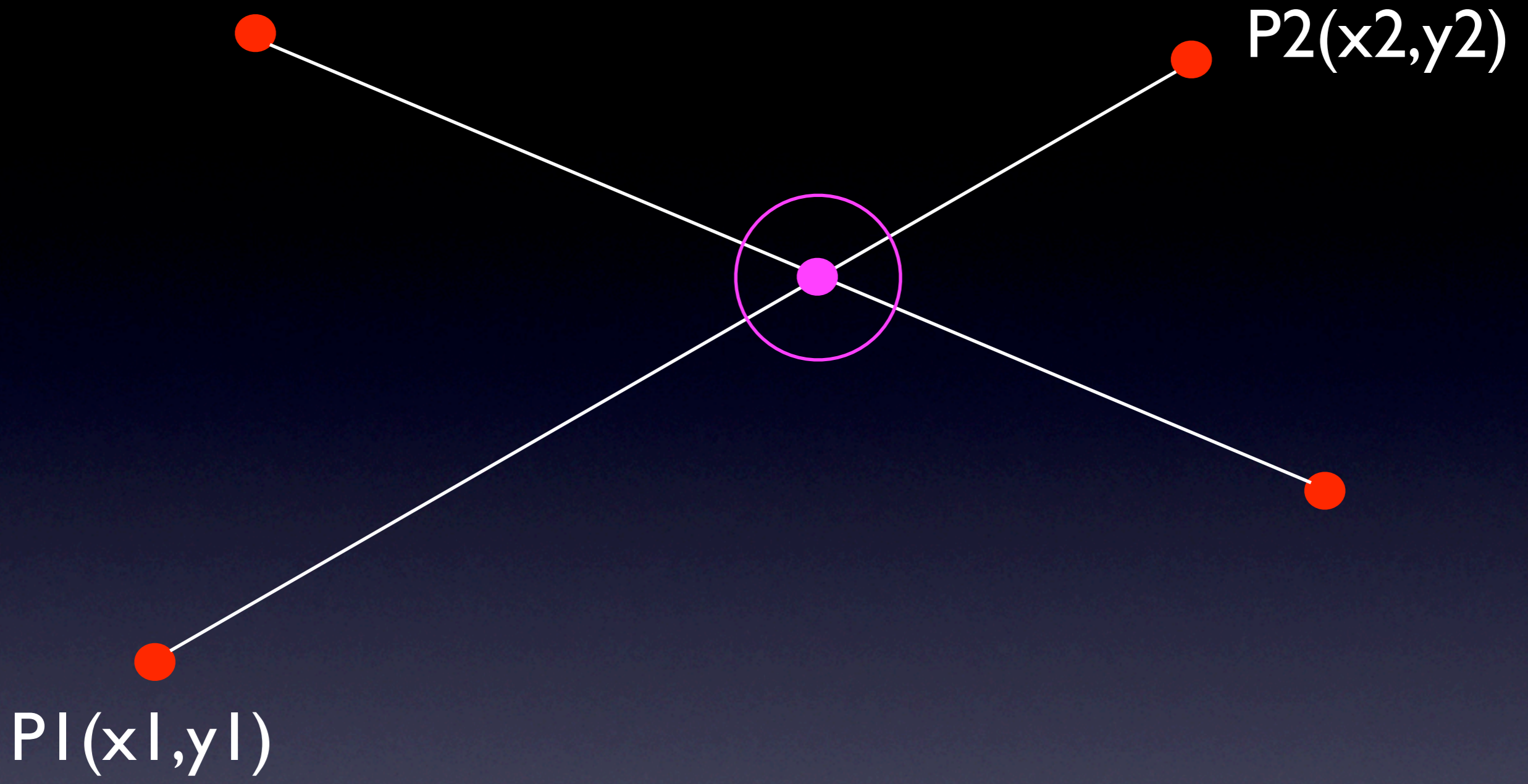


Mathematics: Geometry

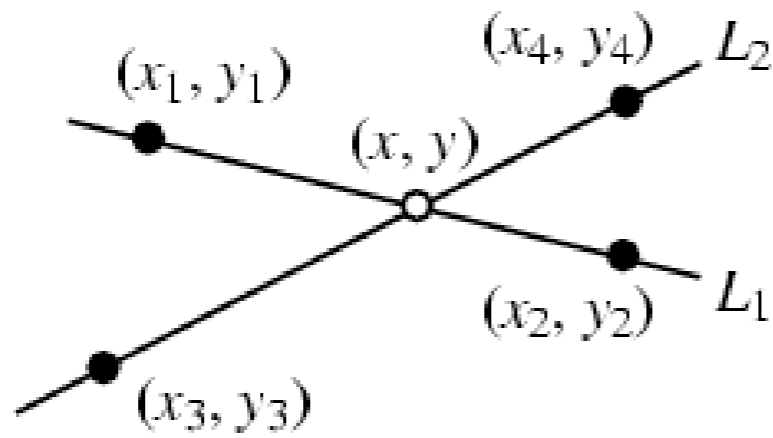
Equation of the straight-line

$A(x_0, y_0)$ & $B(x_1, y_1)$

$$\frac{x - x_0}{x_1 - x_0} = \frac{y - y_0}{y_1 - y_0}$$



Determinants theory



General equations

$$x = \frac{\begin{vmatrix} x_1 & y_1 & | & x_1 & 1 \\ x_2 & y_2 & | & x_2 & 1 \\ x_3 & y_3 & | & x_3 & 1 \\ x_4 & y_4 & | & x_4 & 1 \end{vmatrix}}{\begin{vmatrix} x_1 & 1 & | & y_1 & 1 \\ x_2 & 1 & | & y_2 & 1 \\ x_3 & 1 & | & y_3 & 1 \\ x_4 & 1 & | & y_4 & 1 \end{vmatrix}} = \frac{\begin{vmatrix} x_1 & y_1 & | & x_1 - x_2 \\ x_2 & y_2 & | & x_1 - x_2 \\ x_3 & y_3 & | & x_3 - x_4 \\ x_4 & y_4 & | & x_3 - x_4 \end{vmatrix}}{\begin{vmatrix} x_1 - x_2 & y_1 - y_2 \\ x_3 - x_4 & y_3 - y_4 \end{vmatrix}}$$

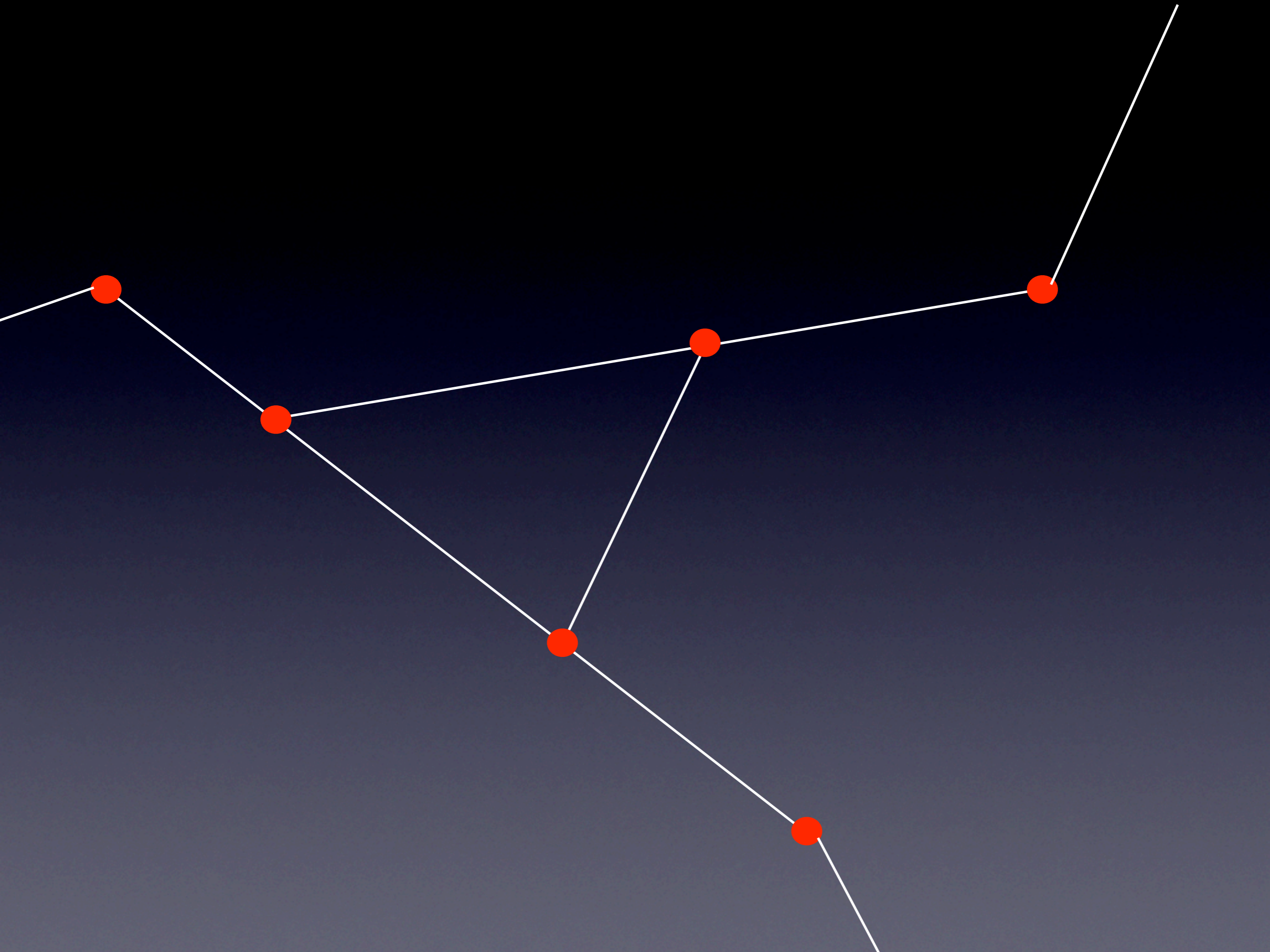
$$y = \frac{\begin{vmatrix} x_1 & y_1 & | & y_1 & 1 \\ x_2 & y_2 & | & y_2 & 1 \\ x_3 & y_3 & | & y_3 & 1 \\ x_4 & y_4 & | & y_4 & 1 \end{vmatrix}}{\begin{vmatrix} x_1 & 1 & | & y_1 & 1 \\ x_2 & 1 & | & y_2 & 1 \\ x_3 & 1 & | & y_3 & 1 \\ x_4 & 1 & | & y_4 & 1 \end{vmatrix}} = \frac{\begin{vmatrix} x_1 & y_1 & | & y_1 - y_2 \\ x_2 & y_2 & | & y_1 - y_2 \\ x_3 & y_3 & | & y_3 - y_4 \\ x_4 & y_4 & | & y_3 - y_4 \end{vmatrix}}{\begin{vmatrix} x_1 - x_2 & y_1 - y_2 \\ x_3 - x_4 & y_3 - y_4 \end{vmatrix}}$$

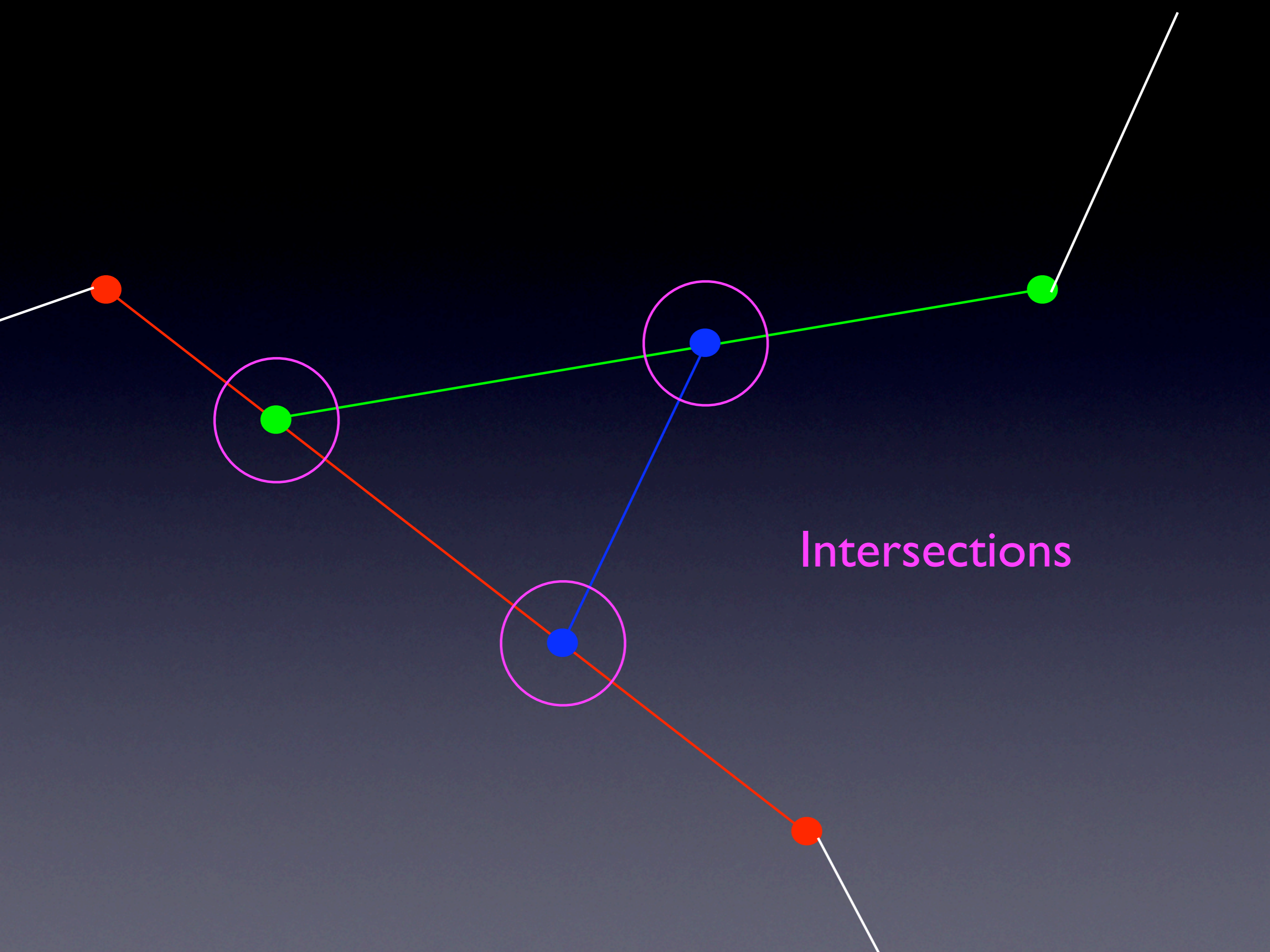
$$\begin{vmatrix} x & y & 1 \\ x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \end{vmatrix} = 0$$

$$\begin{vmatrix} x & y & 1 \\ x_3 & y_3 & 1 \\ x_4 & y_4 & 1 \end{vmatrix} = 0$$

Intersection on $P(x,y)$

Finding the intersections: example





Intersections

Equations to be used:

- Straight line
- Line intersects line
- Point belongs to line

Problem : PRECISION

ESRI

65.5
39.9

65° 30' 00"
39° 52' 45"

Java



12.43px

33.3 px



ESRI

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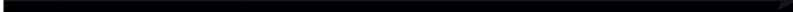
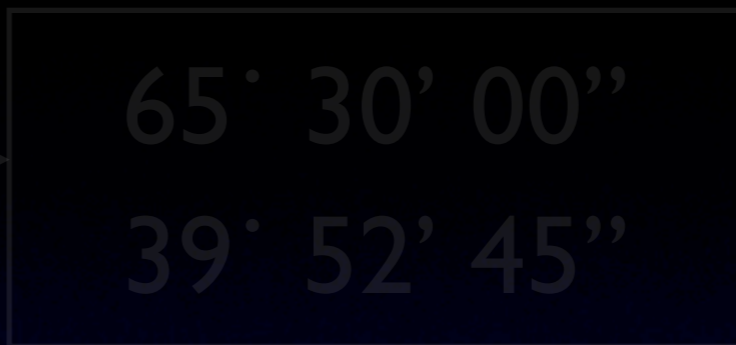
Java



12.43px

33.3 px

ERROR



Errors are found

- Binary comparisons
- Data types
- *JAVA*

Future problems: user interaction

User

65.5
39.9

65° 30' 00"
39° 52' 45"

Java



12.43px
33.3 px

User

65.5
39.9

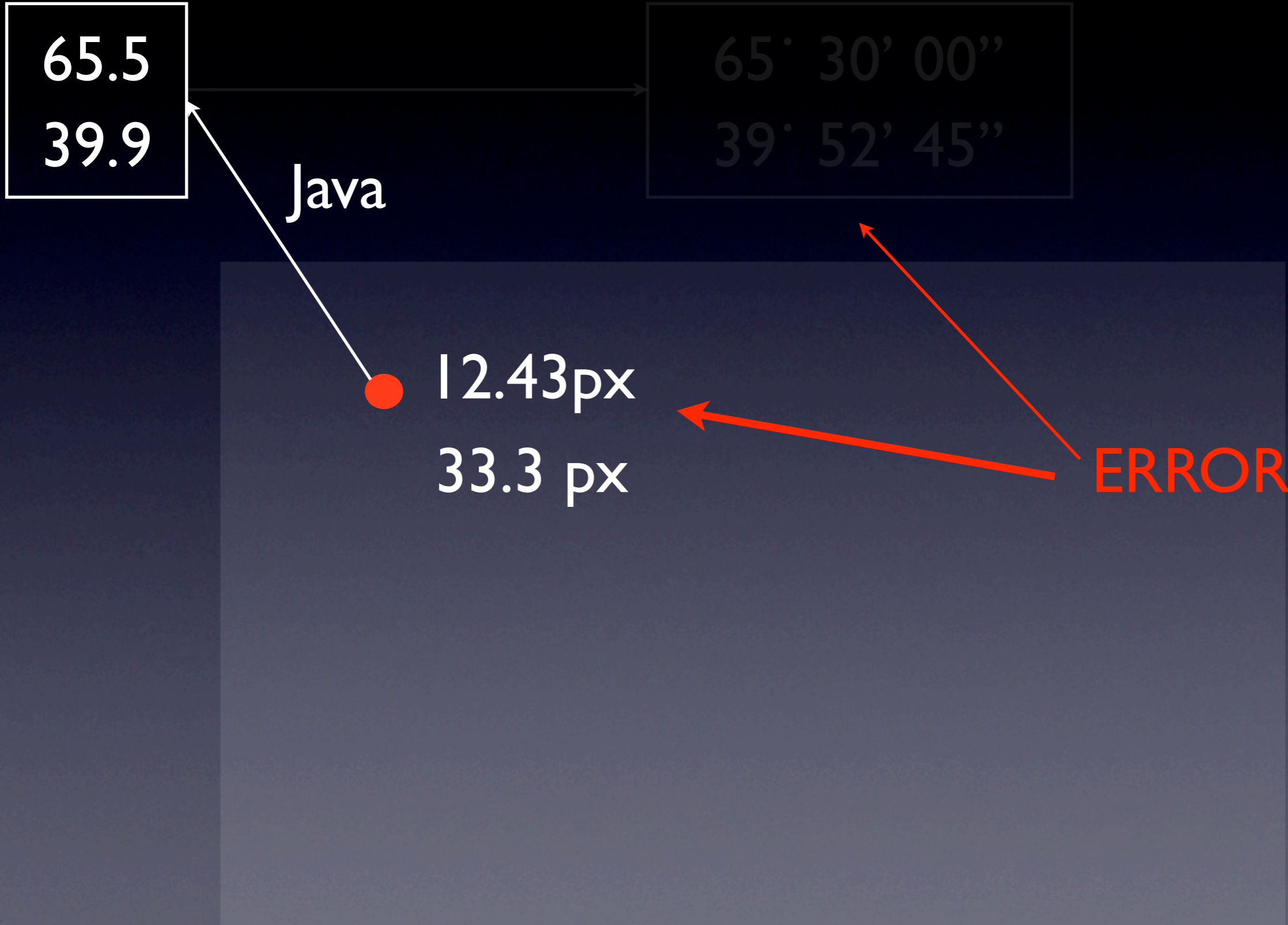
65° 30' 00"
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Java



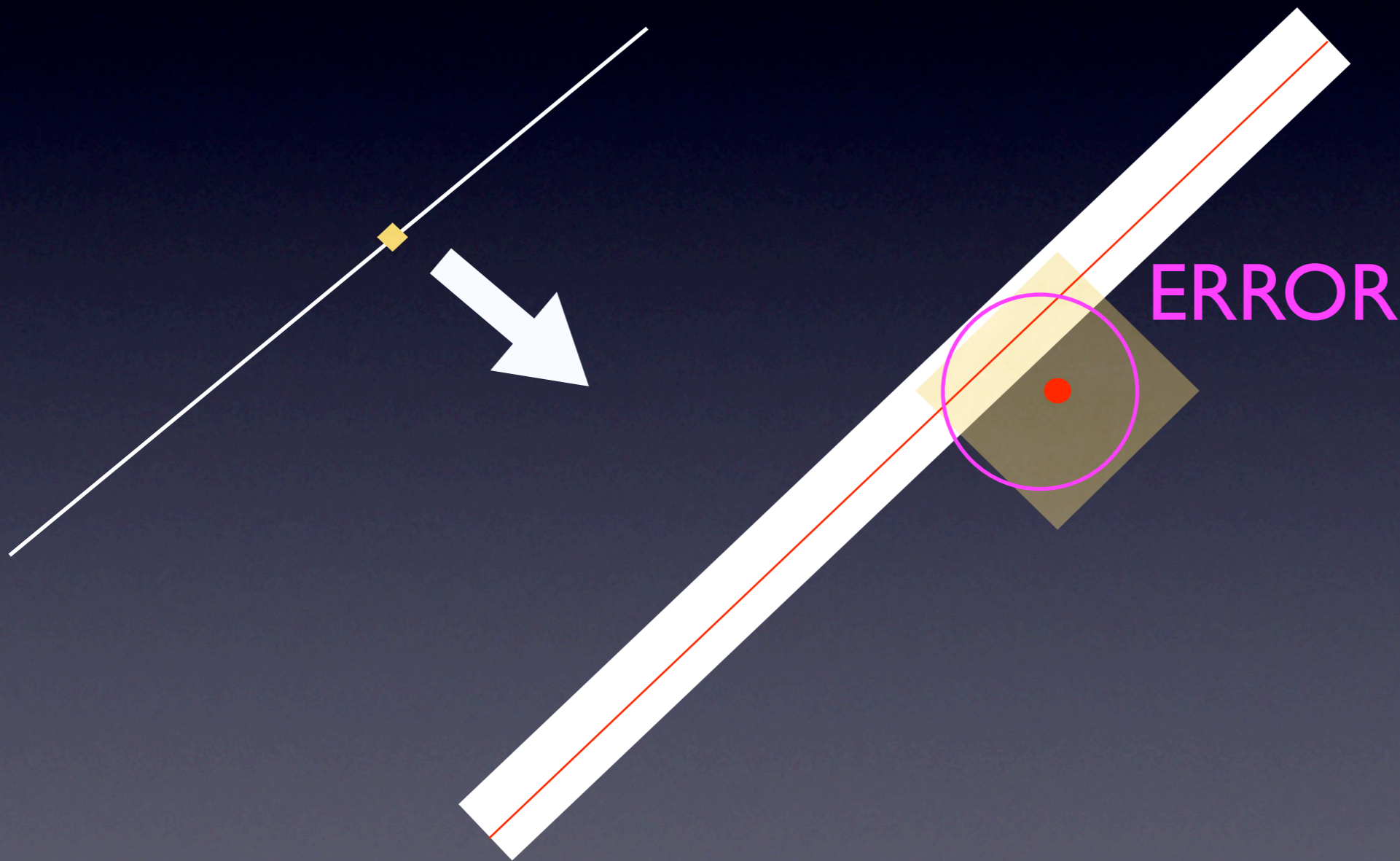
12.43px
33.3 px

ERROR



User interaction brings

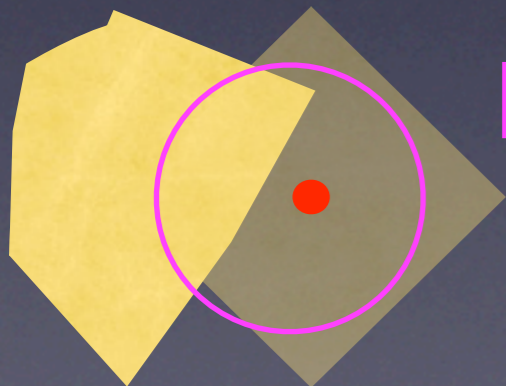
- Precision problems when capturing its input



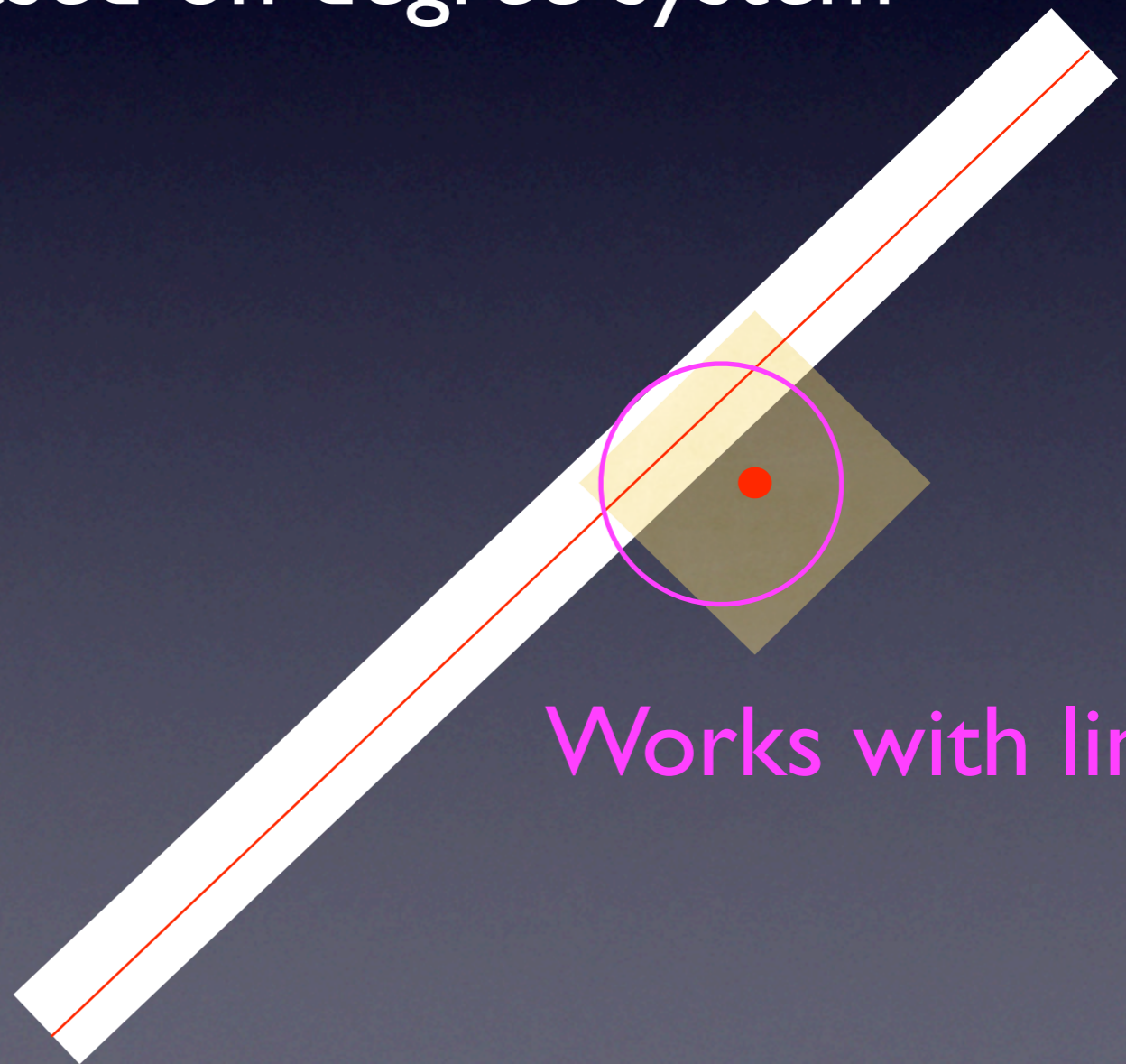
Solutions proposed

- Modify the user input: Point \Rightarrow Polygon
- Modify the equations:
Point belongs to line \Rightarrow Polygon belongs to Polygon
- Create equations based on degree system

New problems arised



Doesn't work
with objects



Works with lines