Note Title 9/28/2006

Lecture 8

Given that we have a rep. for C-obs in a form given q, we can eval. if $q \in C_{obs}$ or it $\notin C_{obs}$

How do we search "C-space" for a curve connecting q_{init} & q_{goal}

Classify exist. alg. into a few approaches:

1) Roadmap based approaches
2) Cell Decomposition
3) Potential based
4) Sampling based

① Criticality based
② Sampling based.

1) Roadmap based approach:

idea is to capture the connectivity of C_{free} in the from of a "network" of 1-dimensional curves lying in C_{free}. This "network" is called roadmap R. provides a set of "standardized" paths. Path Planning is reduced to "connecting" q_{init} and q_{goal}, respectively to R. and search the roadmap.

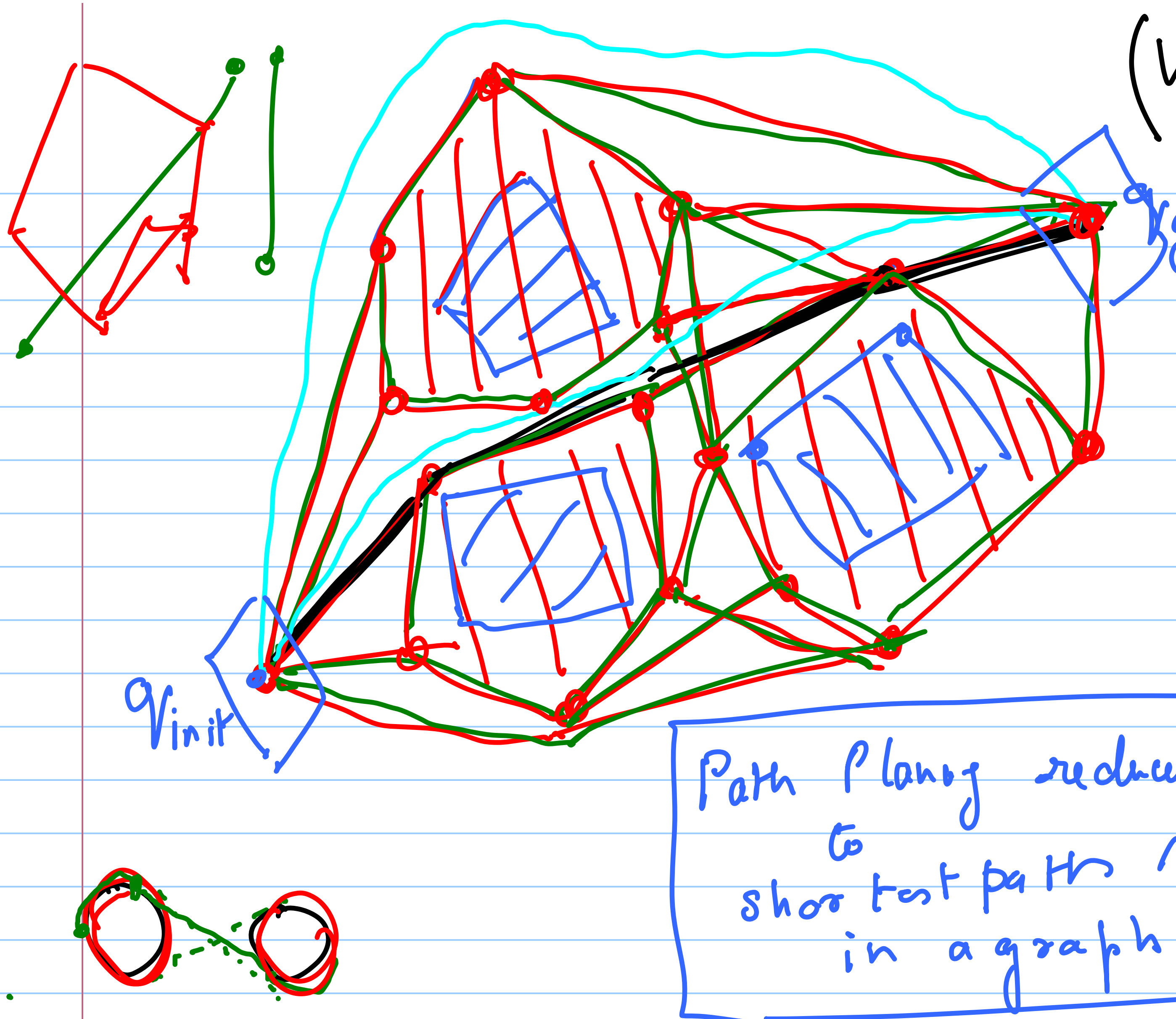
<u>Examples:</u> 2D polygonal (translation):

$\longrightarrow$ $\underbrace{\text{visibility graph}}_{\text{roadmap}}$ in C-space

efficiency issues for Vgraph computation

I won't cover it. Read up

(VGraph Alg)



"Visibility Graph"

shortest path

$R = G(V, E)$

nodes of C_{obs}

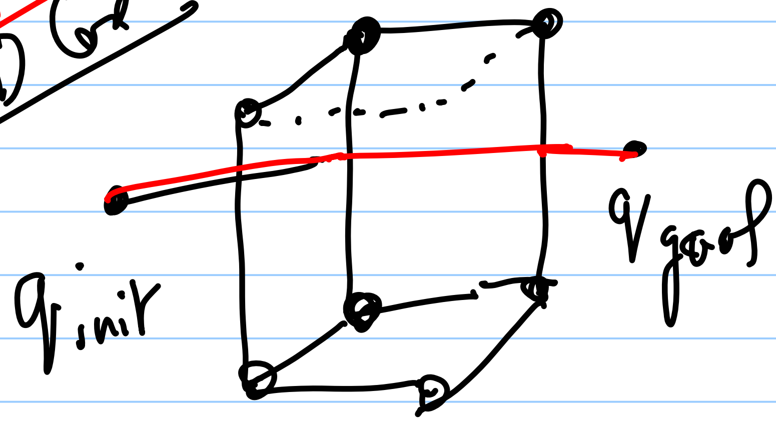
edges that conn. to "visible" nodes

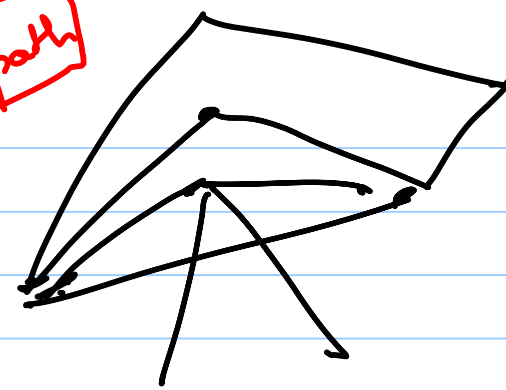
Path Planning reduces to shortest path search in a graph.

$\boxed{\text{Shortest path}}$

3D Grid

NP-hard : $\boxed{\text{Shortest path}}$





"<u>Retraction</u>": Let X be a topological space and let $Y \subset X$. A surjective map $f: X \to Y$ is called a retraction iff f is continuous and its restriction to Y is identity. We are interested in retractions that preserve connectivity.

~~the~~ $x, f(x)$ belong to same connected component

Hence if we can show that R is a retraction, then you have a complete alg. (assume you have a complete search alg. for R)

Hard part: how do you construct R?

In 2D: Voronoi diagram (used xparency for Voronoi Diag. illustr.)

One can show $\rho: C_{free} \to Vor(C_{free})$

is a retraction.

clearance(q) = ~~#~~ dist. to closest obs.

What is ρ: suppose $q \notin Vor(C_{free})$

$\exists$ a $p \in \partial C_{free}$, that is

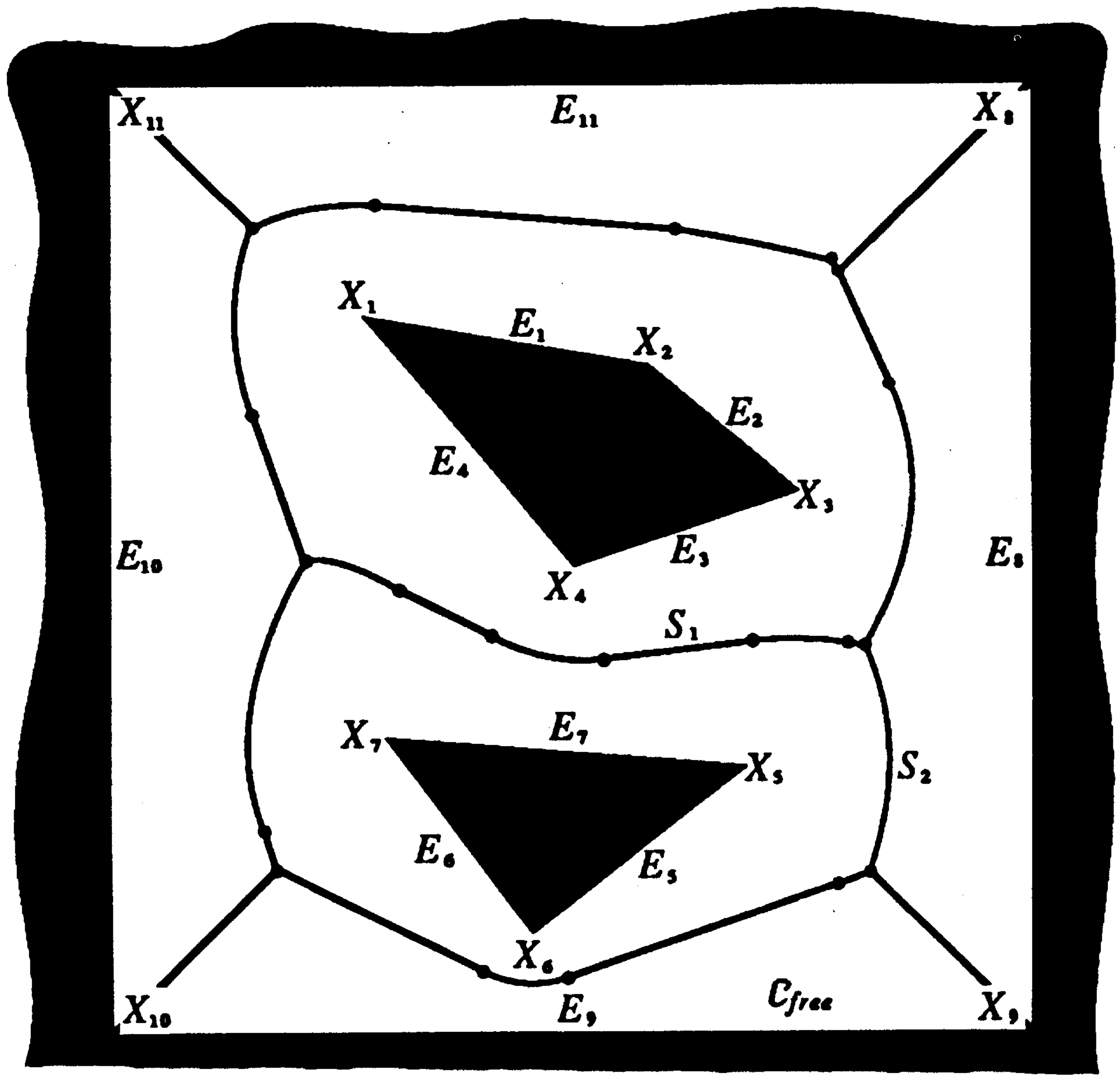
closest to q: $\|q - p\| = \text{clearance}(q)$

the line segment L that connects p to q

extended "away from" p, will intersect

$\mathrm{Vor}(\mathcal{C}_{free})$ in some pt, $\rho(q)$.

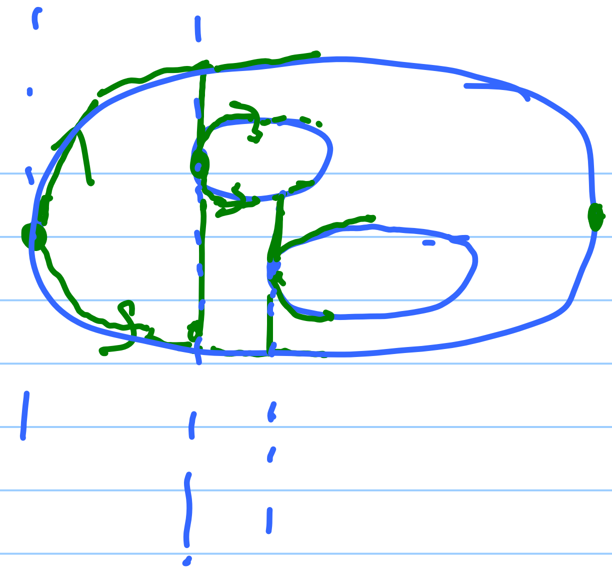
if $q \in \mathrm{Vor}(\mathcal{C}_{free})$, $\rho(q) = q$


X_{11}
E_{11}
X_8
X_1
E_1
X_2
E_2
E_4
X_3
E_{10}
E_3
X_4
E_8
S_1
X_7
E_7
X_5
S_2
E_6
E_5
X_6
C_{free}
X_{10}
E_9
X_9

We will skip some of the general results in this line, mainly theoretical interest, uses tools from semi-alg. geometry

Canny: 1987/88 : "silhouette" method

→ Semialgebraic sets : Polynomials with rational co-effs.



2^{d} ← ~~deg~~ dim of c-space

$\Big\downarrow$ earlier

$2^{2^{d}}$ ← cell decomp.