Algorithmic Robotics and Motion Planning

Spring 2011

Sampling-based motion planning II: BiRRT

Dan Halperin
School of Computer Science
Tel Aviv University

Single-query planners

- RRT
- EST
- many predecessors and successors, see

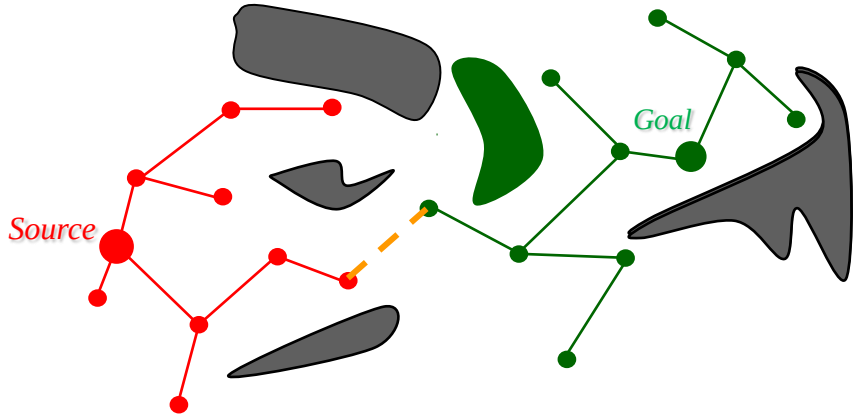
  Sampling-based algorithms, Chapter 7 of the book

  Principles of robot motion: theory, algorithms, and implementation , by Choset et al, The MIT Press, 2005

Growing two trees (Bi-RRT)

[Kuffner and LaValle '00]

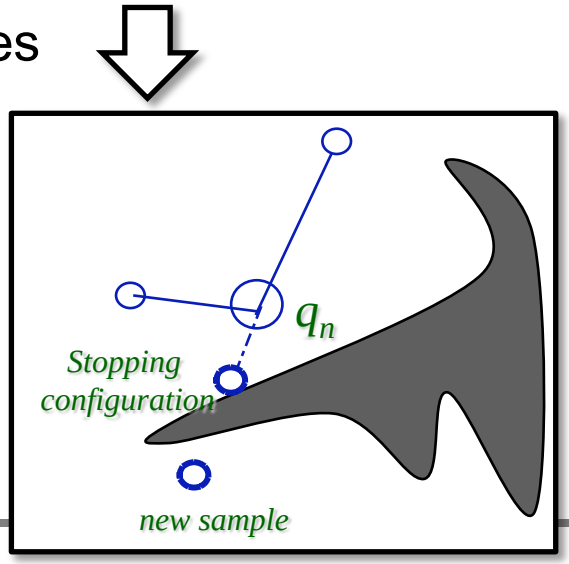
- Maintain two trees rooted at source & goal
- Construction step –
  sample configurations and expand either tree as in RRT
- Merging step –
  connect configurations from both trees



BiRRT slides by Barak Raveh

Bi-RRT – Fine implementation details

1. Distance metrics (l_1, l_2, etc.)
2. Sampling probability distribution (e.g., uniform)
3. Tree-swapping strategy (which tree is extended at each iteration – balancing strategy, etc.)
4. Stopping configurations
5. Swaths of trees



Algorithm 1 Bi-RRT(Ω, q_1 , q_2, M)

1. T_1.init(q_1); T_2.init(q_2); $T_{\text{cur}} = T_1$; $T_{\text{other}} = T_2$;
2. **for** i = 1 **to** M **do**
3. $q_n \leftarrow$ nearest(S_{cur}, σ_i);
4. $q_s \leftarrow$ stopping-configuration(q_n,σ_i);
5. **if** $q_s \neq q_n$ **then**
6. T_{cur}.add_vertex(q_s);
7. T_{cur}.add_edge(q_n, q_s);
8. $q'_n \leftarrow$ nearest(S_{other}, q_s);
9. $q'_s \leftarrow$ stopping-configuration(q'_n,q_s);
10. **if** $q'_s \neq q'_n$ **then**
11. T_{other}.add_vertex(q'_s);
12. T_{other}.add_edge(q'_n , q'_s);
13. **if** $q'_s = q_s$ **then return** SOLUTION;
14. **if** $|T_{\text{other}}| < |T_{\text{cur}}|$ **then** swap(T_{cur},T_{other});
15. **return** FAILURE;

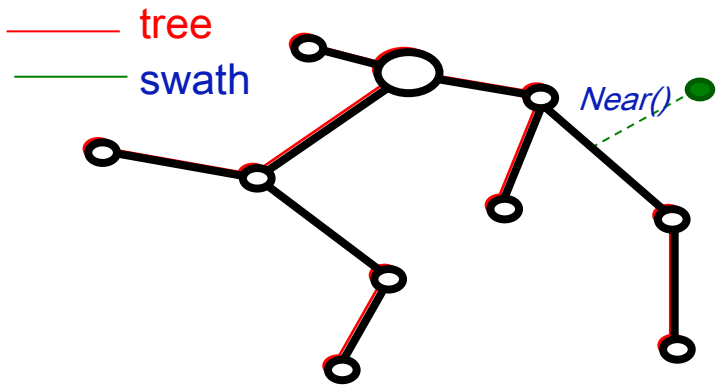
* Pseudo-code adapted from LaValle, *Planning Algorithms*, 2006 – p. 236

Bi-RRT - Fine implementation details – Tree swaths

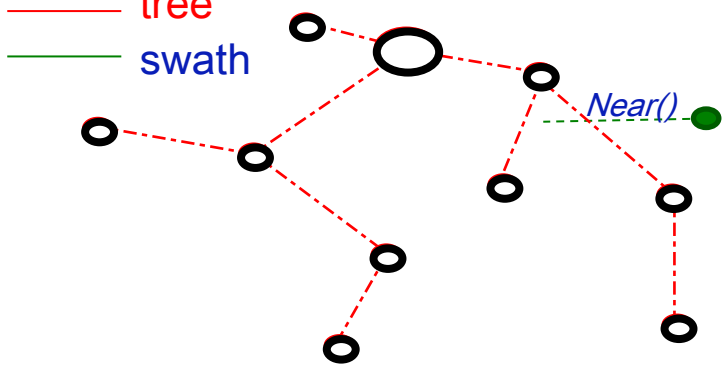
Swath *(The Free Dictionary)*
The space created by the swing of a scythe or the cut of a mowing machine.

Swath *(Planning Algorithms, LaValle '06)*
The image of the vertices and edges of the tree in the configuration space.

Full swath (all node and edge configurations are considered):



Approximate swath (e.g., node configurations only):



Expansive-spaces trees (EST)

[Hsu et al]

- major difference from RRT: expand from a tree node in the vicinity of the node
- major component: probability density function, to aid in expanding from nodes whose neighborhood is not densely sampled

THE END