Background

A Distributed Greedy Heuristic for Computing Voronoi Tessellations With Applications Towards Peer-to-Peer Networks

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Outline

Background Motivation

DGVH

Our Heuristic Peer Management Algorithm Analysis

Experiments

Conclusion



Distributed Hash Tables

- Abstractly, a DHT is a mechanism for maintaining a large state in a decentralized network.
- ▶ In practice, the state is a large number of key, value records.
- A Distributed hash table assigns those records to servers and routes request for those records to those servers.
- Current incarnations of Distributed hash tables assign servers and records locations in an arbitrary metric space.
- Servers are assigned responsibility for records that are "close" to them, and to peer with "nearby" servers.
- DHTs currently use a variety metric spaces.



- ▶ *P2P file sharing* is by far the most prominent use of DHTs. The most well-known application is BitTorrent [?].
- Distributed Domain Name Systems (DNS) have been built upon DHTs [?] [?].
 Distributed DNSs are much more robust that DNS to orchestrated attacks, but otherwise require more overhead.
- Distributed machine learning [?].
- Many botnets are now P2P based and built using well established DHTs [?]. This is because the decentralized nature of P2P systems means there's no single vulnerable location in the botnet.



Extant Varieties of DHT

Background

- ► Ring Based DHTs
 - Chord
 - Pastry
 - Tapestry
- ► Tree Based DHTs
 - CAN
 - Kademlia

How are DHTs and Vonroi Tesselation/Delunay Trianguation related?

A Server is responsible for records "close" to it (Voronoi Triangulation) A Server peers with other servers that bound it's Voronoi Region (Delunay Triangulation) DHTs often have peers in excess of the Delaunay triangulation to shorten lookups, however the peers that are the Delunay neighbors

Ring Based DHTs

Background

- ► Chord: a unidirectional modulus ring metric
- Pastry, Symphony: bidirectional modulus ring
- Tree Based DHTs
 - CAN: Euclidean distance
 - Kademlia: XOR distance



Why do we need DGVH?

- The different topologies DHTs utilize present optimization trade-offs (lookup latency, number of lookup hops, network robustness, availability, processing overhead)
- The primary effort in implementing a new metric space in a DHT is implementing Voronoi Regions/Delunay Triangulation algorithm in that metric.
- DGVH allows many metrics to be tested without requiring the design and development effort of generating an exact Voronoi Regions/Delunay Triangulation algorithm.



Distributed Greedy Voronoi Heuristic

- ▶ Geometrically intuitive method of approximating the one-hop delaunay peers of a Node
- Is guaranteed to form a connected mesh (unlike k-nearest heuristic)
- Can be utilized in any continuous metric space



DGVH Algorithim

- 1: Given node n and its list of candidates.
- 2: $peers \leftarrow empty set that will contain n's one-hop peers$
- 3: Sort candidates in ascending order by each node's distance to n
- 4: Remove the first member of candidates and add it to peers
- for all c in candidates do
- m is the midpoint between n and c
- if Any node in *peers* is closer to m than n then
- Reject c as a peer
- else 9:

11.

- Remove c from candidates 10:
 - Add c to peers
- end if 12:
- 13: end for

Our Heuristic

Visual Intutution

PUT PICTURES HERE!!!!

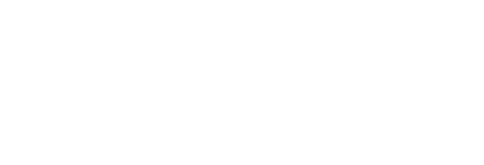


Background

Realistic Canidate set Size

- In application, a single node will not need to calculate the triangulation for every peer in the network, rather it will only calculate it's own peers.
- A smart "join" process will prevent the Candidate Set from reaching O(n)
- ► Expected size of the candidate set is $O(degree^2)$ which compromises current peers and 2-hop peers
- \triangleright The average degree of many metric spaces is O(1), then therefore DGVH will practically run in O(1) in those metric spaces.





Conclusion