Optimal Locations for New Cell Antennas

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July 13, 2015
Problem Description

Given initial Cell Antenna Locations and the corresponding RSRP Maps to determine the best locations for $k$ new Antennas. Several problems such as best location for the next Antenna or optimal locations for Antennas in a completely empty area can be reduced to the above problem.
Cannot be solved Optimally as even a very simplified version i.e. circle fitting is NP-Hard.

We use binary search for maximising the minimum distance in between the Cell Antennas so as to maximise coverage. After fixing minimum distance a greedy approach is used for fitting.

Simplifying assumptions taken for new cells:

- Circular region of coverage.
- Assuming equal permeability of signals at all points.
Algorithm

Step 1: Generate Average RSRP map.
Average RSRP - Average of RSRP value in surrounding area.
Step 2: Generate Distance Maps.
Distance - Distance to closest point with Average RSRP value above threshold.
Algorithm

Step 3: Separate area with high Distance value i.e. potential positions into disjoint regions.
The next steps will be run separately on these regions.
Algorithm

Step 4: Binary search for the maximum $\lambda$ in a range $[\text{high, low}]$. $\lambda$ represents the maximum value of the minimum distance in between 2 cells.
Algorithm

Step 5: Fitting Algorithm: After choosing a $\lambda$ new cell is placed at a position with distance greater than $\lambda$ and minimum average distance. After this distance is set to 0 in the surrounding area of cell and distance is recomputed for the complete region. Due to this approach the cell is always placed at boundary rather than the centre.
Step 6a: We keep adding new cells with the same $\lambda$ till we have added $k$ cells. This has a time complexity of $O(Ak^2r^2\log_2(high - low))$.

Step 6b: We recurse on the same region for adding $k - 1$ cells. This has a time complexity of $O(Ak^2r^2\log_2(high - low))$.

In such a case 6b would give better results than 6a.
In conclusion we have taken simplifying assumptions in both the problem and the objective, then used a binary search approach to maximize distance in between cells.

Further Improvements :

- Rather than just using RSRP values other metrics such as SINR and traffic strength can be used for calculating the distance maps.
- The fitting algorithm can be replaced with an approximation algorithm with strict approximation guarantees.