# How to Find the Best Place for the Shared Bikes?

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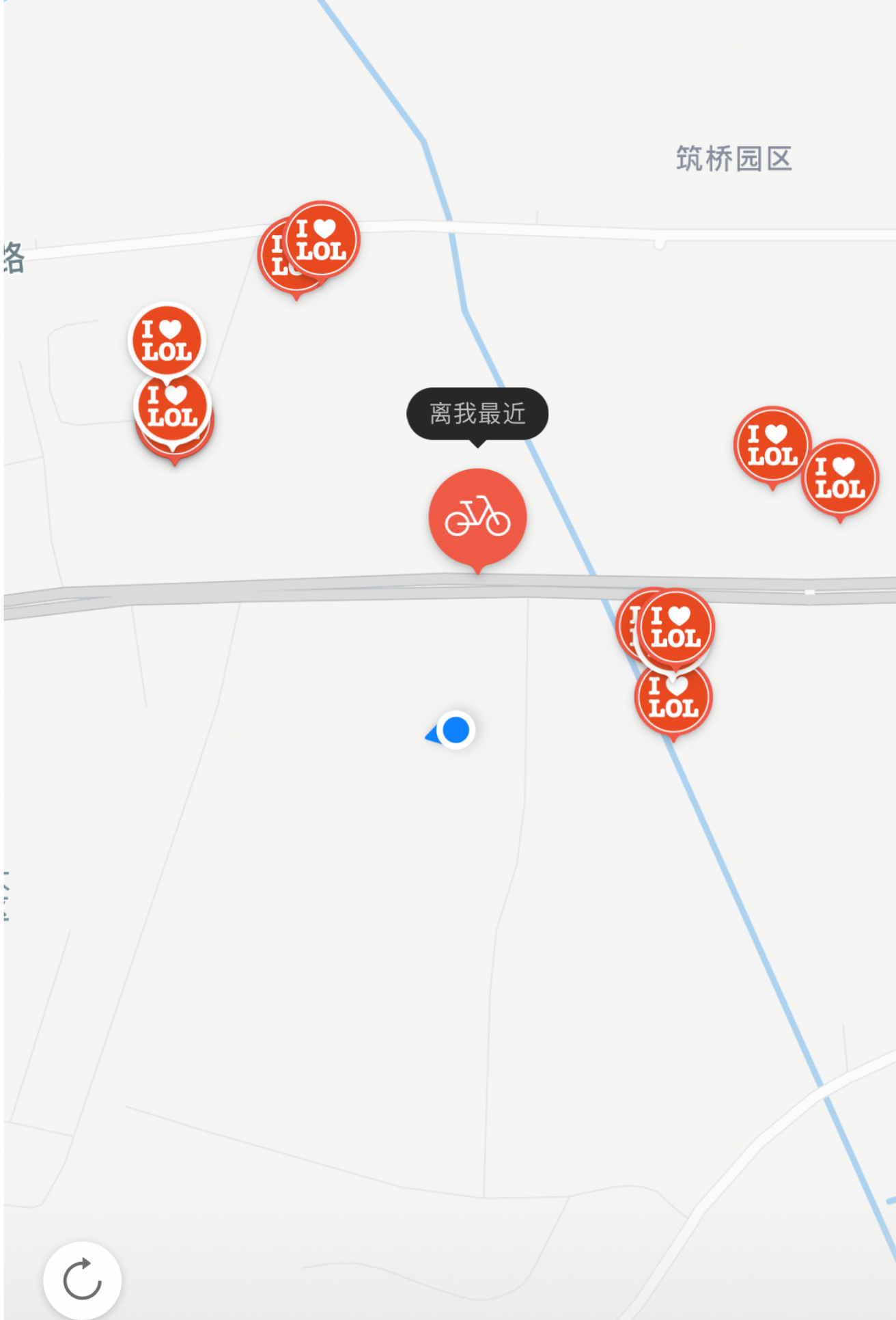


# Problem to Solve

- Find a place where most people want to use the shared bikes.
- Which means to find the place of the user who want to find a shared bike.

# Numerical Solution Method

- Known: the coordinates of 100 shared bikes($p_k$,$q_k$), 100 distance from the shared bikes to the user($d_k$)
- Goal: $\min_{x \in \mathbb{R}^n} \ \frac{1}{2} \|f(x)\|_2^2 \ ,$
- So that we can find the user coordinate(u,v)
- Here, $r_k = d_k - \sqrt{((u-p_k)^2 + (v-q_k)^2)}$

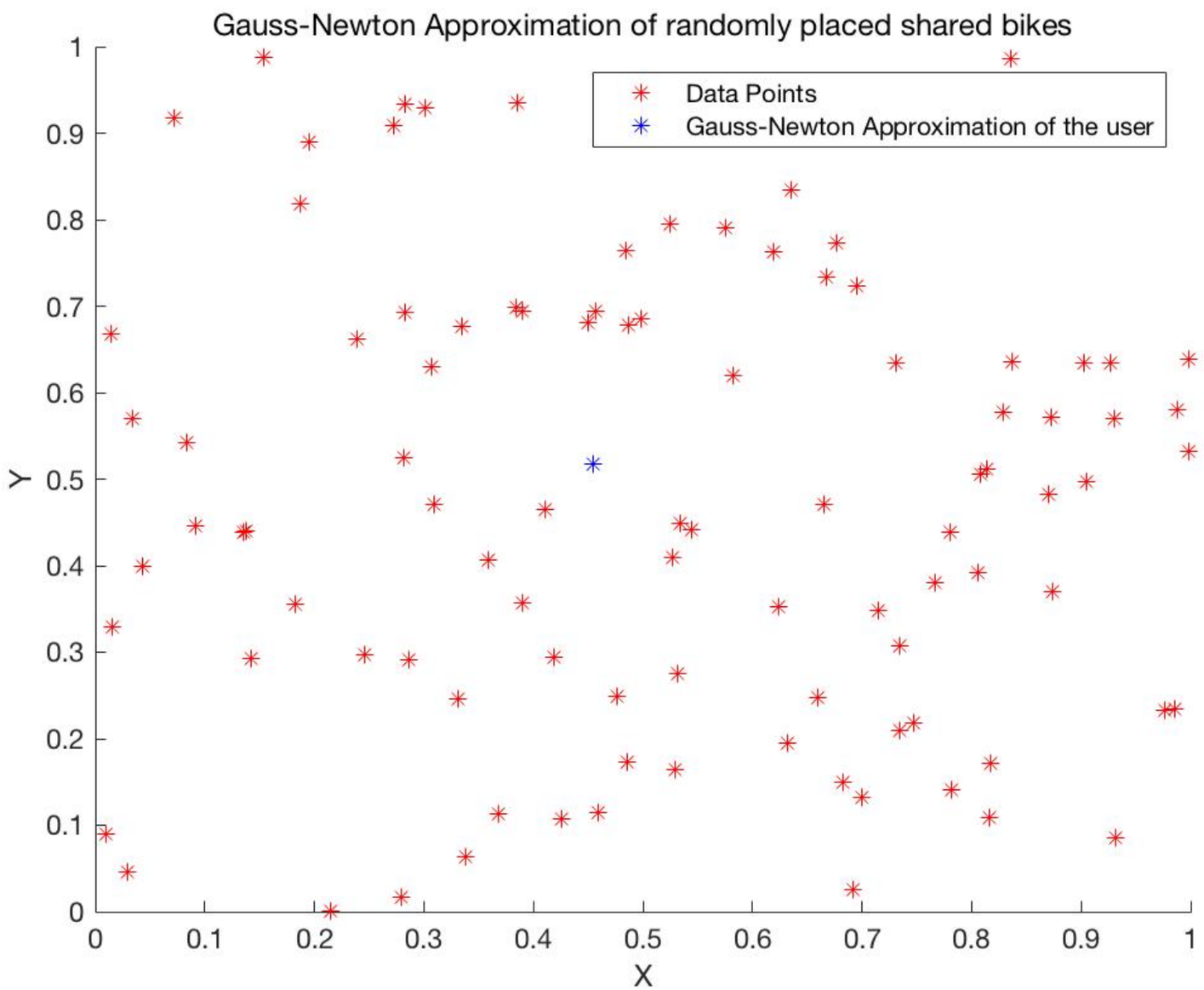
# Software Implementation

- Software : Matlab
- Math Method: Newton and Gauss-Newton Method

```
p = rand(100,1);
q = rand(100,1);
d = rand(100,1);
a = [0.5;0.5];
m = length(p);
n = length(a);
aold = a;
for k = 1:maxstep
    S = 0;
    for i = 1:m
        for j = 1:n
            J(i,j) = df(p(i),q(i),a(1,1),a(2,1),j);
            JT(j,i) = J(i,j);
        end
    end
    Jz = -JT*J;
    for i = 1:m
        r(i,1) = d(i) - sqrt((a(1,1) - p(i))^2 + (a(2,1) - q(i))^2);
        S = S + r(i,1)^2;
    end
    k
    S
    g = Jz\JT;
    a = aold - g*r;
    unknowns = a;
    error(k) = a(1,1) - aold(1,1);
    if (abs(error(k)) <= tolerance)
        break;
    end
    aold = a;
end
```

# Numerical Results

- Result:



# Numerical results

- u = 0.455063512025084
- v = 0.517654307605491

| Newton Iteration number | S |
|---|---|
| 1 | 11.226468316987443 |
| 23 | 2.336787628799997 |
| 24 | 1.687637548267686 |

| Newton-Gauss Iteration number | S |
|---|---|
| 1 | 11.226468316987443 |
| 47 | 12.336232899083551 |
| 48 | 12.336232899083541 |

# Comment on Results

- Newton method has a better convergence.
- Gauss-Newton meet the tolerance slower.
- Computation complexity is almost the same.
- Initial guess change.