A Study of Efficient GNSS Coordinate Classification Strategies for Epidemic Management

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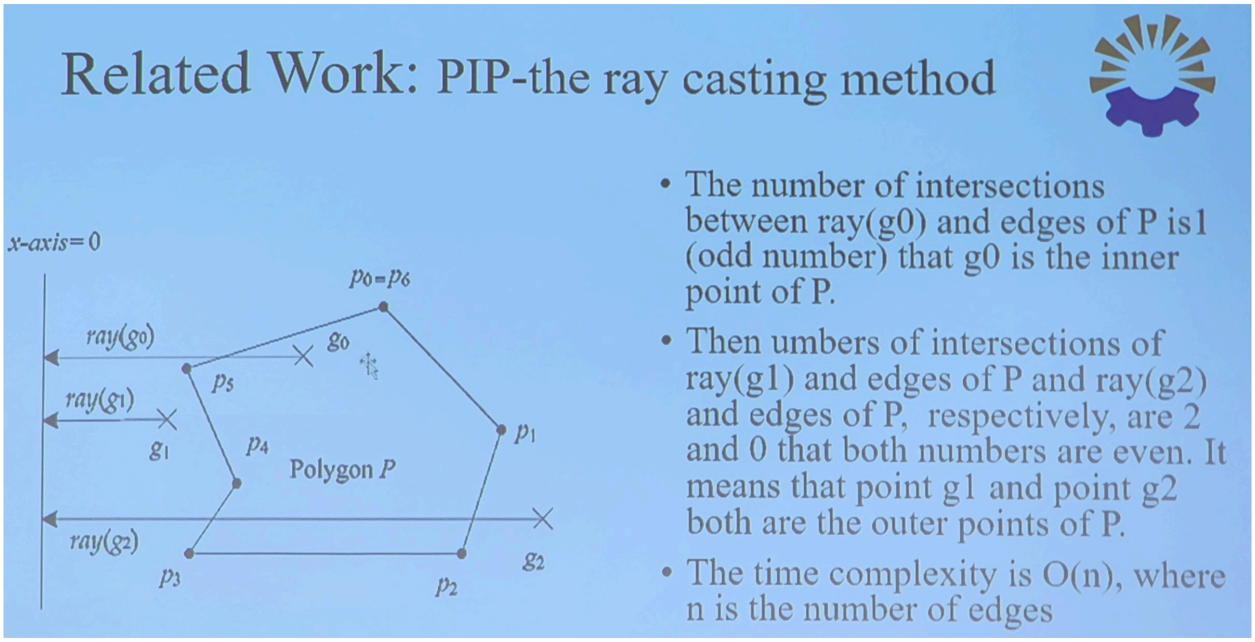
Introduction

- GNSS 高準確性
    - 誤差幾公尺

Point in Polygon (PIP)

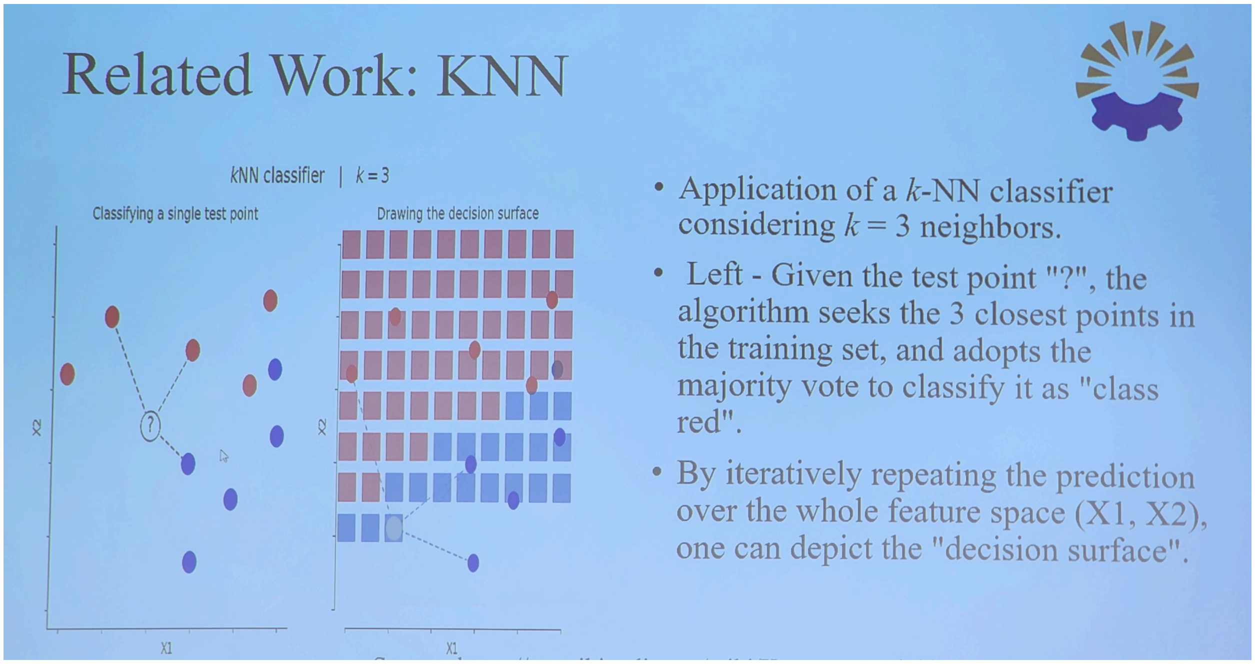
- 判斷點是否在多邊形內
    - 射線：交點問題
        - 穿過幾次來判斷是否在多邊形內
    - 繞線：角度問題
        - 以邊為準，設定：
            - 幾度是進
            - 幾度是出



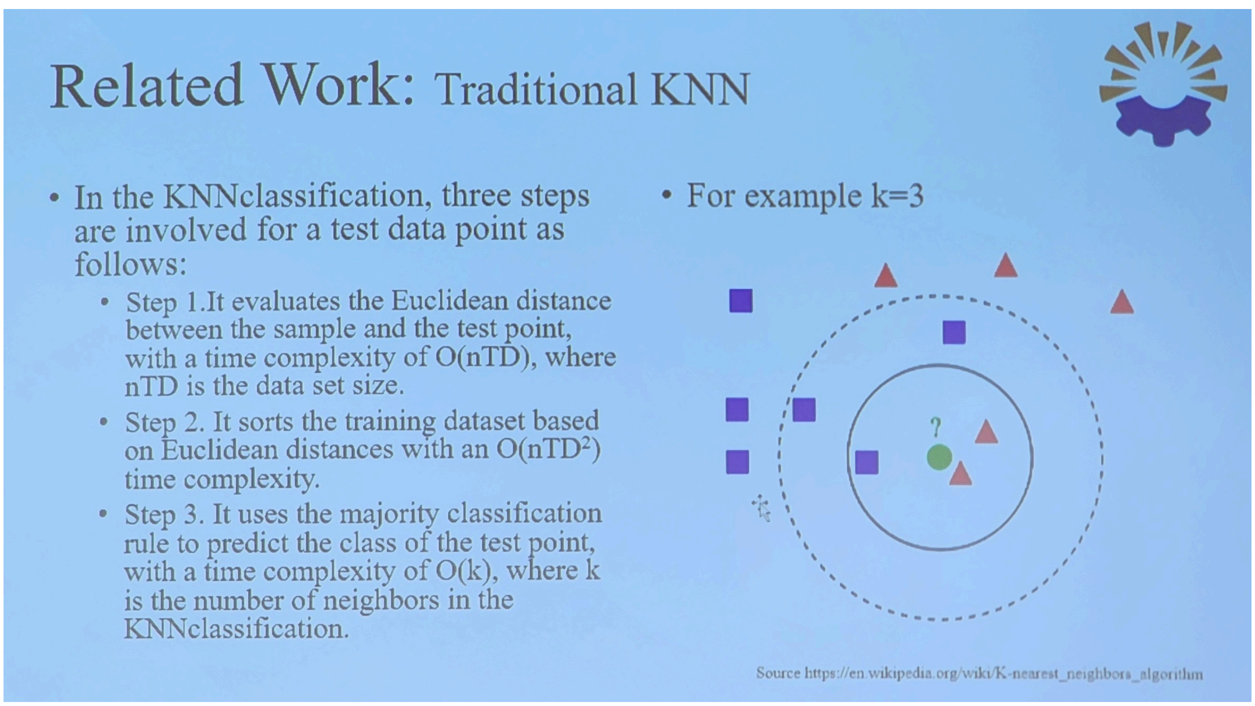
K-Nearest Neighbors (KNN)

💡 蒐集很多標籤 → 分類
貼完標籤 → 投票預測

1. 圓點 → 已分類好的點
2. 全部掃描完 → 找最接近的點

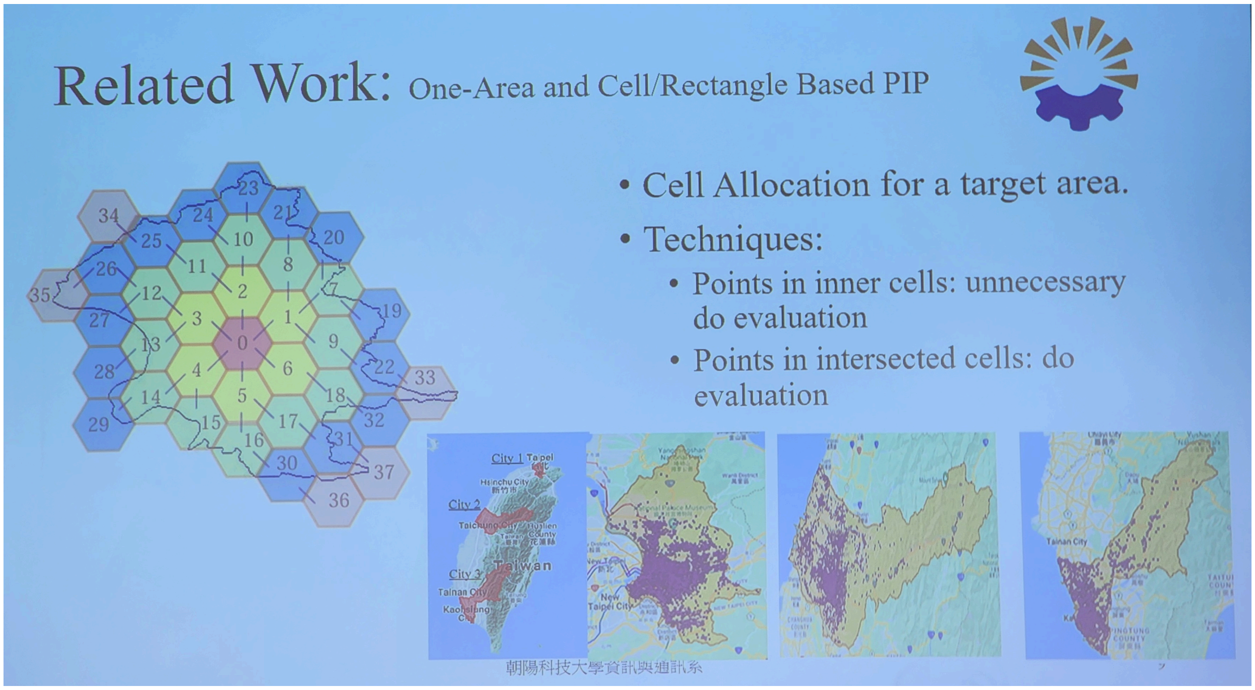


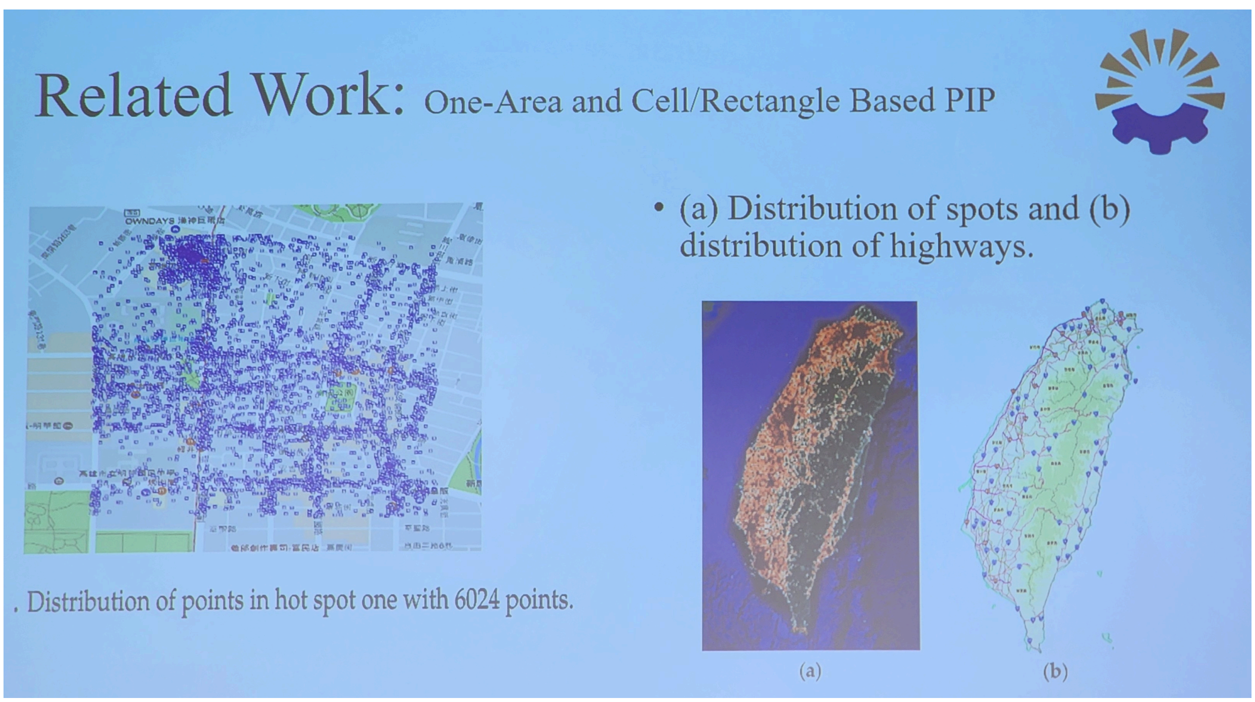
- 資料要數值化
- Step 2 針對大資料量



One-Area and Cell/Rectangle Based PIP

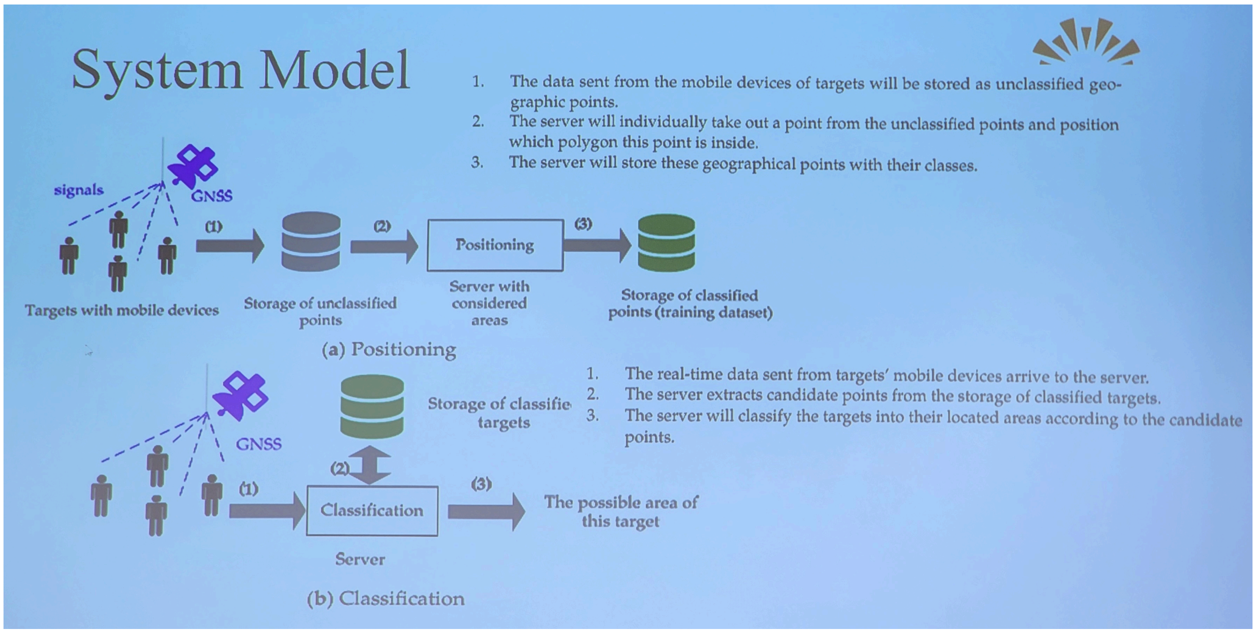
- 用CELL配置區域
    - 無線網路切CELL 代表基地台的位置
- 有交界才要跑PIP
- 資料會重複 → 改正方形的配置





System Model

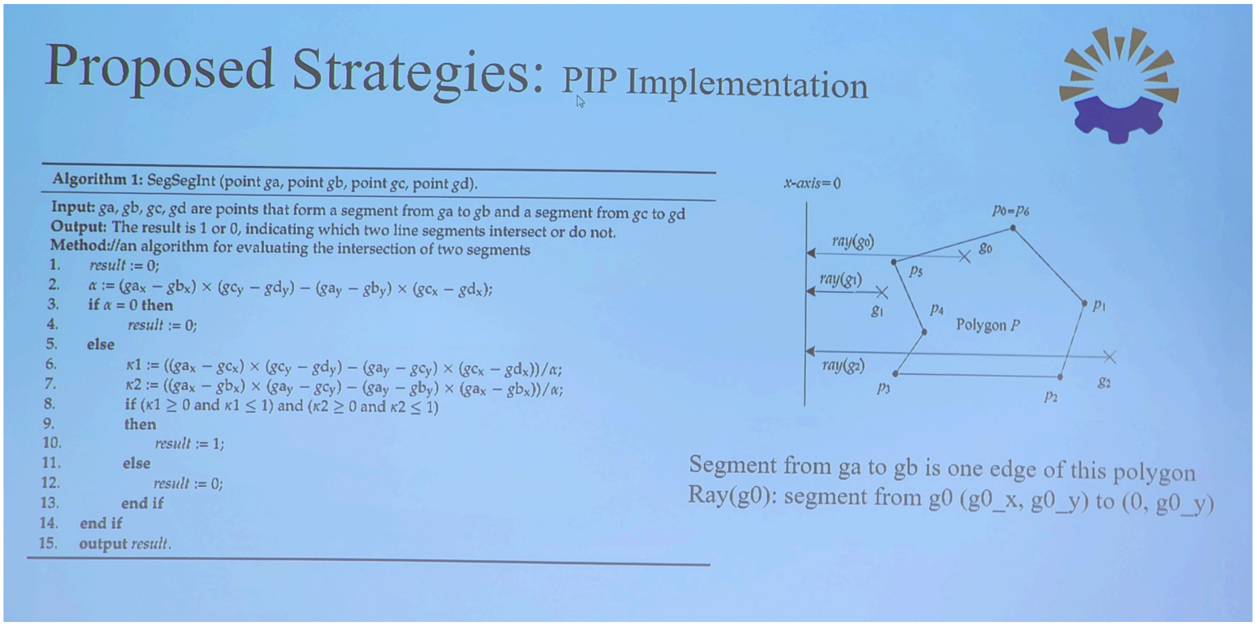
💡 手機 gps座標 → 定位 → 上標籤 → 訓練 → 分類

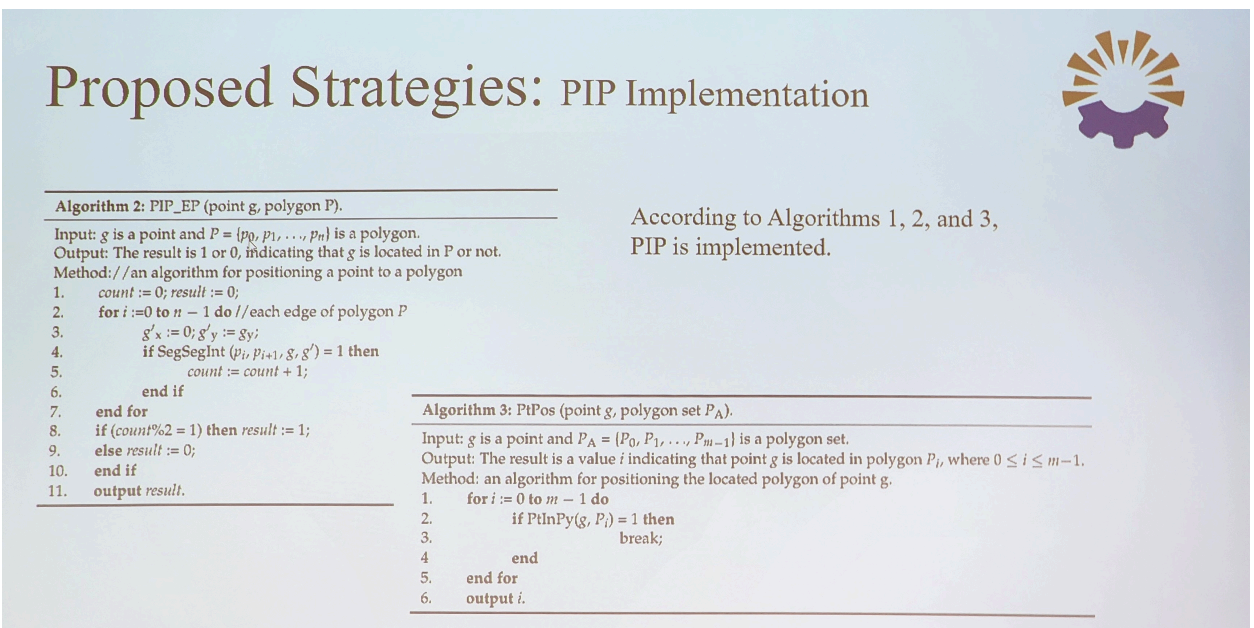


Strategy

- 段落跟段落有沒有交點
  - 射線跟邊有沒有交接
- 計算斜率
  - 斜率 0
    - 沒有交點
  - 斜率 其他
    - 判斷交點位置
- 交點

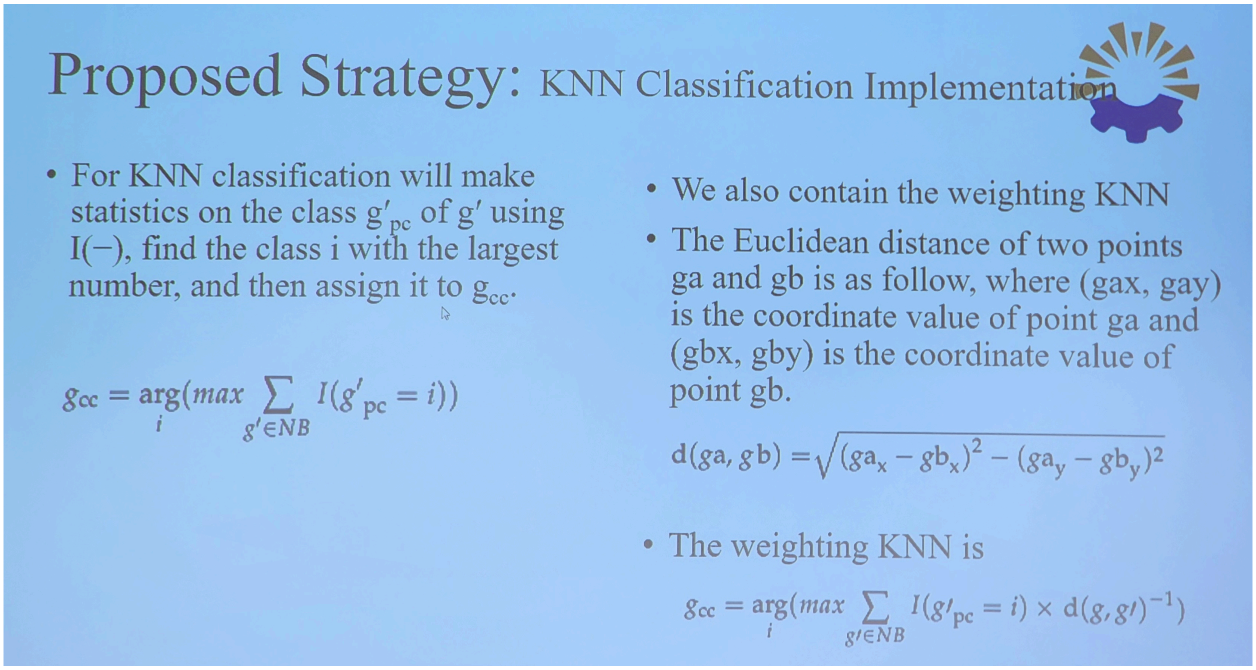
- 奇數 → 裡面
- 偶數 → 外面

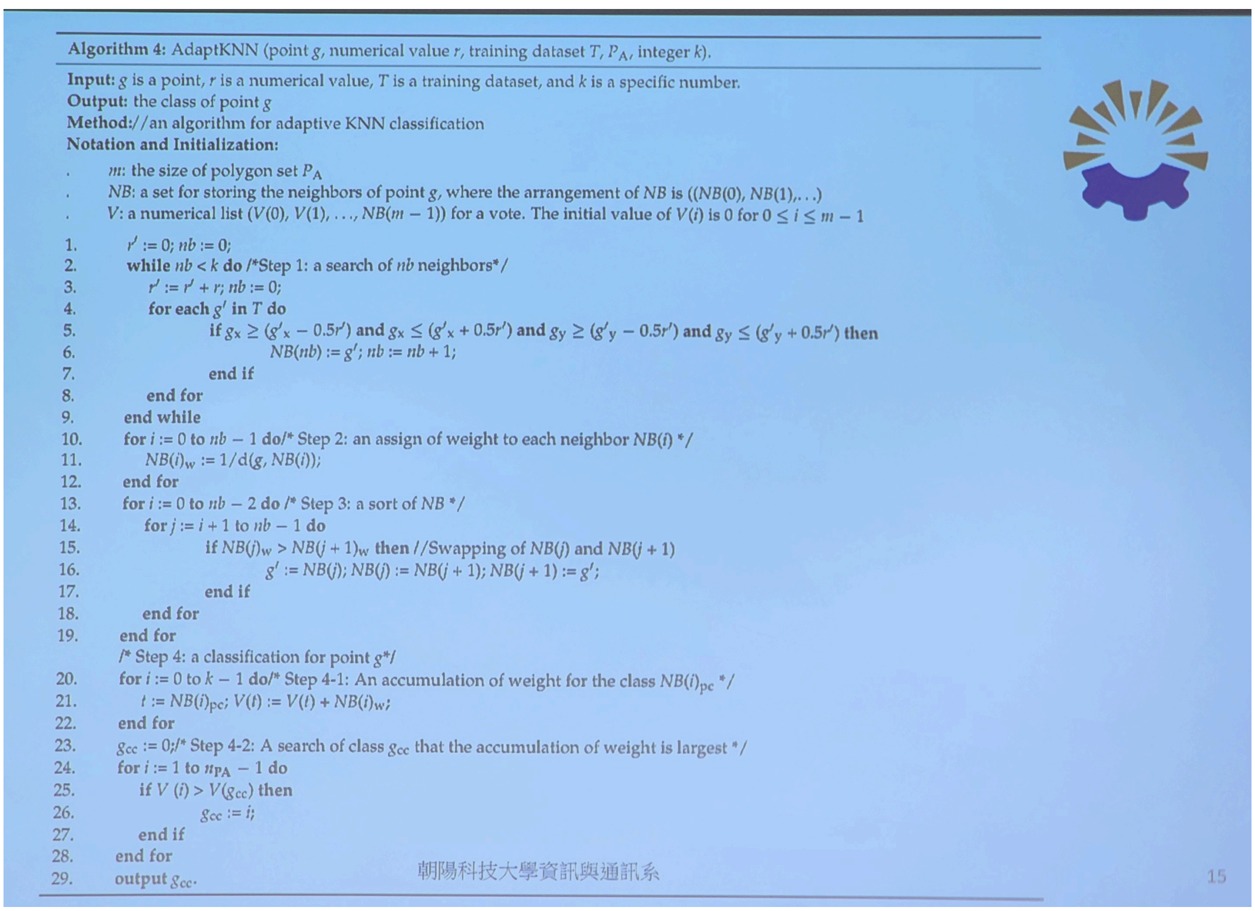




- gcc 為預測的分類
- 權重
    - 越遠越高

- 越近越低





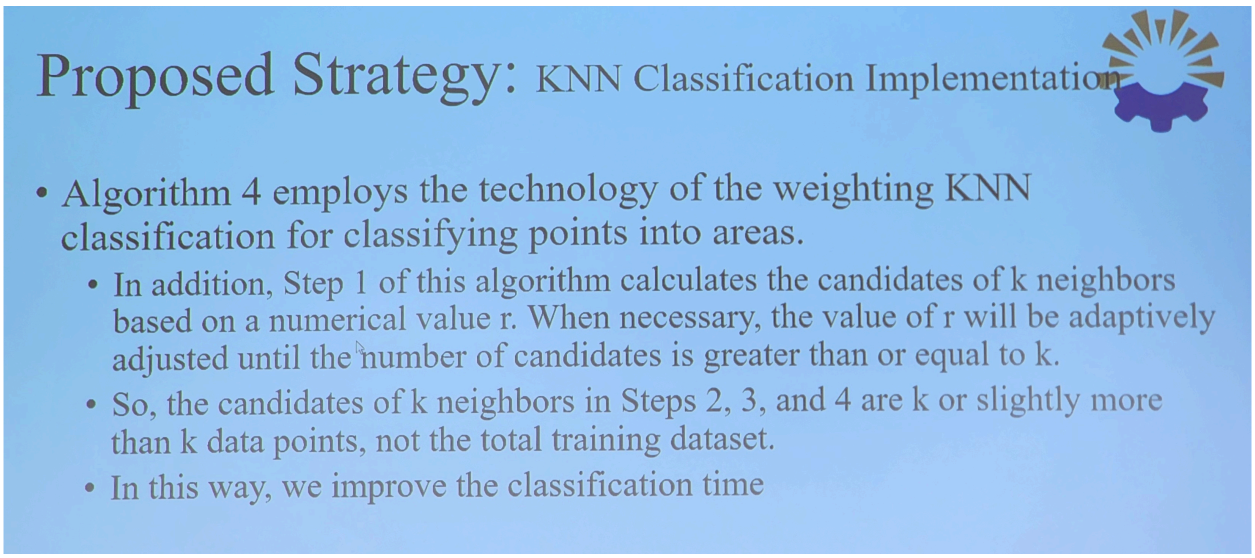
Algorithm 4: AdaptKNN (point g, numerical value r, training dataset T, P_A, integer k).

Input: g is a point, r is a numerical value, T is a training dataset, and k is a specific number.
Output: the class of point g
Method://an algorithm for adaptive KNN classification
Notation and Initialization:

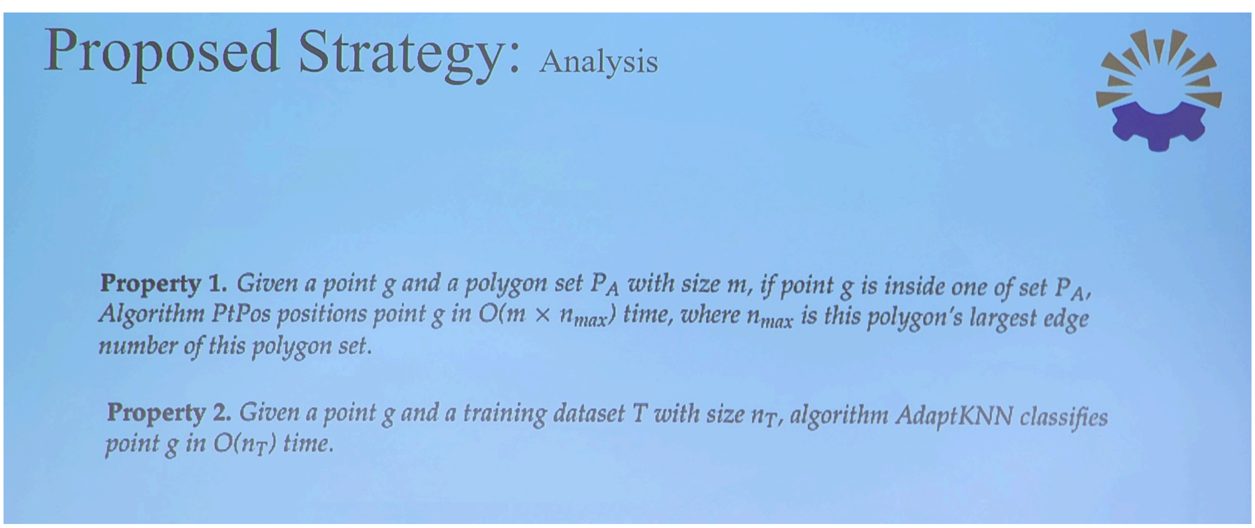
- m: the size of polygon set P_A
- NB: a set for storing the neighbors of point g, where the arrangement of NB is $((NB(0), NB(1),\ldots)$
- V: a numerical list $(V(0), V(1), \ldots, NB(m-1))$ for a vote. The initial value of $V(i)$ is 0 for $0 \le i \le m-1$

```
r' := 0; nb := 0;
while nb < k do /*Step 1: a search of nb neighbors*/
    r' := r' + r; nb := 0;
    for each g' in T do
            if g_x ≥ (g'_x − 0.5r') and g_x ≤ (g'_x + 0.5r') and g_y ≥ (g'_y − 0.5r') and g_y ≤ (g'_y + 0.5r') then
                    NB(nb) := g'; nb := nb + 1;
            end if
    end for
end while
for i := 0 to nb − 1 do/* Step 2: an assign of weight to each neighbor NB(i) */
    NB(i)_w := 1/d(g, NB(i));
end for
for i := 0 to nb − 2 do /* Step 3: a sort of NB */
    for j := i + 1 to nb − 1 do
            if NB(j)_w > NB(j + 1)_w then //Swapping of NB(j) and NB(j + 1)
                    g' := NB(j); NB(j) := NB(j + 1); NB(j + 1) := g';
            end if
    end for
end for
/* Step 4: a classification for point g*/
for i := 0 to k − 1 do/* Step 4-1: An accumulation of weight for the class NB(i)_pc */
    t := NB(i)_pc; V(t) := V(t) + NB(i)_w;
end for
g_cc := 0;/* Step 4-2: A search of class g_cc that the accumulation of weight is largest */
for i := 1 to n_PA − 1 do
    if V (i) > V(g_cc) then
            g_cc := i;
    end if
end for
output g_cc.
```

- 傳統的做法
    - 求距離 → 排序
- 現在的做法
- 只看固定區域
    - 自適應調整區域
        - 直到人數夠 → 加權重

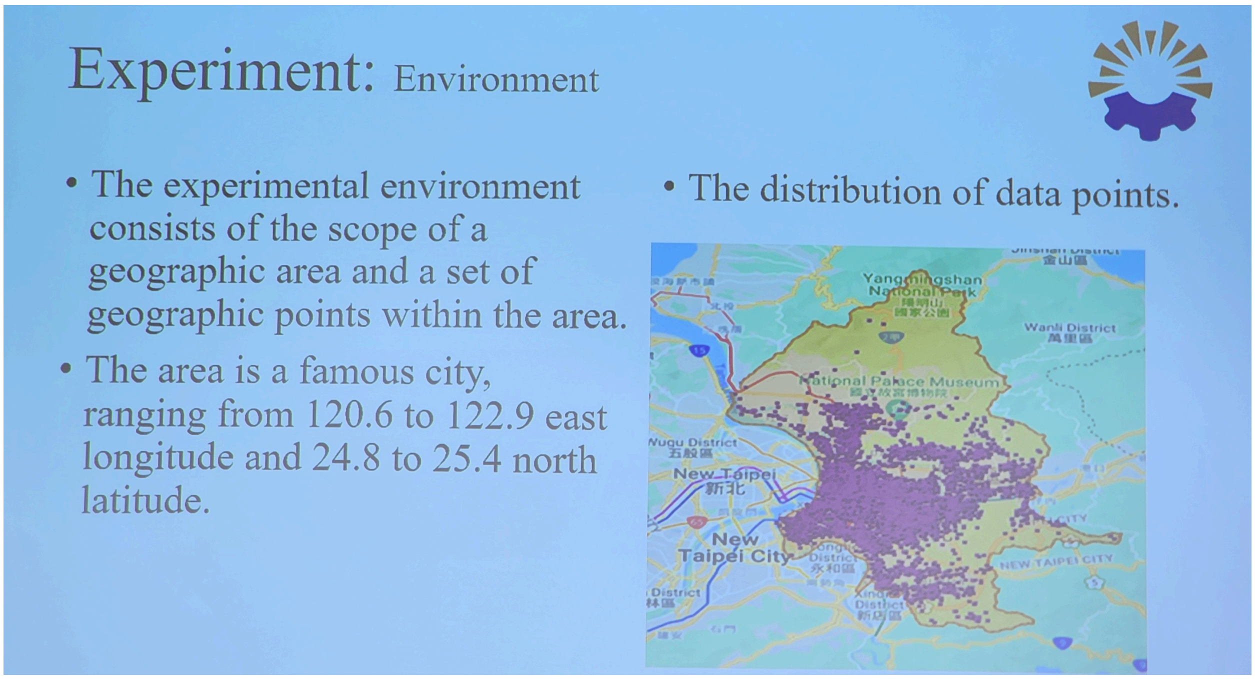


💡 降低時間複雜度

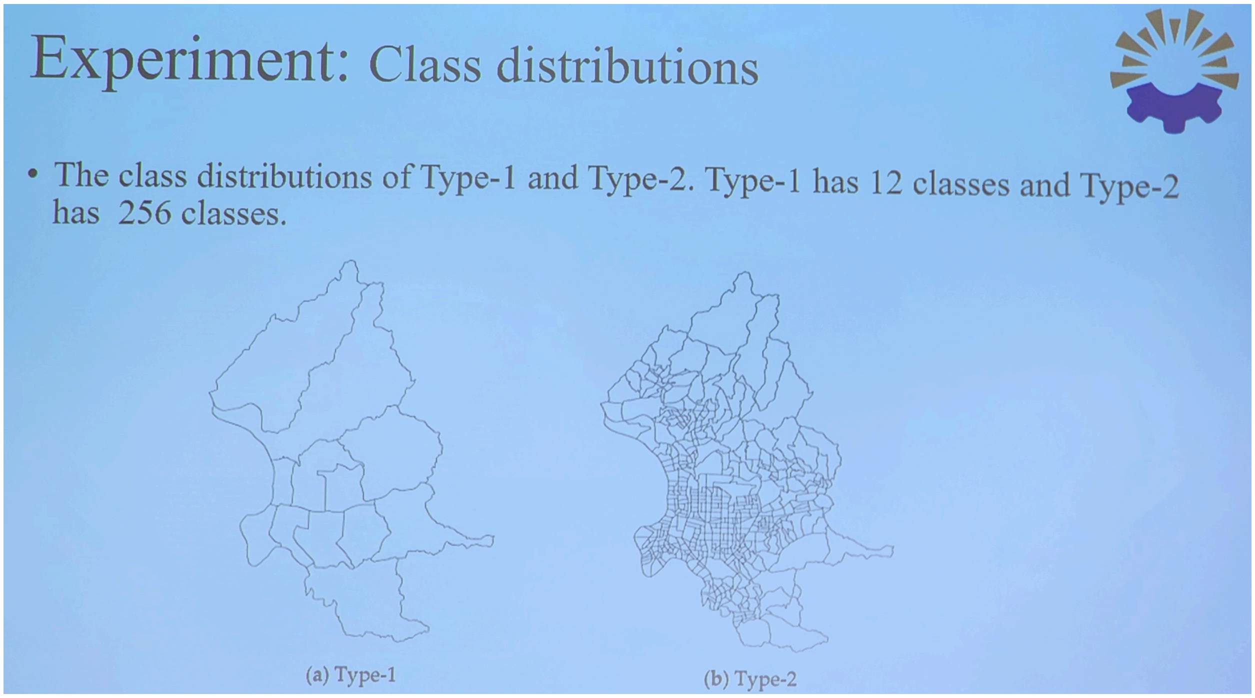


Experiment

- 地點
  - 台北市
- 打卡的地方當作人



- Type 1
  - 切比較大範圍
    - 12 classes
- Type 2
  - 切更細
    - 256 classes



> 💡 準確度跟KNN, wKNN 和 awKNN 比較

- awKNN 不保證是最接近的節點

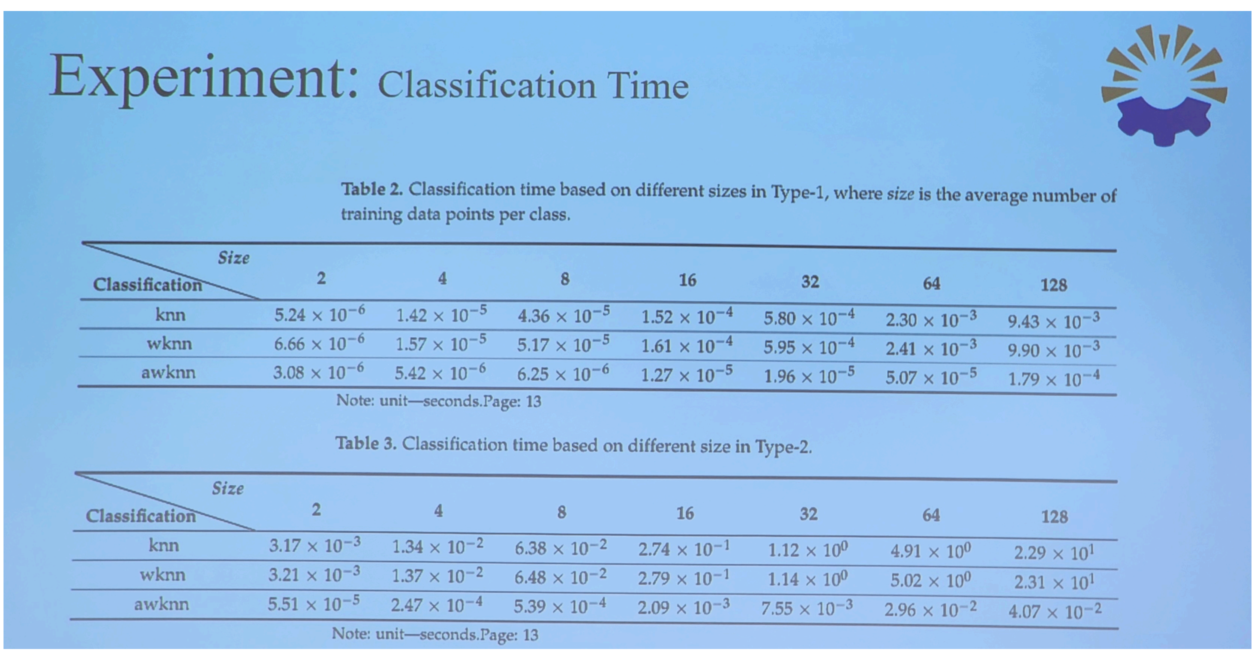


Table 2. Classification time based on different sizes in Type-1, where *size* is the average number of training data points per class.

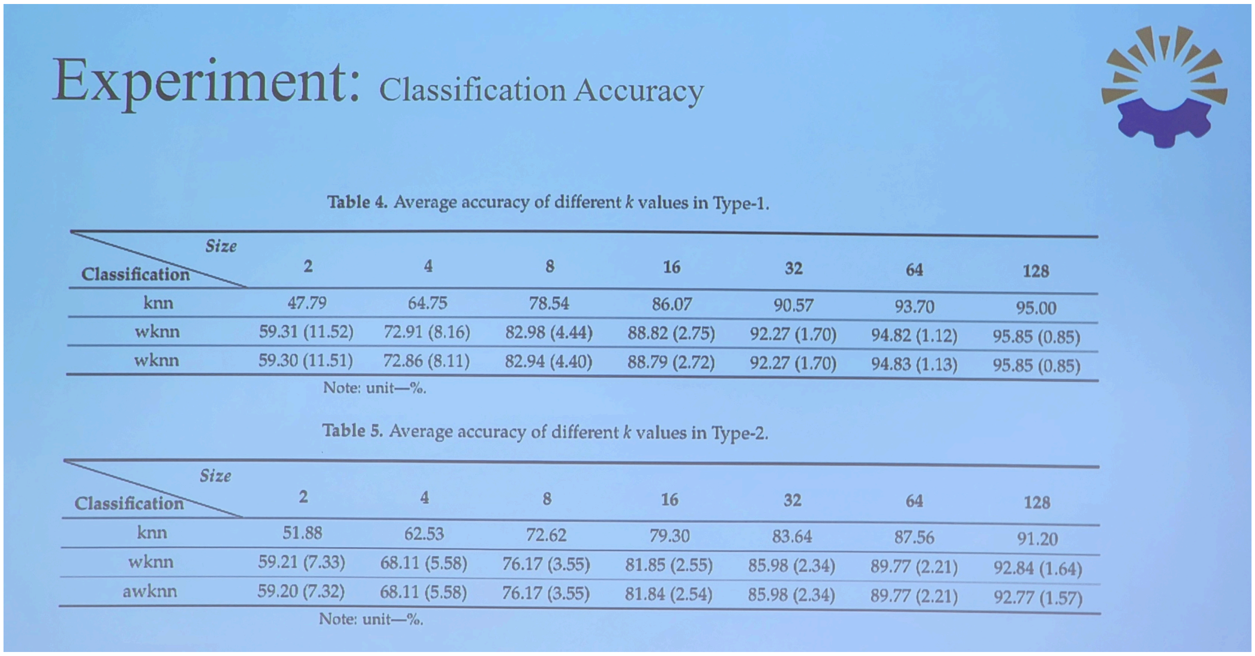
Classification \ *Size*	2	4	8	16	32	64	128
knn	5.24×10^{-6}	1.42×10^{-5}	4.36×10^{-5}	1.52×10^{-4}	5.80×10^{-4}	2.30×10^{-3}	9.43×10^{-3}
wknn	6.66×10^{-6}	1.57×10^{-5}	5.17×10^{-5}	1.61×10^{-4}	5.95×10^{-4}	2.41×10^{-3}	9.90×10^{-3}
awknn	3.08×10^{-6}	5.42×10^{-6}	6.25×10^{-6}	1.27×10^{-5}	1.96×10^{-5}	5.07×10^{-5}	1.79×10^{-4}

Note: unit—seconds.Page: 13

Table 3. Classification time based on different size in Type-2.

Classification \ *Size*	2	4	8	16	32	64	128
knn	3.17×10^{-3}	1.34×10^{-2}	6.38×10^{-2}	2.74×10^{-1}	1.12×10^{0}	4.91×10^{0}	2.29×10^{1}
wknn	3.21×10^{-3}	1.37×10^{-2}	6.48×10^{-2}	2.79×10^{-1}	1.14×10^{0}	5.02×10^{0}	2.31×10^{1}
awknn	5.51×10^{-5}	2.47×10^{-4}	5.39×10^{-4}	2.09×10^{-3}	7.55×10^{-3}	2.96×10^{-2}	4.07×10^{-2}

Note: unit—seconds.Page: 13



Experiment: Classification Accuracy

Table 4. Average accuracy of different *k* values in Type-1.

Classification \ Size	2	4	8	16	32	64	128
knn	47.79	64.75	78.54	86.07	90.57	93.70	95.00
wknn	59.31 (11.52)	72.91 (8.16)	82.98 (4.44)	88.82 (2.75)	92.27 (1.70)	94.82 (1.12)	95.85 (0.85)
wknn	59.30 (11.51)	72.86 (8.11)	82.94 (4.40)	88.79 (2.72)	92.27 (1.70)	94.83 (1.13)	95.85 (0.85)

Note: unit—%.

Table 5. Average accuracy of different *k* values in Type-2.

Classification \ Size	2	4	8	16	32	64	128
knn	51.88	62.53	72.62	79.30	83.64	87.56	91.20
wknn	59.21 (7.33)	68.11 (5.58)	76.17 (3.55)	81.85 (2.55)	85.98 (2.34)	89.77 (2.21)	92.84 (1.64)
awknn	59.20 (7.32)	68.11 (5.58)	76.17 (3.55)	81.84 (2.54)	85.98 (2.34)	89.77 (2.21)	92.77 (1.57)

Note: unit—%.