點型態分析
樣方分析

空間分析 2021.04.24

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Lab 5

台南市學校的空間型態檢定

(using quadrat analysis)

Quadrat Analysis

Step 1 - fishnet st_make_grid()

Step 2 - spatial intersection: st_intersection()

Step 3 - calculate counts of points: summarise()

Step 2+3 – quadrat counting: st_contain()

Step 4 - calculate mean and variance of counts

Step 5 - hypothesis testing: **Variance-Mean Ratio Test** (t-test)

Step 6 - make a conclusion

Poisson

Poisson分布：單位時間或空間中，隨機事件發生的次數之機率分布

- 參數 – 單位區間內發生的次數(λ)
- 特性 – 期望值=變異數= λ

單位分成成n等分 → n個獨立Bernoulli試驗 = Binomial $(n = n, p = \frac{\lambda}{n})$

$$P(X = k) = \lim_{n\to\infty} \binom{n}{k} \left(\frac{\lambda}{n}\right)^k \left(1 - \frac{\lambda}{n}\right)^{n-k} = \frac{e^{-\lambda}\lambda^k}{k!}$$

vs. Binomial

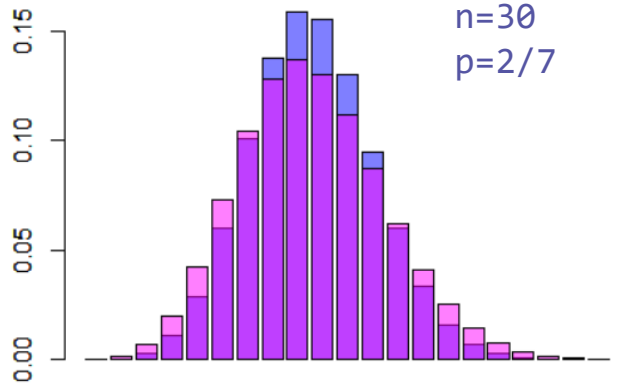
Q：一週賣出2份，一個月？

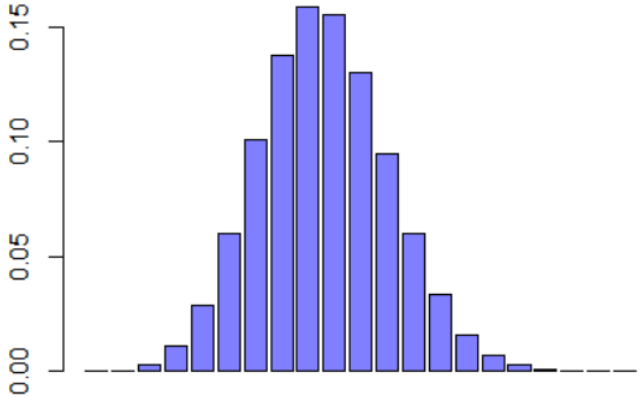
Binomial
1天：p=2/7, 30天：n=30

n大，p小
Binomial近似Poisson
b(n,p) → poi(λ=np)

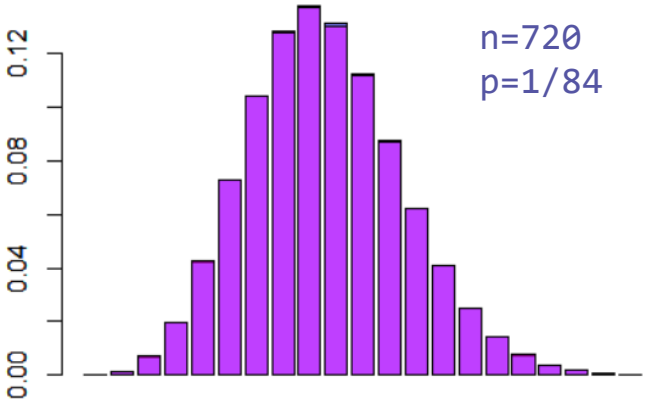
Poisson
30天平均：λ=60/7

Binomial以天為單位(分30間隔)





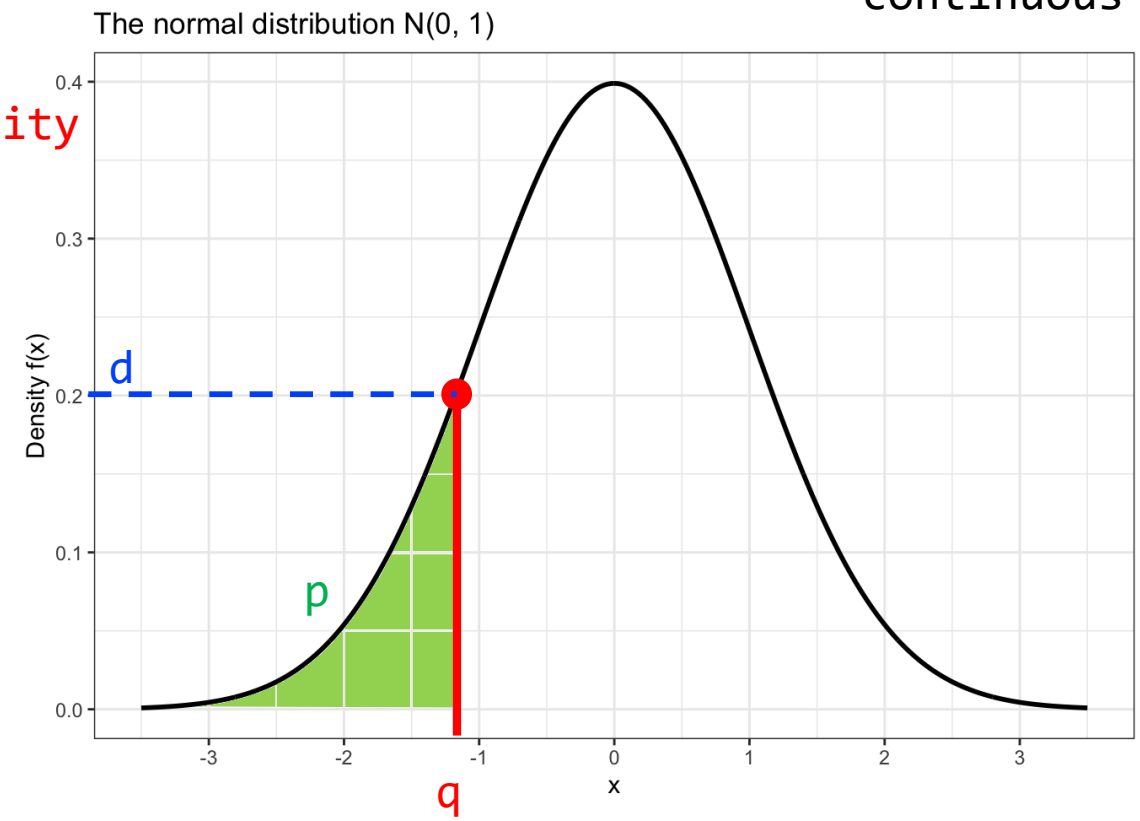
Binomial以小時為單位(分720間隔)



機率分布

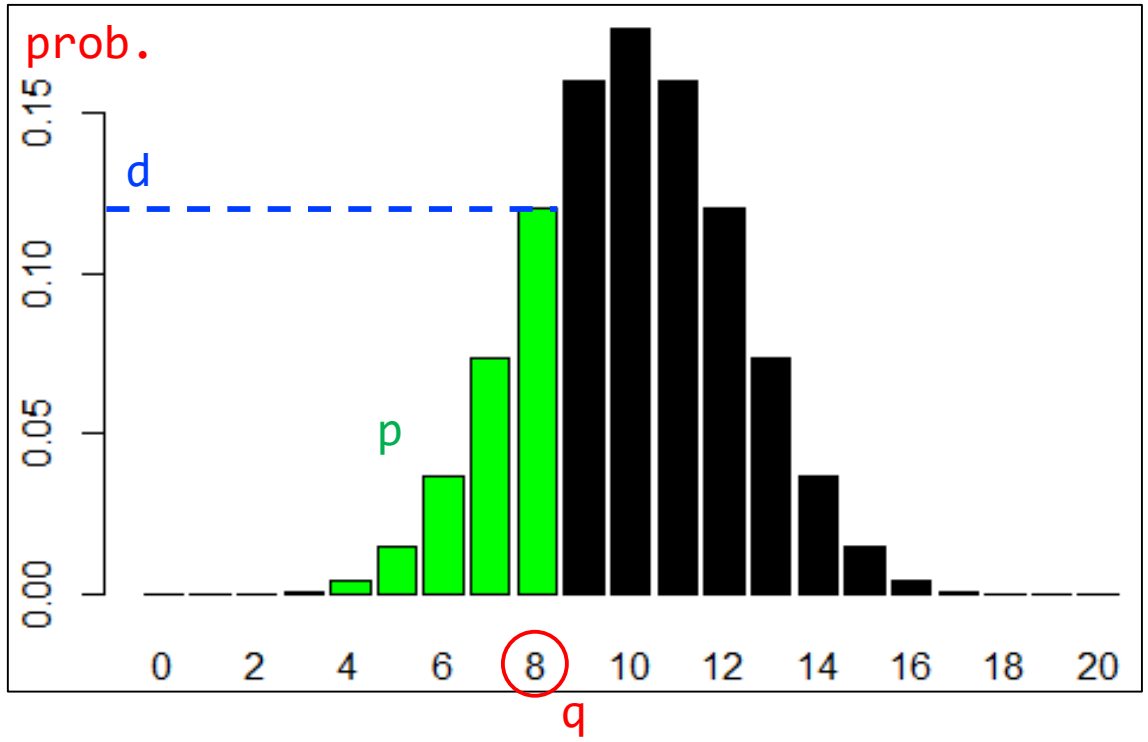
R **d,p,q,r + distribution**

continuous



- dnorm(q) → d → 機率密度
- pnorm(q) → p → 累積機率
- qnorm(p) → q

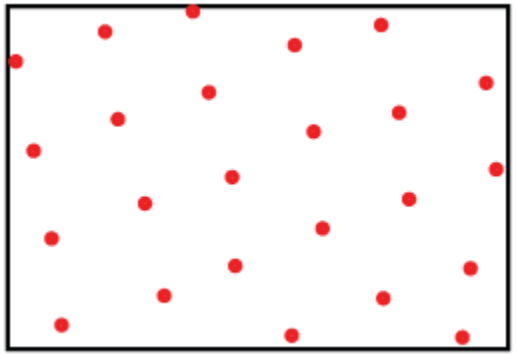
discrete



- dbinom(q,*n*,*p*) → d → 機率
- pbinom(q,*n*,*p*) → p → 累積機率
- qbinom(p,*n*,*p*) → q

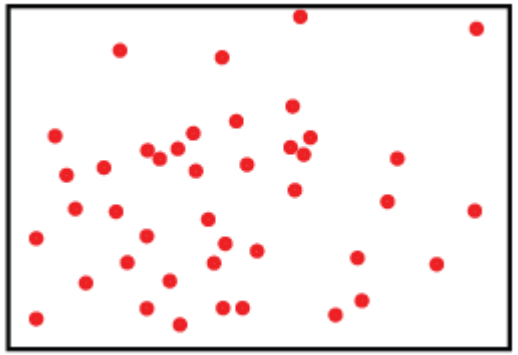
點型態分布

分散



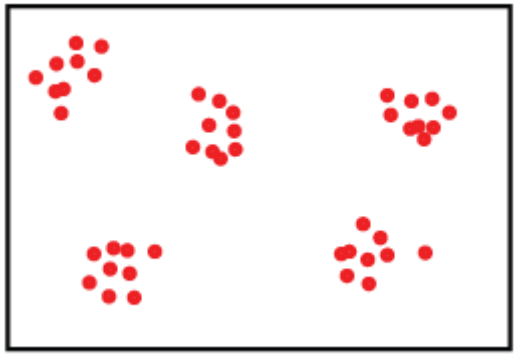
均勻分布
uniform
dispersion

隨機

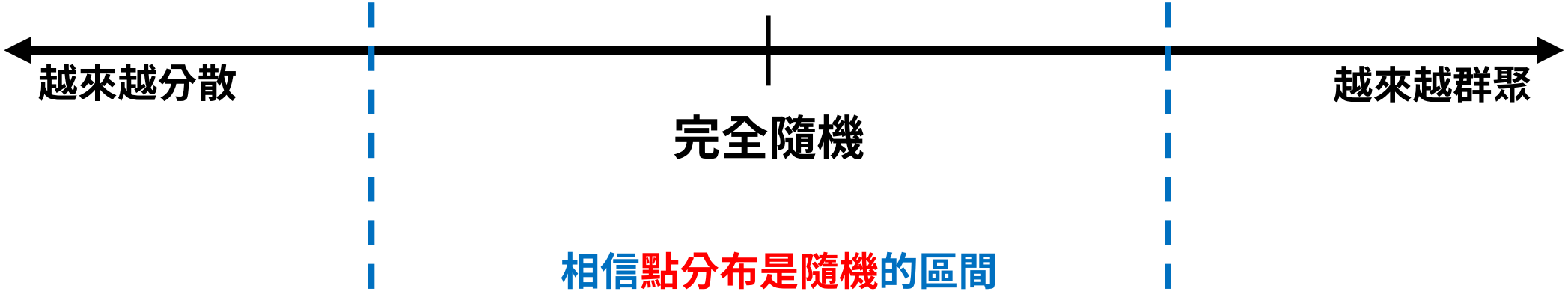


隨機分布
random
independent

群聚



聚集分布
cluster
aggregated



Quadrat Analysis

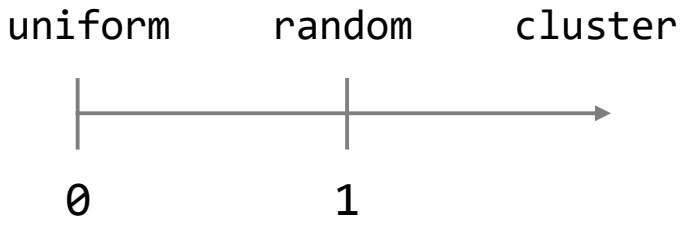
網格內點分布的次數，**是不是呈現隨機分布 → Poisson分布**？

VMR test

(t-test)

Variance-Mean Ratio (Index of dispersion - wiki)

- quantify whether a set of observed occurrences are clustered or dispersed
- assess whether observed data can be modeled using a Poisson process



$$\text{VMR} = \frac{\text{variance}}{\text{mean}}, \quad \boldsymbol{t} = \frac{\boldsymbol{VMR - 1}}{\boldsymbol{s.e.}}, \quad s.e. = \sqrt{\frac{2}{k-1}}, \quad df = k - 1$$

k: # of grids

Chi-square test

spatstat::quadrat.test()

$$\chi^2 = \sum_{i=1}^{k} \frac{(x_i - \lambda)^2}{\lambda}, \quad df = k - 1$$

Lab: VMR test

設定方格邊長5km

```
# 1. Fishnet
    grid = st_make_grid(school, 5000)
    k=length(grid)
    grid = st_sf(grid,ID=1:k)

# 2. Quadrat Counting
    school_in_grid=st_contains(grid, school)
    count = lengths(school_in_grid)
    grid$count = count

# 3. VMR Test
    variance=var(count)
    mean= mean(count)
    VMR = variance/mean
    se  = sqrt(2/(k-1))
    t   = (VMR-1)/se
```

→ 計算t的p-value（注意單雙尾）

```
> st_contains(grid, school)
 1: (empty)     #第1個網格中有 0 個點
 2: 22, 23, 24, 113
 3: 116, 117, 118, 119, 423
 4: 121, 146, 313, 400, 417
 5: 144, 188    #第5個網格中有 2 個點
> lengths(school_in_grid)
[1]  0  4  5  5  2
```