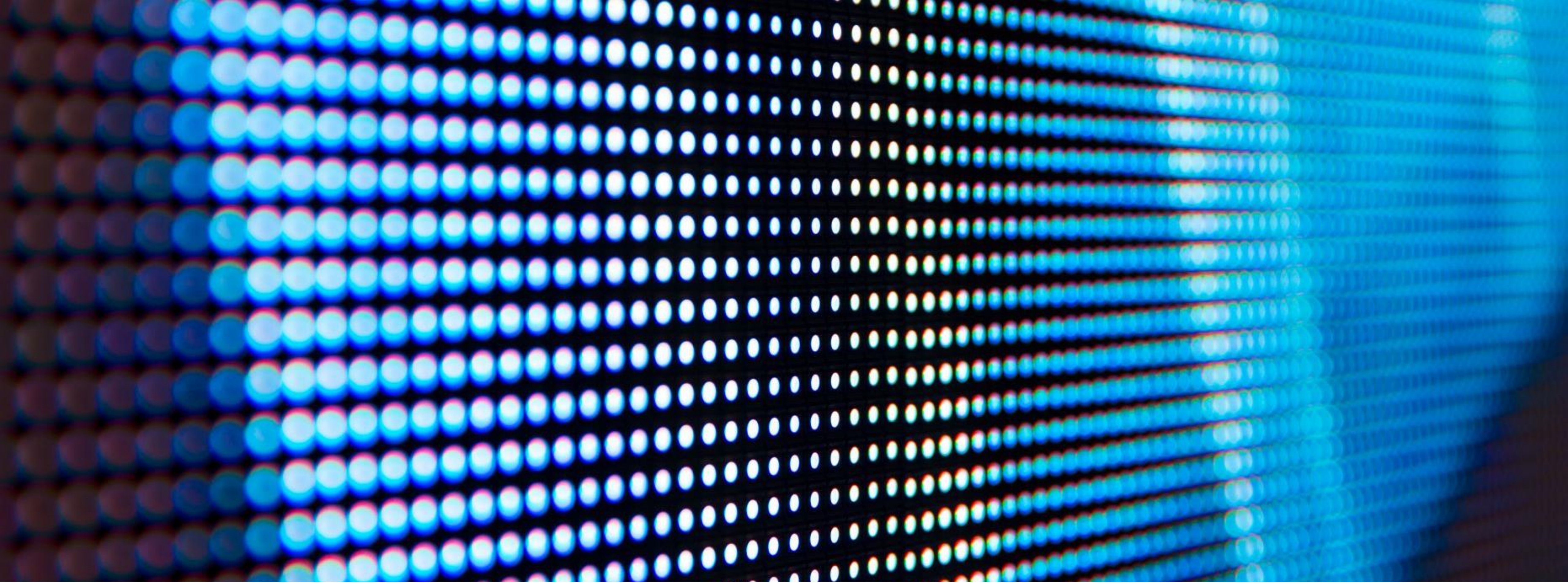
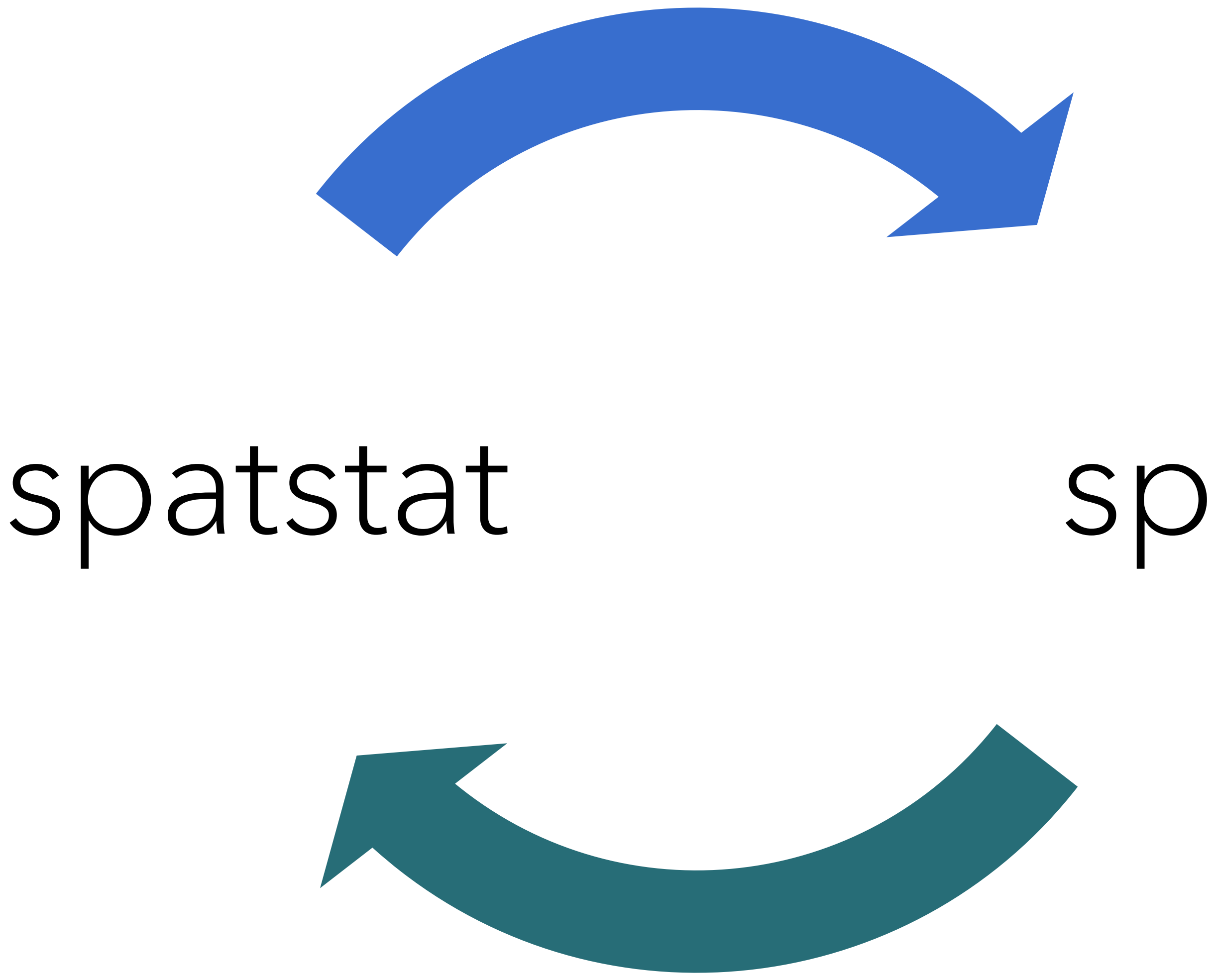


ECON 6027 5b

Quadrat Count Analysis

Packages you need



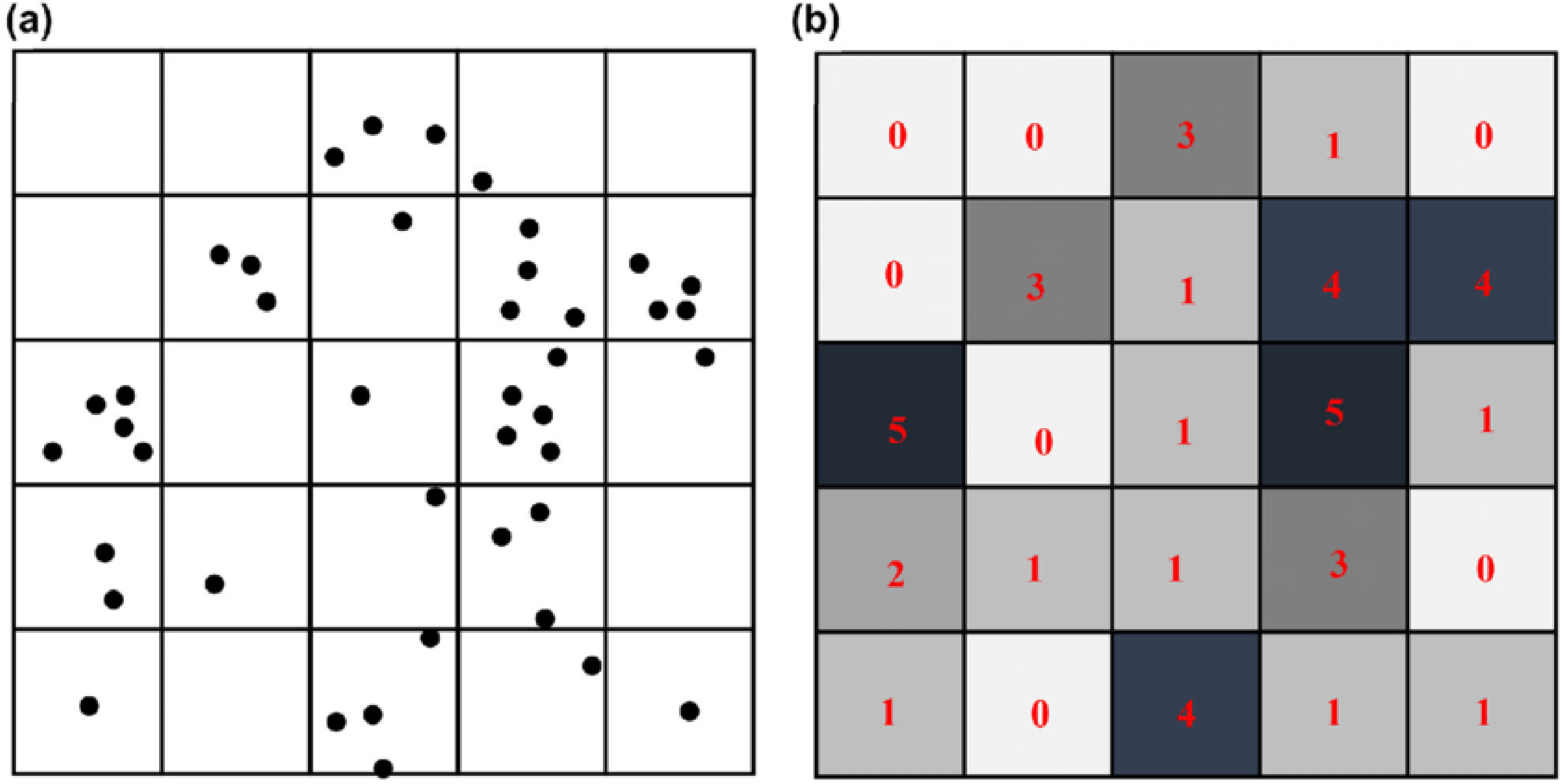
The method

- The quadrat count method determines the point distribution by examining its "density/frequency" over the study area.
- Analysis is based on **sub-quadrats** (grid cells) that are constructed over a given study area (called "A").
- Given the MAUP, the size of the grid cell is critical and could influence the estimation of measures derived from the analysis.
- It is common to use square grids (but not necessary and can depend on the analytical objectives).

Steps in conducting a quadrat count analysis

Divide	Count	Calculate	Compare	Test	Conclude
Divide the study region (A) into grid cells (sub-quadrats) that are equal in area.	Count the number of points in each cell (let's call this, the variable *X*) and determine the **frequency distribution of *X*** (the number of points in each cell).	Calculate the **observed and expected probability** of the points for *X*. Using the probabilities, calculate the observed **mean** and the **variance** of the variable *X*.	Compare (visually) the observed distribution of points to a theoretical random pattern to assess whether it is, • Clustered: points are concentrated in a few cells, and many are empty • Disperesed • Random	Calculate the **Chi-square test** statistic of the hypothesis and the variance mean ratio (**VMR**).	Use the observed statistic and critical value to conform or deny the null hypothesis.

Quadrat counts



a) Square grid cells are used
b) Compare the frequency in each cell to that of an HPP.

Let X be the count in each cell

E(X) = 1.68

Var(X) = 2.6976

If X follows a Poisson distribution, we should observe E(X) ~ Var(X) which is an estimate for lambda.

Quadrat count analysis is thus focused on inferring how close the quadrat counts get to a Poisson distribution.

X	P(X = x)
0	7/25
1	9/25
2	1/25
3	3/25
4	3/25
5	2/25

Quadrat count (qc) analysis

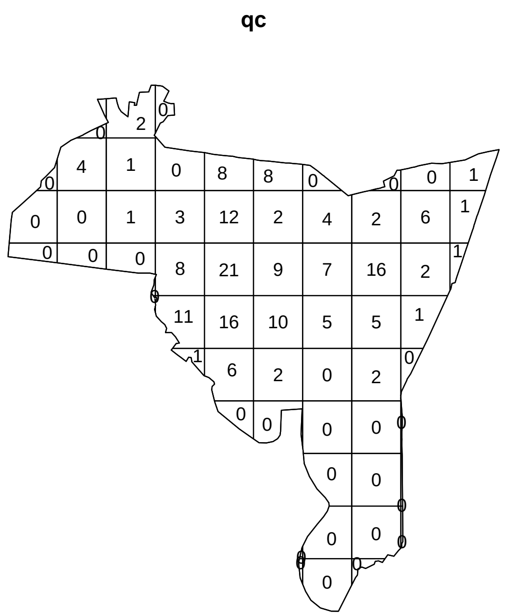
1. Generate quadrat counts

We will continue with the Newhaven dataset…

```
> (qc = quadratcount(breach.ppp,nx=10, ny=10))
```

```
> class(qc) # [1] "quadratcount" "table"
```

```
> plot(qc)
```

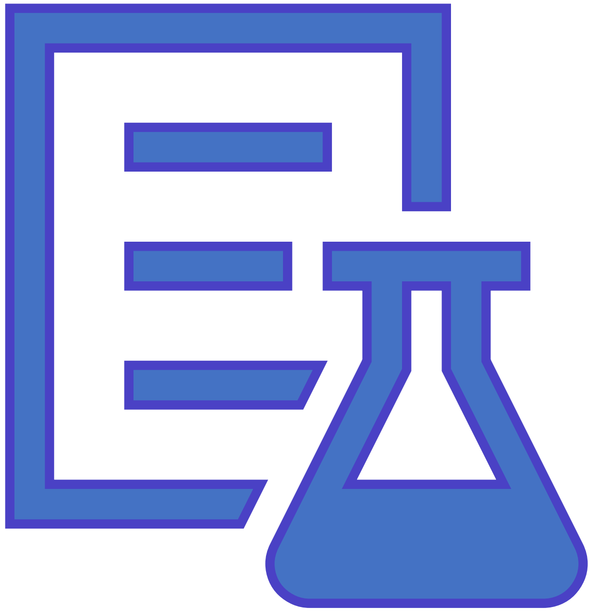


2. Chi-square goodness-of-fit test

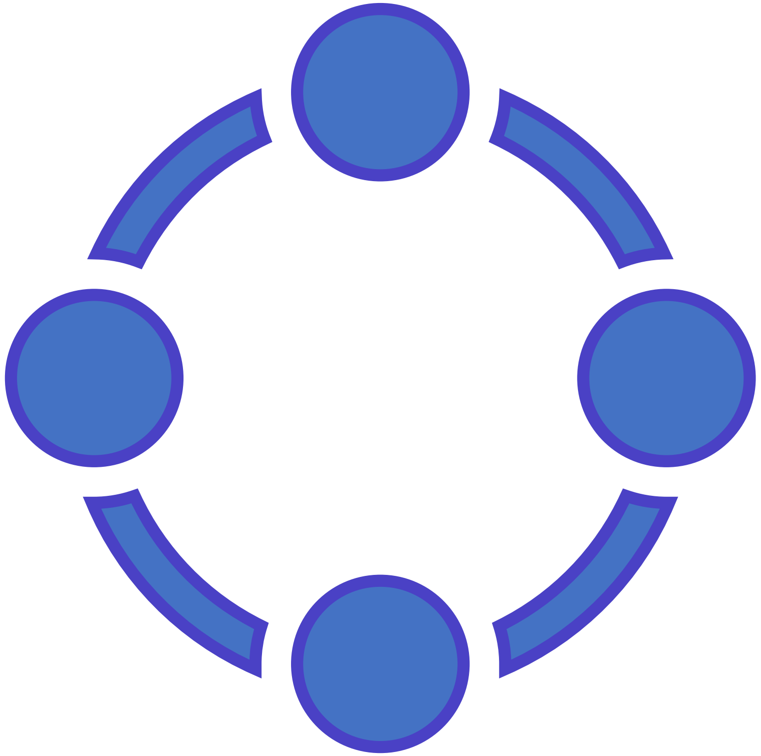
- H0: qc ~ Po(λ_0)
- Test Statistic:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i} \sim \chi^2_{n-1}$$

- Where, O_i are observed quadrat count and E_i are expected frequencies and n is the number of sub-quadrats.



Chi-square goodness-of-fit test using spatstat



```
> (quad.test = quadrat.test(breach.ppp,
nx=10, ny=10))
```

Chi-squared test of CSR using quadrat counts

data: breach.ppp

X2 = 273.06, df = 60, p-value < 2.2e-16

alternative hypothesis: two.sided

Quadrats: 61 tiles (irregular windows)

Conclusion: Reject H0.

3. Estimate mean (implied λ_0 in the Chi-square test null)

Estimate lambda (the average number of counts per quadrat)

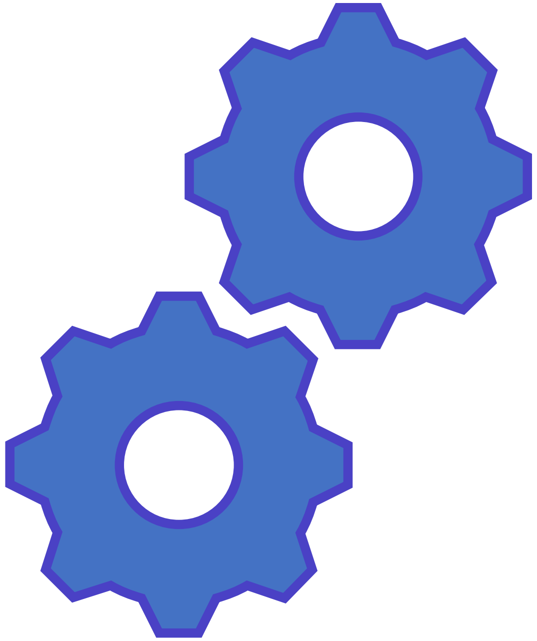
`> View(quad.test)` # inspect the quad.test list object.

`> quad.test$observed` # gives the observed number of points in each quadrat

`> quad.test$parameter` # gives the number of df (i.e. n=df+1)

```
> n = quad.test$parameter+1
> (lambda = sum(quad.test$observed)/n)
```

2.918033

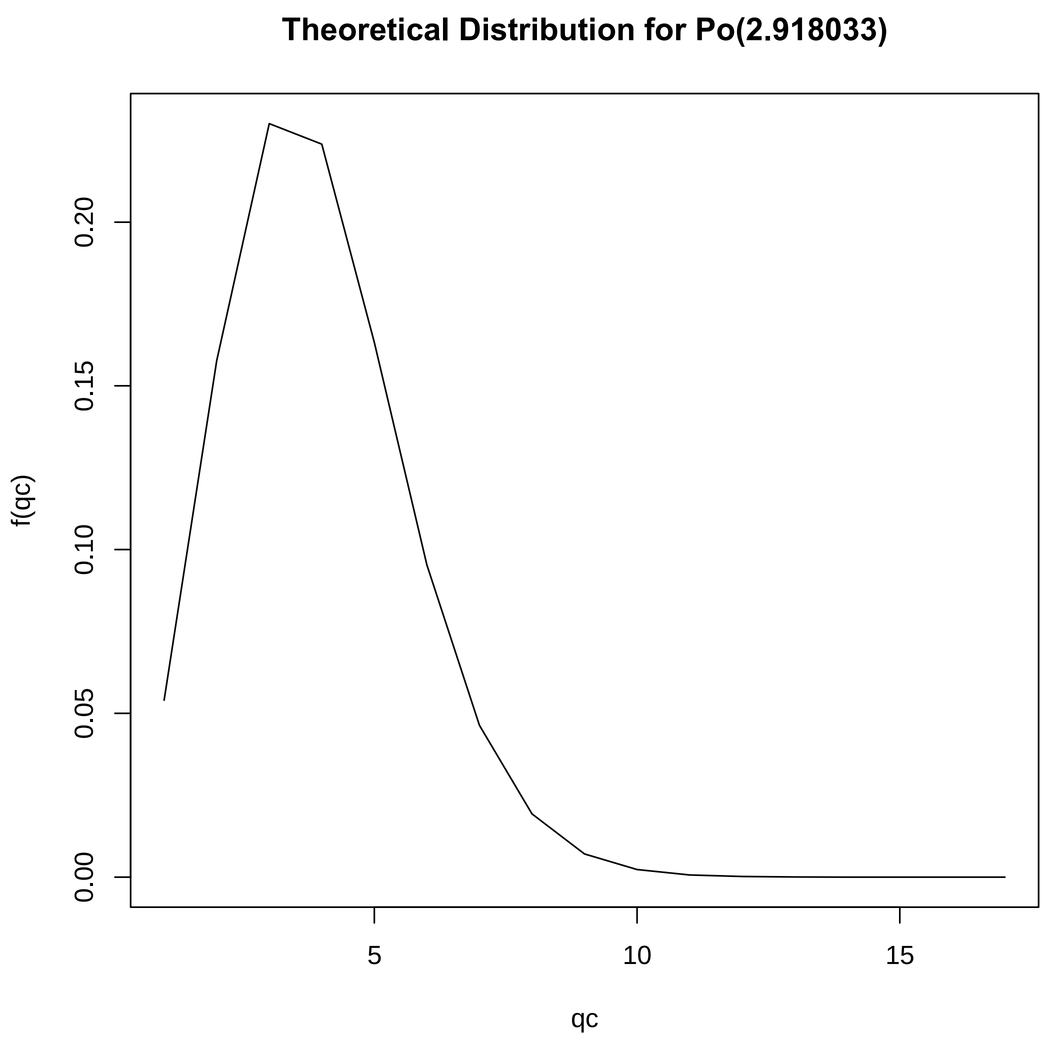


We will use 2.918033 as the lambda of the Poisson distribution to compute the expected quadrat counts (frequencies) if the process was a CSR under the null.

If qc ~ Po(2.918033)

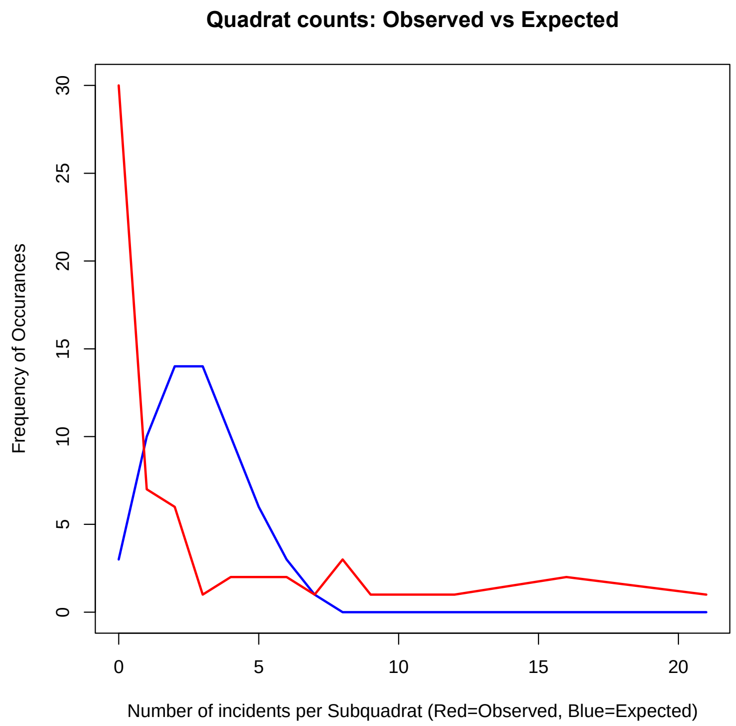
- If the point pattern follow a HPP (CSR), then the quadrat counts should have a frequency distribution as depicted here following a Poisson distribution with a mean 2.918033.

```
> plot(dpois(0:16, lambda=lambda),type="l",xlab="qc",ylab="f(qc)",main="Theoretical Distribution for Po(2.918033)") # do not run
```

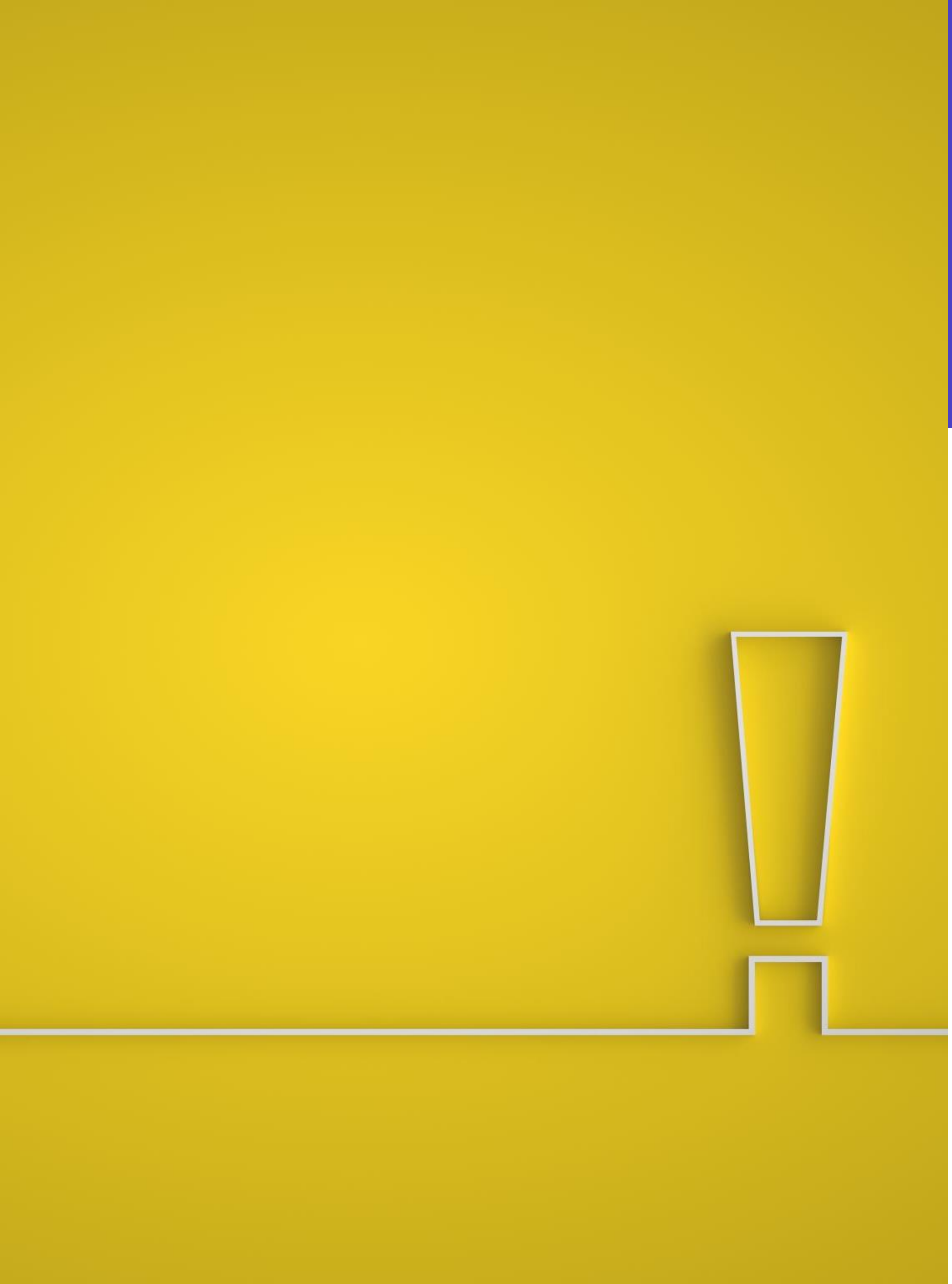


4. Visual comparison (not compulsory)

```
> observed = table(quad.test$observed)

> max.num = max(quad.test$observed) # maximum
number of observations in a single quadrat

> max.freq = max(observed) # maximum frequency

> plot(c(0,max.num),c(0,max.freq), type="n",
xlab="Number of incidents per Subquadrat
(Red=Observed, Blue=Expected)", ylab="Frequency
of Occurances", main="Quadrat counts: Observed vs
Expected")

> points(dpois(0:max.num, lambda=lambda)*n,
type="l", col="Blue", lwd=2)

points(observed, col="Red", type="l", lwd=2)
```



Clearly the point pattern does not follow an HPP.



Exercise A

1. Explain whether the quadrat count analysis is trying to identify a first-order effect or a second order effect.
2. Conduct a quadrat count analysis for the ppp object “bramblecanes” that comes with “spatstat”. Use a 9X9 grid. Be sure to state your conclusion clearly.

Disadvantages of QC Analysis

- MAUP: quadrat size
  - If too small, they may contain only a couple of points
  - If too large, they may contain too many points
- Quadrat count is a measure of dispersion, and not really pattern per se, because it is based primarily on the density of points, and not their arrangement in relation to one another.
- Results in a single measure for the entire distribution, so variations within the region are not recognized.
- The hypothesis test itself tells us whether the point process is an HPP or not. To conclusively show that there is definite clustering (or dispersion) we need to perform alternative test(s).

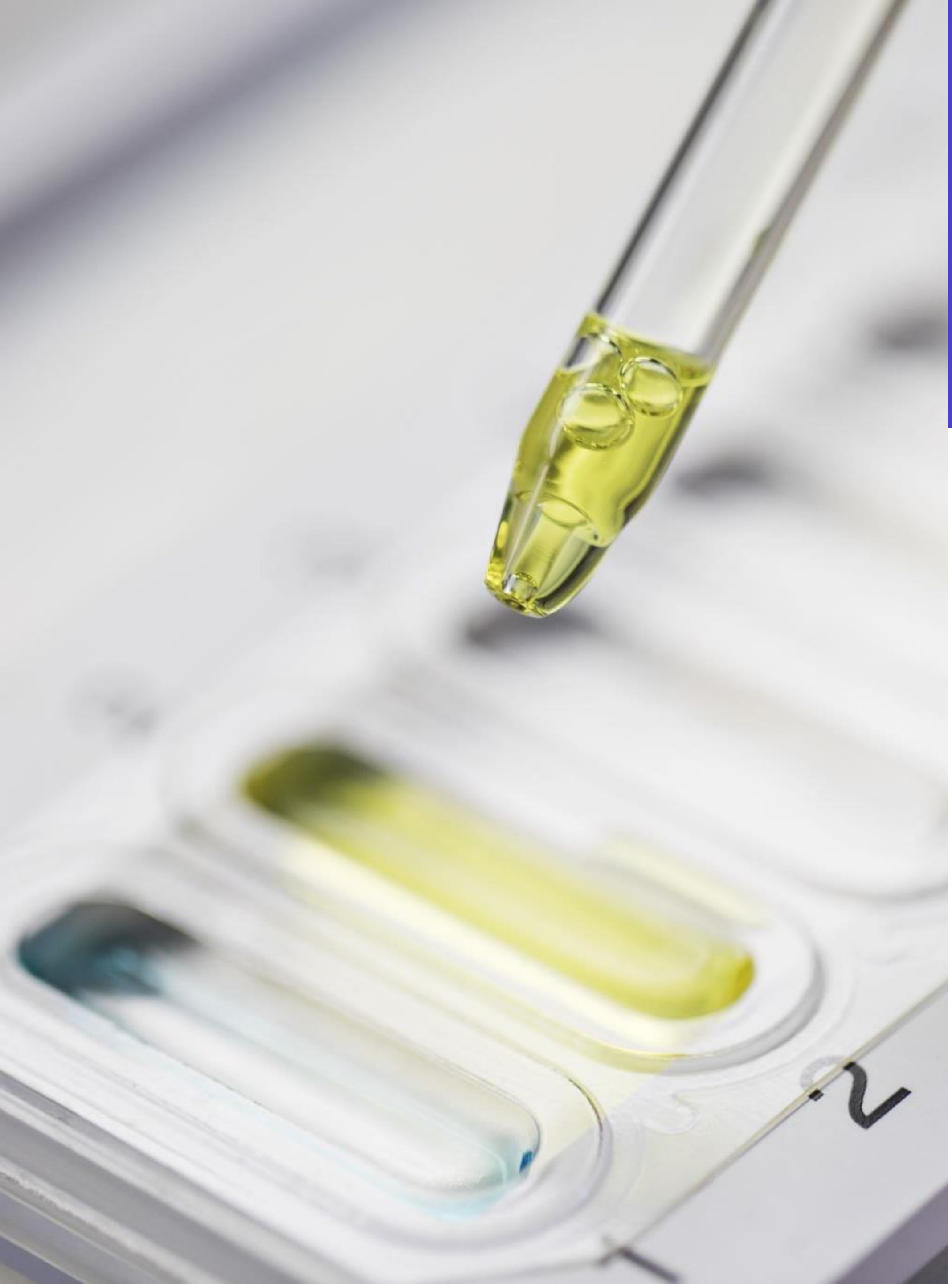
Take home points

The general method of quadrat count analysis

Steps involved in quadrat count analysis

Conducting a quadrat count analysis and the chi-square test

Disadvantages of the method



Important R functions

- quadratcount()
- quadrat.test()

References

- ***Spatial Analysis*** by Tonny Oyana, 2nd edition, Chapter 6.
- ***Applied Spatial Data Analysis with R*** by Roger S. Bivand, Edzer Pebesma, and Virgilio Gómez-Rubio, 2nd edition, (2013), Chapter 7.
- https://cran.r-project.org/web/packages/spatstat/spatstat.pdf
- https://cran.r-project.org/web/packages/maptools/maptools.pdf
- https://en.wikipedia.org/wiki/Goodness_of_fit