Geographic Data Science - Lecture IX

Points

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Today

- The *point* of points
- Point patterns
- Visualization of point patterns

The *point* of points

Points like polygons

Points *can* represent **"fixed" entities**

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In this case, points are **qualitatively** similar to **polygons/lines**

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In this case, points are **qualitatively** similar to **polygons/lines**

The **goal** here is, taking location fixed, to model other aspects of the data

Points like polygons

Examples:

Points like polygons

Examples:

- Cities (in most cases)

Points like polygons

Examples:

- Cities (in most cases)
- Buildings

Points like polygons

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- Cities (in most cases)
- Buildings
- Polygons represented as their centroid

Points like polygons

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- Buildings
- Polygons represented as their centroid
- ...

When points are not polygons

Point data are not only a different geometry than polygons or lines...

When points are not polygons

Point data are not only a different geometry than polygons or lines...

... Points can also represent a fundamentally different way to approach spatial analysis

Points unlike polygons

Points unlike polygons

- Rather than exhausting the entire space, points can be **events** subject to **occur anywhere**

Points unlike polygons

- The **location** of the event is **part** of what we are trying to understand / **model**

Points unlike polygons

- The interest focuses on **characterizing** the **pattern** that the points follow **over space**

Points unlike polygons

- Rather than exhausting the entire space, points can be **events** subject to **occur anywhere**
- The **location** of the event is **part** of what we are trying to understand / **model**
- The interest focuses on **characterizing** the **pattern** that the points follow **over space**

A few examples...

+800 crimes between 11/11/2015 - 11/17/2015

CLICK then DRAG

Use Mini Icons

The map can't plot any more crimes. Zoom In.

Streets | Terrain | Labeled Satellite

[Source

NYC Street Trees by Species

New York City's urban forest provides numerous environmental and social benefits, and street trees compose roughly one quarter of that canopy. This map shows the distribution and biodiversity of the city's street trees based on the last tree census. Read more.

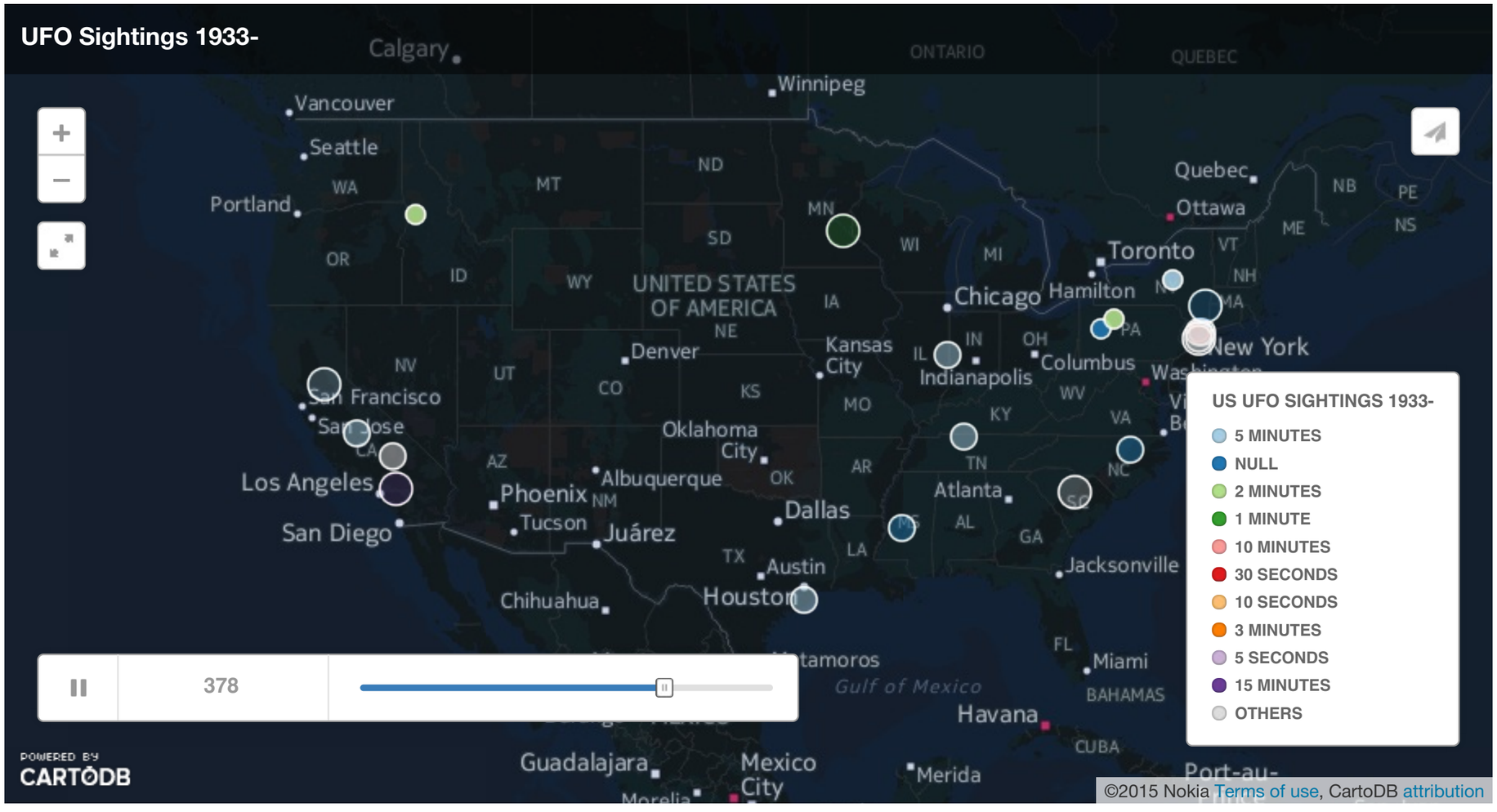
[Source]

Dot size is roughly proportional to tree trunk diameter

FILTER BY SPECIES

BASE MAP

UFO Sightings (1933-)



Map created by lcpearso

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Geo-tagged tweets

Point patterns

Point patterns

Distribution of **points over** a portion of **space**

Assumption is a point can happen anywhere on that space, but only happens in specific locations

Point patterns

Distribution of **points over** a portion of **space**

Assumption is a point can happen anywhere on that space, but only happens in specific locations

- **Unmarked**: locations only
- **Marked**: values attached to each point

Point Pattern Analysis

Describe, characterize, and explain point patterns, focusing on their **generating process**

- Visual exploration
- Clustering properties
- Statistical modeling of the underlying processes

Visualization of PPs

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Two routes (today):

- *Aggregate*
- *Smooth*

Visualization of PPs

Two routes (today):

- *Aggregate* ⇔ "Histogram"
- *Smooth*

Visualization of PPs

Two routes (today):

- *Aggregate* ⇔ "Histogram"
- *Smooth* ⇔ KDE

Aggregation

Points meet polygons

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Use **polygon** boundaries and **count** points per area

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[Insert your skills for **choropleth mapping** here!!!]

Points meet polygons

Use **polygon** boundaries and **count** points per area

[Insert your skills for **choropleth mapping** here!!!]

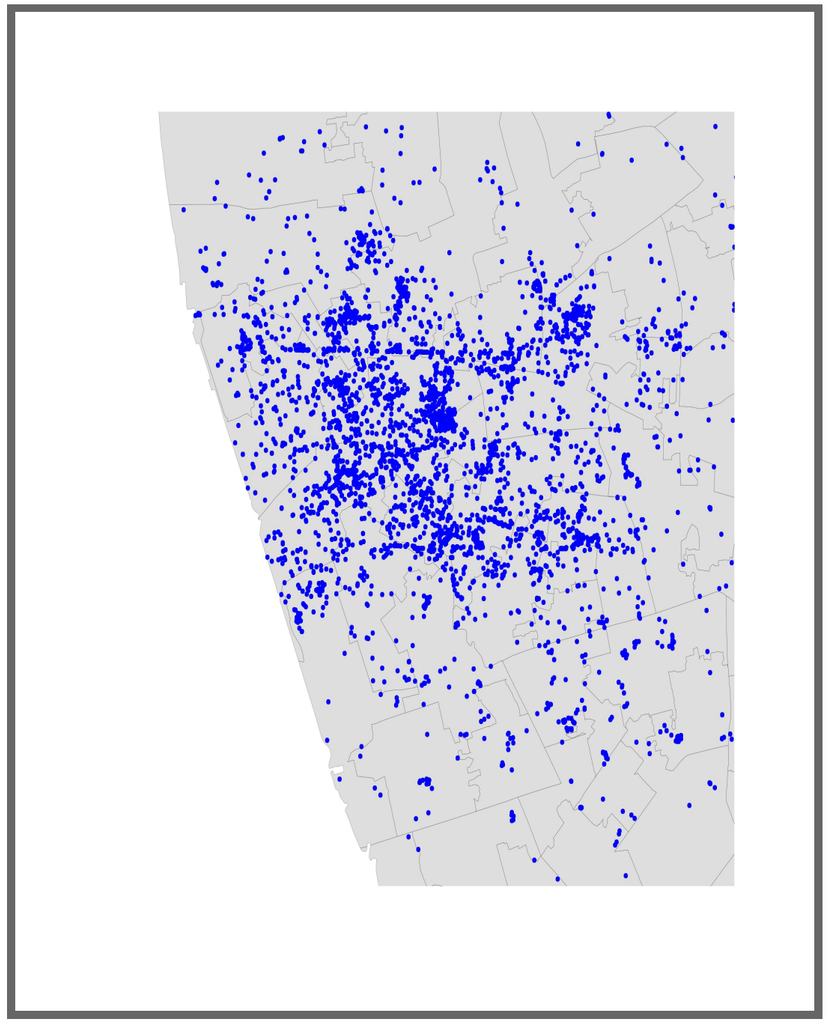
But,

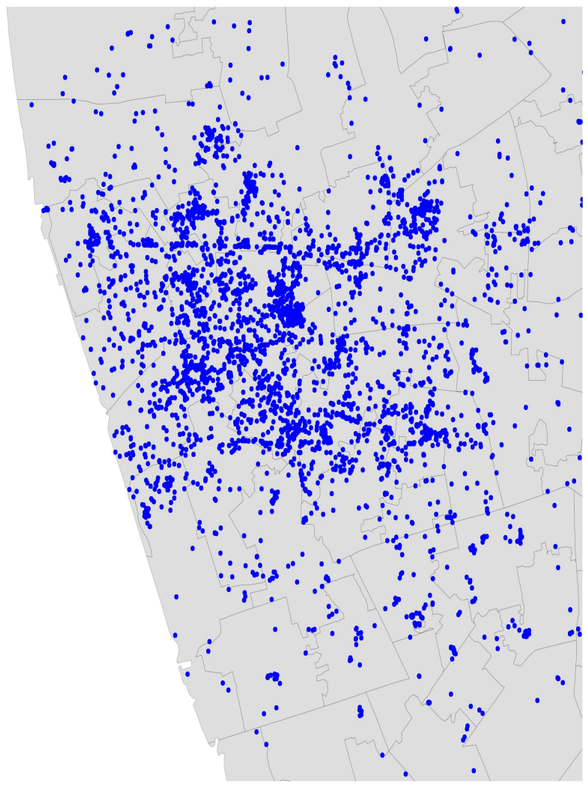
Points meet polygons

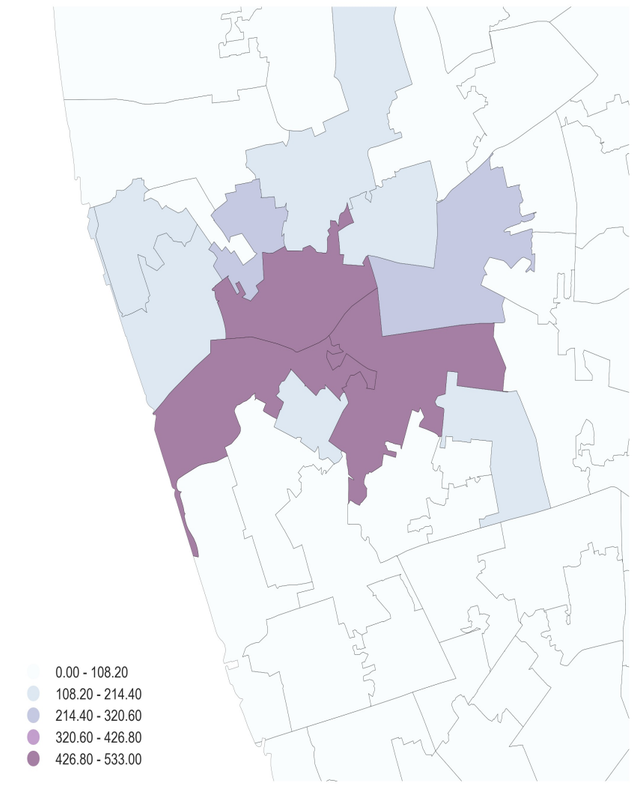
Use **polygon** boundaries and **count** points per area

[Insert your skills for **choropleth mapping** here!!!]

But, the polygons need to *"make sense"* (their delineation needs to relate to the point generating process)






0.00 - 108.20
108.20 - 214.40
214.40 - 320.60
320.60 - 426.80
426.80 - 533.00

Hex-binning

If **no** polygon boundary seems like a **good candidate** for aggregation...

Hex-binning

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...draw a **hexagonal** (or squared) **tesselation**!!!

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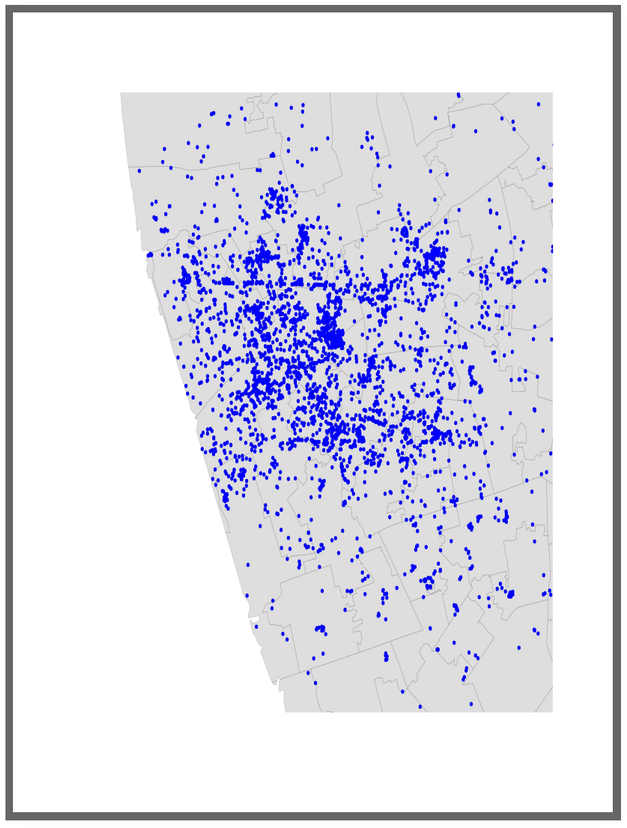
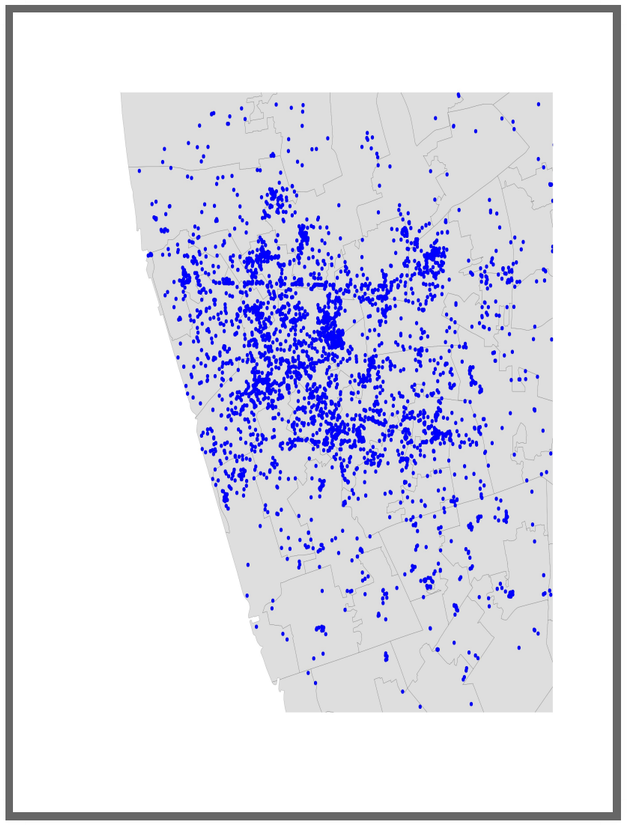
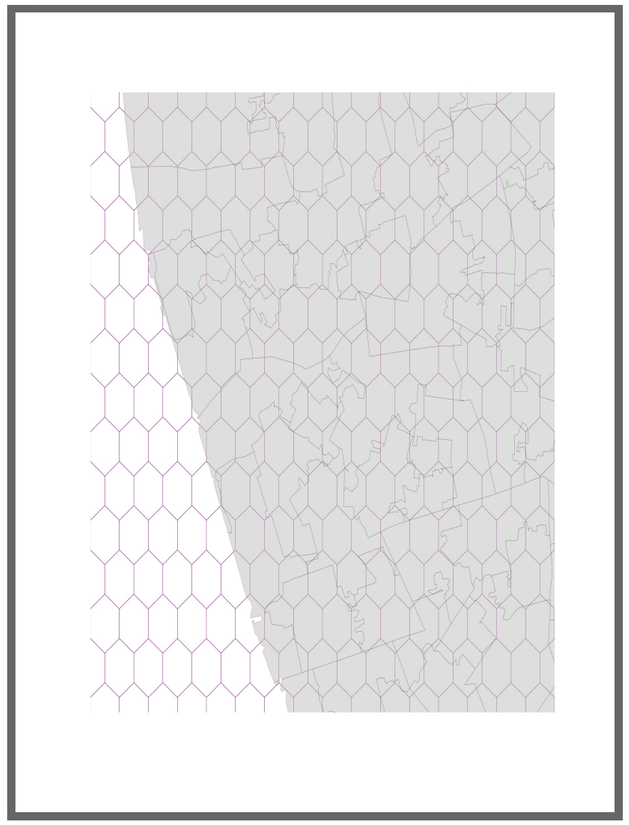
...draw a **hexagonal** (or squared) **tesselation**!!!

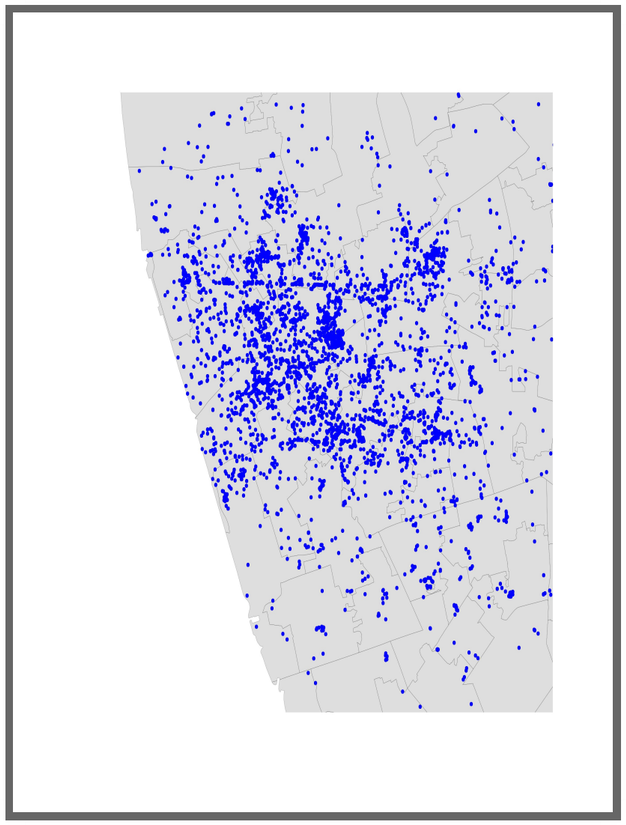
Hexagons...

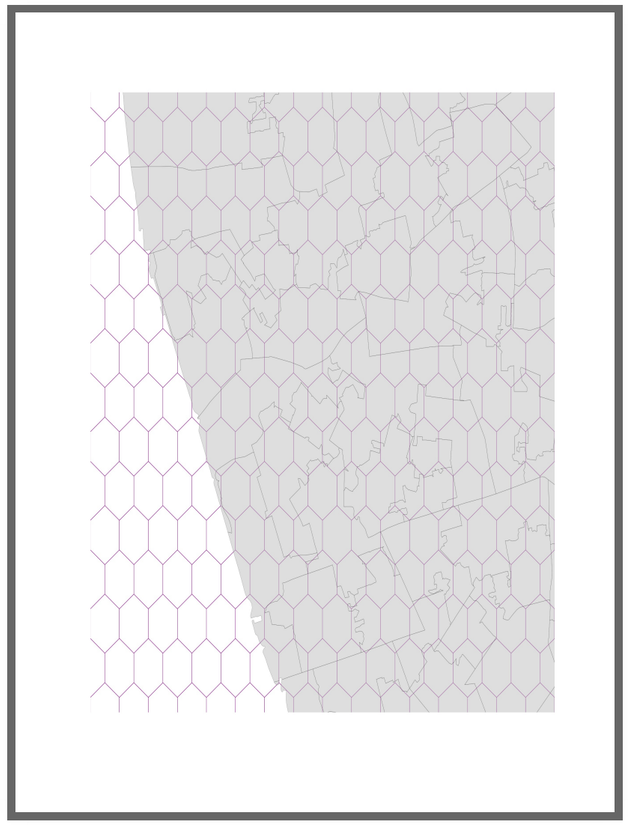
- Are **regular**
- **Exhaust** the space (Unlike circles)
- Have **many sides** (minimize boundary problems)

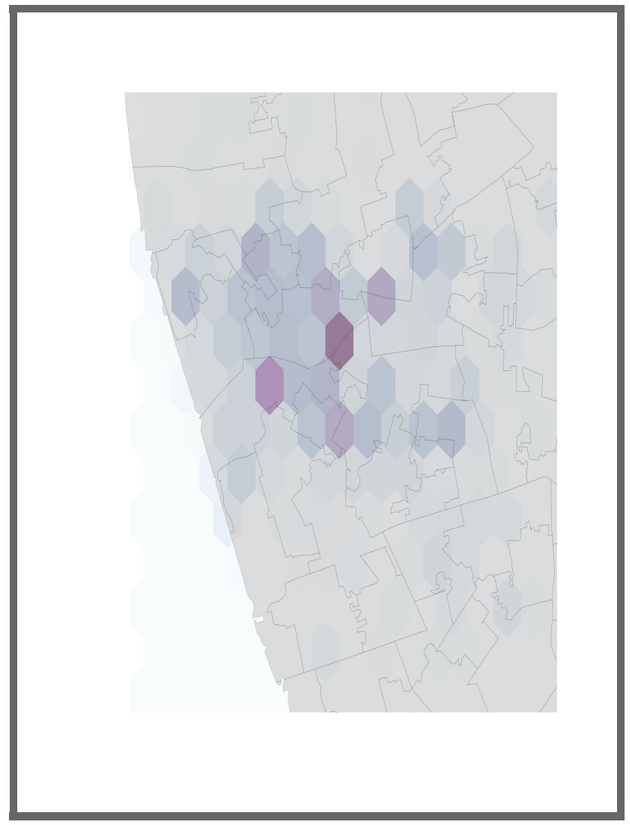












But...

But...

(Arbitrary) aggregation may induce **MAUP** (see Lecture 4)

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+

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(Arbitrary) aggregation may induce **MAUP** (see Lecture 4)

+

Points usually represent events that affect to only **part** of the population and hence are best considered as **rates** (see Lecture 4)

Kernel Density Estimation

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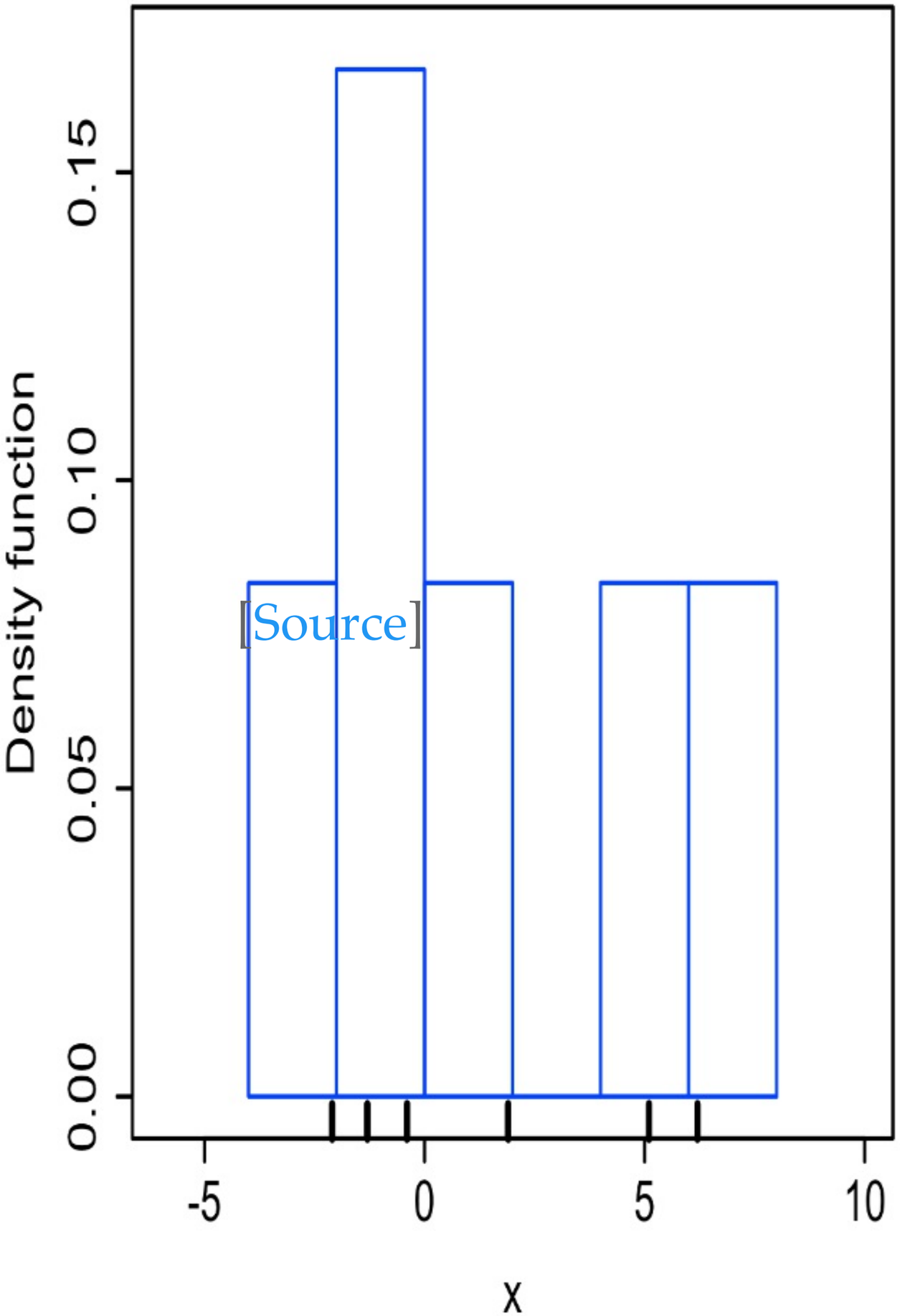
*Estimate the (**continuous**) observed **distribution** of a variable*

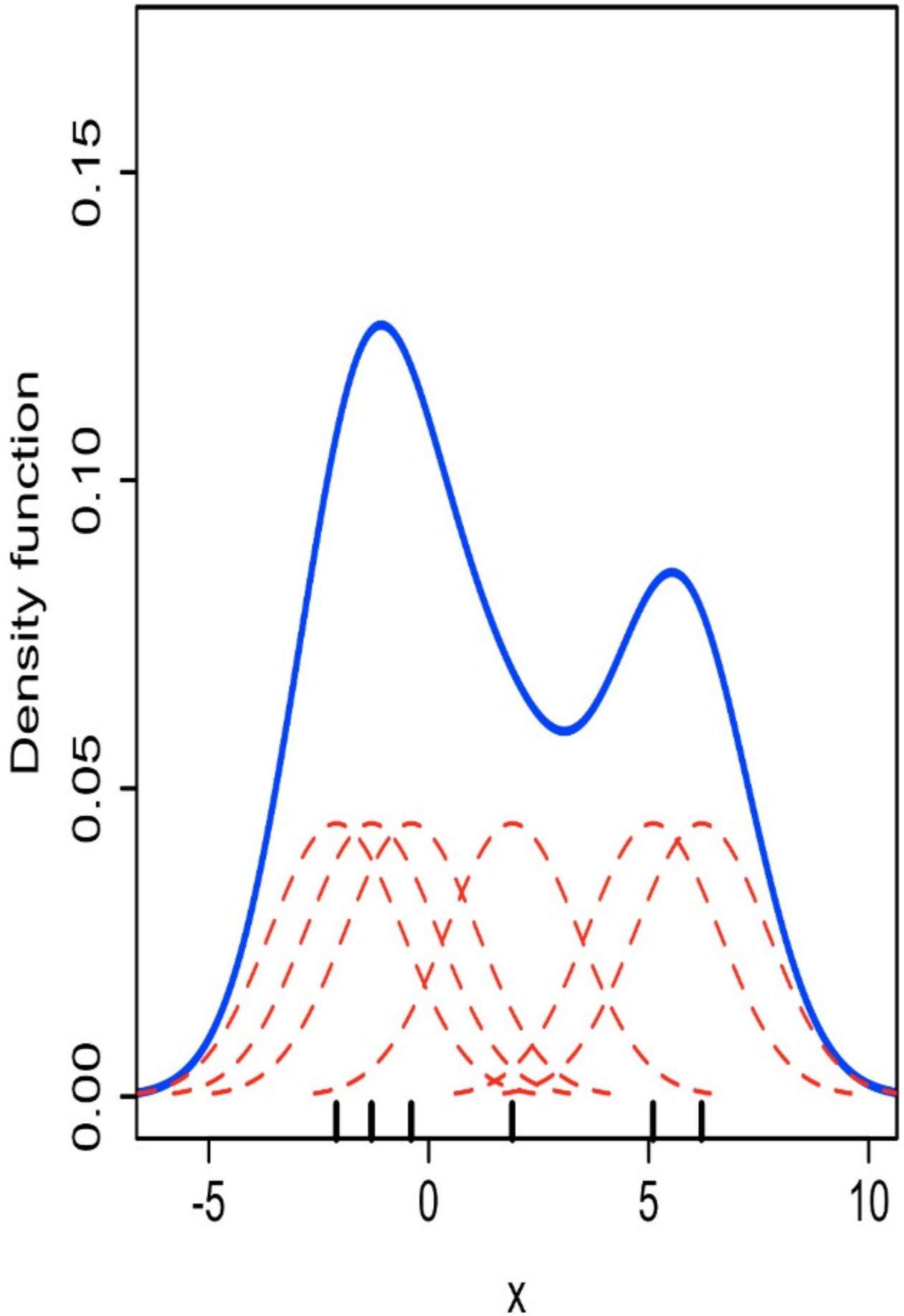
Kernel Density Estimation

*Estimate the (**continuous**) observed **distribution** of a variable*

- Probability of finding an observation at a given point
- "Continuous histogram"
- Solves (much of) the MAUP problem, but not the underlying population issue


Density function
0.00
0.05
0.10
0.15
-5
0
5
10
x

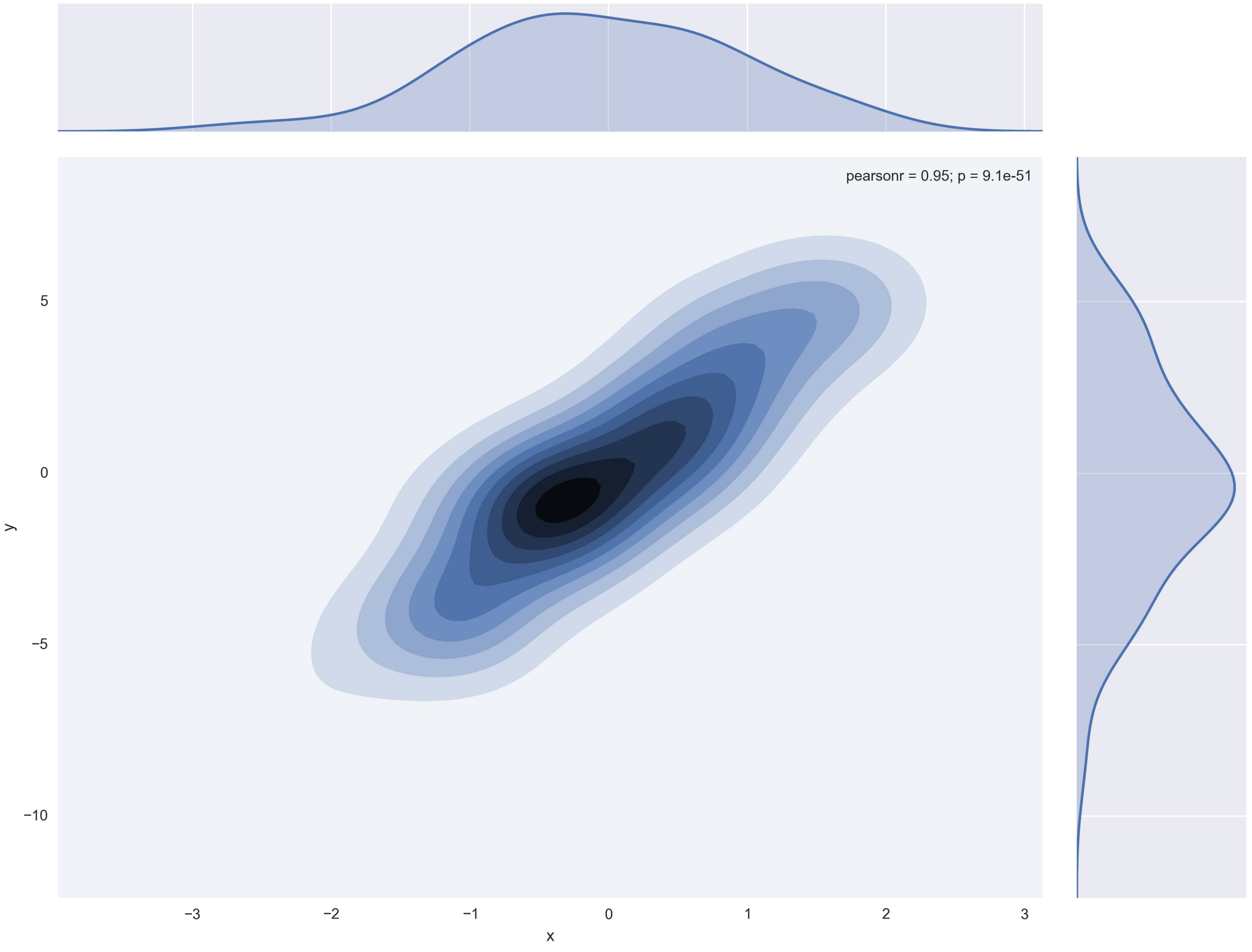
[Source]

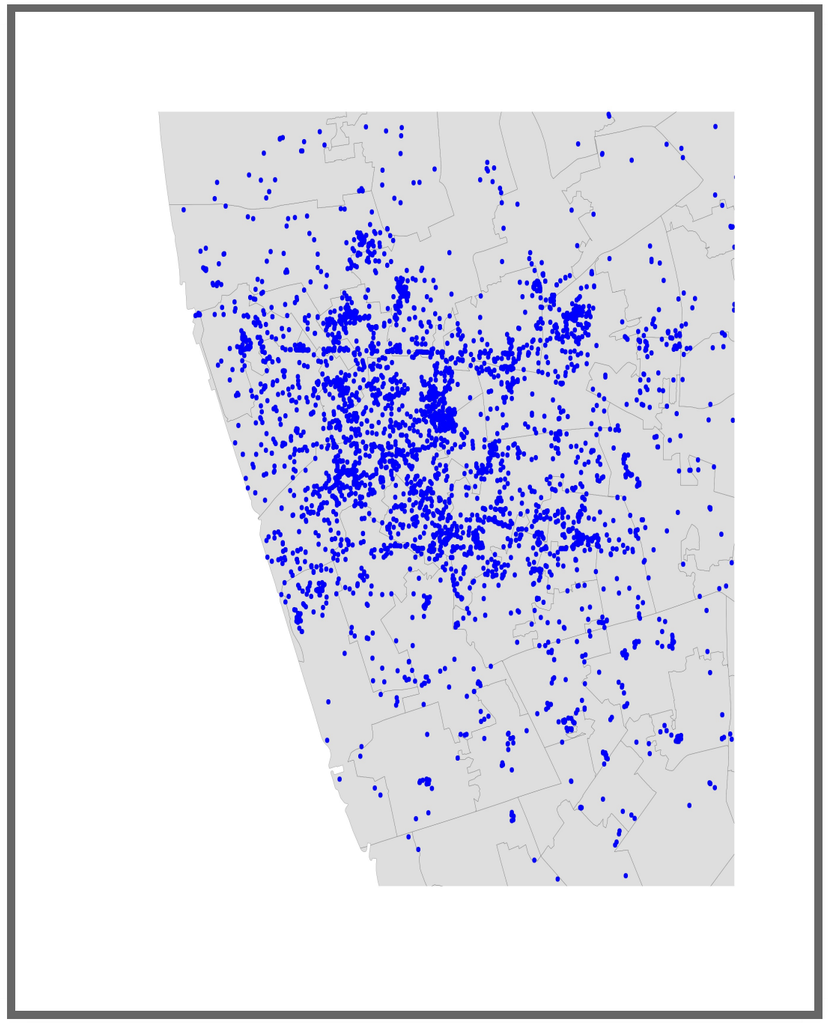

Density function
0.00
0.05
0.10
0.15
-5
0
5
10
x

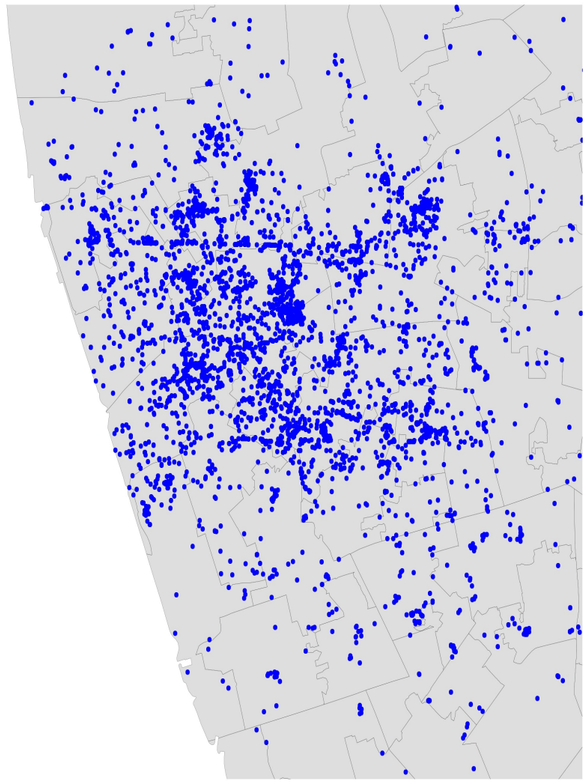
Bivariate (spatial) KDE

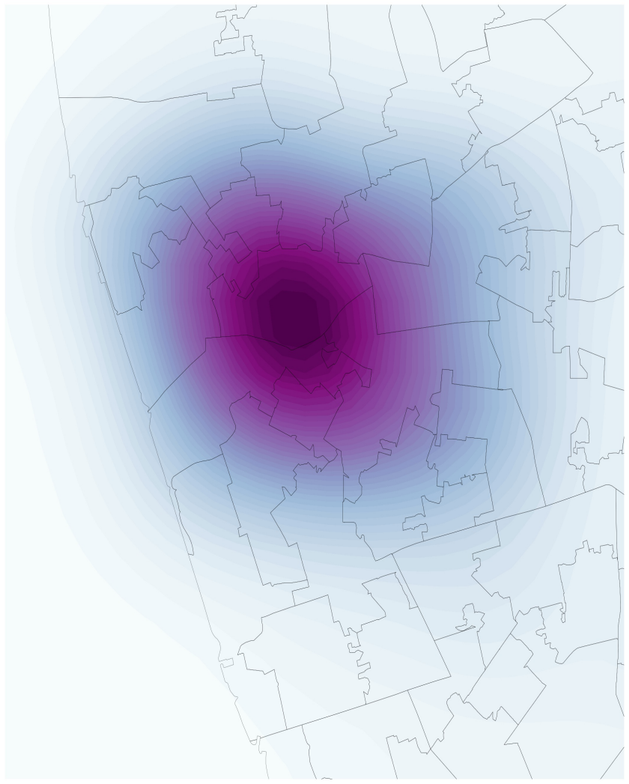
Probability of finding observations at a given point in space

- **Bivariate** version: distribution of **pairs of values**
- In **space**: values are coordinates (XY), locations
- Continuous "version" of a choropleth


pearsonr = 0.95; p = 9.1e-51
5
0
−5
−10
y
−3
−2
−1
0
1
2
3
x







Recapitulation

- **Points** can be understood as a **fixed** or **random** process over space
- If seen as a random, *where* points are located is part of the interest in the (**point pattern**) analysis
- **Visualization** of point patterns can be done through **aggregation** or **smoothing** (but issues relating to the MAUP and underlying populations need to be kept in mind!)