Universität Stuttgart

Institut für Visualisierung und Interaktive Systeme

Assignment 11

Information Visualization & Visual Analytics (WS 2019/20)

Due: Monday, 27.01.2020, 12:00 **Discussion:** Wednesday, 29.01.2020

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Please solve the assignment in **groups of up to three (3) students**. Choose one student who uploads your solution on the assignments page in ILIAS as PDF (for theoretical submissions) or ZIP (for practical submissions Impl). The submitted files should follow the naming scheme `yourlastname1_yourlastname2_yourlastname3` with respective file-ending, of course. Make sure that you create your team before uploading the solution.

Please post general questions regarding the exercise, but *no solutions,* to the forum. In case of more specific problems, especially such that cannot be posed outside of the context of your own solution, please send an email to, or make an appointment with, the tutor responsible for the exercise.

Task 1 Geographical Visualization *[Points: 11]*

(a) *(2 points)* To visualize geographic information on a two-dimensional plane it first needs to be projected. What is the fundamental problem when doing a map projection? According to which map characteristics can map projections be categorized?

(b) *(3 points)* Describe the purpose of *Tissot's indicatrix*. Explain how the indicatrix will look like when it is used with (1) the Mercator projection, and (2) the Cassini projection. Add a sketch to support your descriptions.

(c) *(2 points)* How would the Tissot indicatrices look like for the *Fuller* or *Dymaxion* projection? What does that imply about that projection? Which difficulties do you see with the Fuller projection?

(d) *(2 points)* Which characteristic of the *Mercator projection* led to its broad use up to today and why was this characteristic important? Discuss the importance or relevance of that characteristic for visualization in particular. Are there other, more important characteristics for GeoVis? If so, why?

(e) *(2 points)* Describe the purpose of choropleth maps. List one advantage and one disadvantage for each of the three different classifications *Equal Interval Classification*, *Quantile Classification*, and *Natural breaks classification.*

Task 2 Impl Kernel Density Estimation *[Points: 8]*

Create a plot showing the kernel density estimation for the provided dataset. The dataset is given as a CSV file with the x values in the first column and the y values in the second column. Use a standard Gaussian kernel

$$K(u) = \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{u^2}{2}\right)$$

with a smoothing factor of $h = 5$ and the Euclidean metric

$$\text{dist}(p, q) = \sqrt{(p_x - q_x)^2 + (p_y - q_y)^2}$$

as the distance function. Figure 1 shows the point data and an exemplary solution.

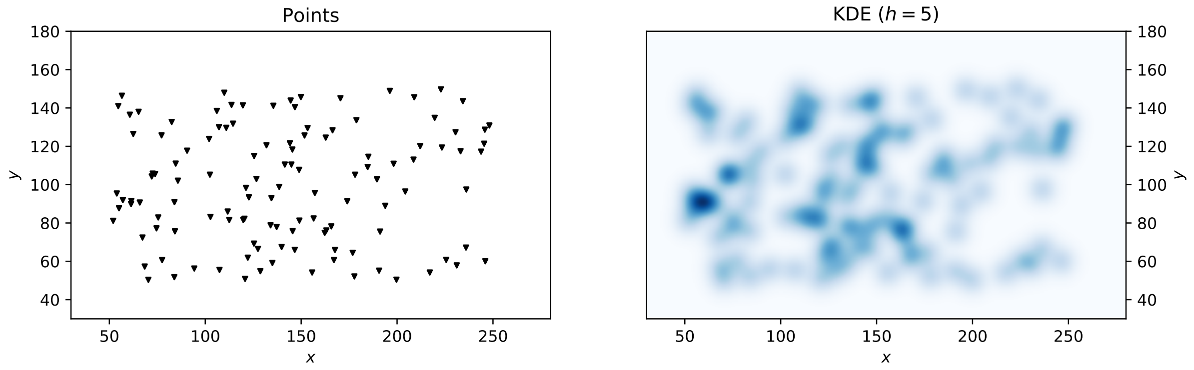

Figure 1: Scatterplot (l) and example result (r) with $h = 5$ for the provided dataset.

For this task, you may use a programming language of your choice. However, you *must* write the code for creating the density estimation data yourself. You may use an external library to show the calculated density estimation. For example (Python), you may use

```
matplotlib.pyplot.imshow(calculated_density, origin='lower')
```

where `calculated_density` is the per-pixel density you calculated in your own code, but not

```
seaborn.kdeplot(xs, ys)
```

where this information is calculated from the point data (`xs`, `ys`) by `seaborn`.

For this task, submit the source code of your program, as well as a screenshot of the resulting visualization. If the language of your choice has no low-level image show/output functionality, you could use the Netpbm P3 format[1] to write your result into an image file. In this very verbose format, image data is stored pixel by pixel.

[1] `https://en.wikipedia.org/wiki/Netpbm_format#PPM_example`