Lesson 8: Raster Data Analysis – Density Surfaces

## INTRODUCTION

In this lesson you will learn about raster data analysis and density surfaces. Map density is defined and explained with examples to further your understanding on this topic. You will learn about converting between vector and raster data and view examples of how this process occurs.

## LESSON OBJECTIVES

By the end of this lesson, you will be able to:

1. Construct data density surfaces from point data using appropriate methods.

2. Convert between vector and raster formats.

3. Develop approach to address questions using density techniques.

## LEARNING SEQUENCE

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| Required Reading | Read the following:  Raster Data Analysis - Density Surface   * Density * Converting Between Vector and Raster |
| Assignments | Complete the following:   * Lab: Raster Data Analysis – Density Surfaces * Quiz: Using Advanced Attribute and Spatial Queries for Data Exploration |

## INSTRUCTION

**Density**

## Mapping Density

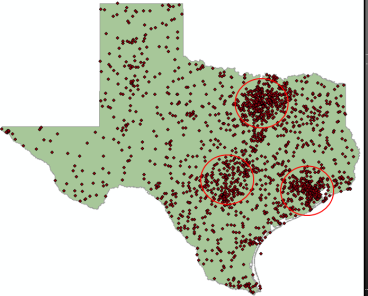
Mapping density allows the user to see where large numbers of observations or higher values occur. Densities show the spatial relationship amongst the different locations of data and also allow us to create predictions from the data as to where other locations or values will occur.

Here are a few examples of why and when density maps would be created.

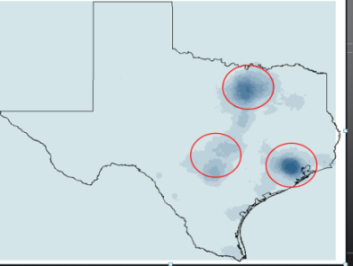
* You would create a density map if you wanted to locate the area with the most or least hospitals which may be an indicator of health care coverage.
* The survey they ask you to do at the store asks your ZIP code, phone number, address, or other things which allow the store to map the density of where their customers are mostly coming from which may allow them to do targeted marketing.
* Mapping population densities can be used to make determinations of where the population lives, where public services may be needed, or where workers are traveling to and from.

## Density Analysis: Point Density

Point density calculates the density of point features across a specific area. It accomplishes this by adding the point to the specified study area and dividing the total by the area of the study area.

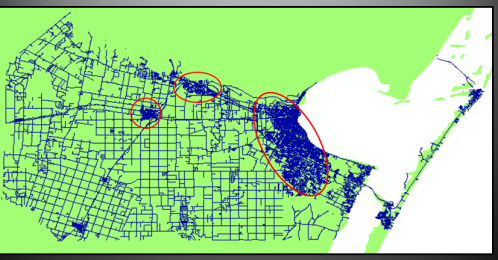


For example, if we consider this data set showing the locations of cities in Texas, we can visually see that there are dense groupings of dots, however, it may be difficult to visually discern which of the three major areas are denser.

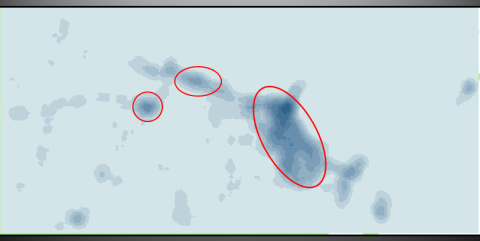
If we run a density analysis, the results assist us in visually determining where the densest areas are located. This density map is derived from the point locations of all the Texas cities, and clearly show that the Houston area as the most concentrated density of cities with the Dallas-Fort Worth area coming second and the Austin/San Antonio area coming third.

## Density Analysis: Line Density

Line density is similar to point density as it calculates the more dense areas versus less dense areas containing line features.



This data set shows all the locations of streets in Nueces County, Texas. Circled in red are what appear to be three most densely paved portions of the county. If we run a line density analysis on the streets, we can get a simpler representation of where the roads are most dense in this county.

This line density raster confirms that the three circles encompass the most densely paved portions of the county. What is interesting to note on this density map, is that it generally shows the connectivity between the different cities in the county and how strong those connections are with regards to roads.

## Density Analysis: Kernel Density

The kernel density function can calculate density of either line or point features using a kernel function. The kernel density function allows some features to hold more weight than other features based on specific values.

For example, when searching for the density of fire hydrants in an area, some hydrants provide more water pressure, thus covering a wider area than others; these fire hydrants will hold more weight than those that have a lower water pressure, when the kernel density function is executed.

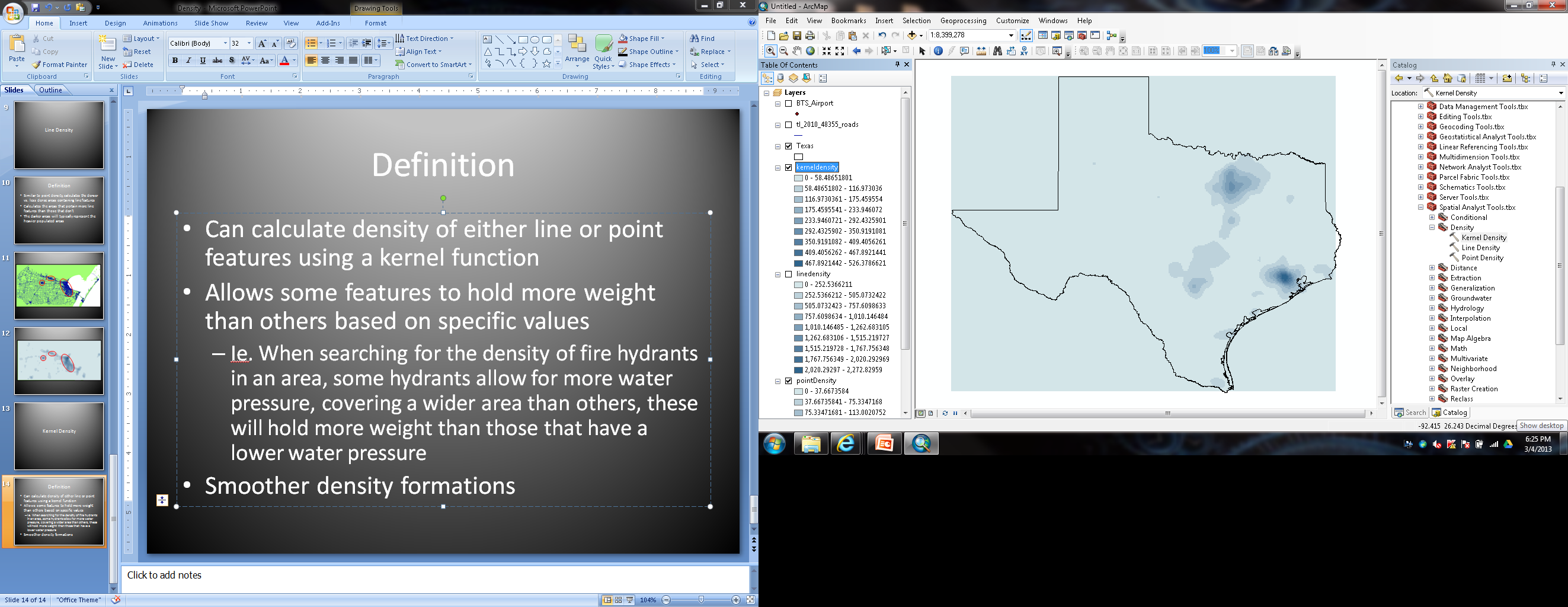
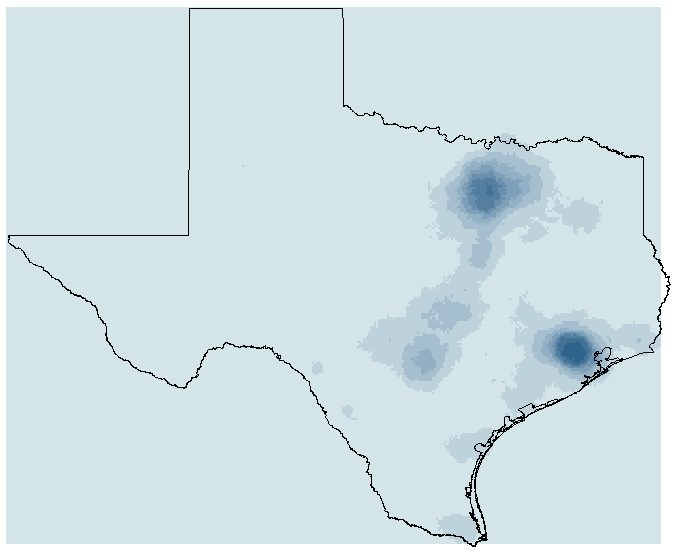
## Differences in Density Functions

There are a few important differences between kernel density and point and line density functions.

* Kernel density tends to create smoother density formations.
* Kernel density can also omit features with no data values, essentially giving them a weight of zero.
* The kernel density function assigns the highest values to the center of the point or line in question and tapers the values down to zero as you move out to the edge of the search radius

To illustrate kernel density and how it produces different results than point density, take a look at the example maps provided. Note that the kernel density function creates a smoother density map as the densities are not as dispersed as seen within the point density map.

**Point Density Kernel Density**



**Converting between Vector and Raster Data**

## Vector to Raster Conversion

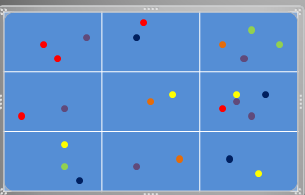
You can convert points, lines, and polygons to rasters. You may want to do this if you wish to allow the user to get a continuous view of the previously discrete data. One major issue to keep in mind in regards to converting vector data to raster data, is that the overall accuracy of the existing data may be degraded due to the logistics of expanding a small point or line to an entire cell or cells. This could create misconceptions regarding where certain areas truly exist.

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| **Key Facts**  Converting between Vector and Raster   * It is possible to convert points, lines, and polygons to rasters. * Conversion allows the user to get a continuous view of the data. * Conversion from vector to raster may degrade the accuracy of the data. |

## Point to Raster Conversion

When converting a point to a raster, if there is more than one point in a cell when creating the raster, the point with the most common value will be selected. If there are multiple points with the same amount of values, the points with the lowest “Feature ID” (FID) will win out. Otherwise, the value of the cell can be determined in an alternate manner of your choosing. Priorities of which point will be set as the raster’s cell value can be set. Points with the highest priority will be selected above all others.

The example provided illustrates converting points to a raster. Note that when there are multiple points in a cell, the cell takes on the value of the points with the most common value. If there is a tie, then the cell’s value will be equal to the point with the lowest FID value.

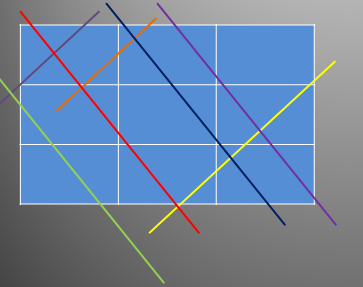
 

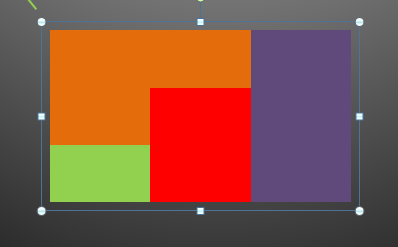


## Lines to Raster Conversion

When converting lines to a raster if there are multiple lines in a cell, the lowest FID will again be selected. If there are priorities, again, the highest priority is selected. A common method of prioritization is to select lines based on the longest length as being the highest priority.

The example provided illustrates converting lines to a raster.



## Polygons to Raster Conversion

You can convert polygons to a raster, however the determination of which polygon’s value to set to the output rasters cell value is a little more complicated. There are three predominant methods of making this determination. The three methods are maximum area, maximum combined area, and cell center.

### Maximum **Area**

The maximum area method chooses the polygon with the highest total area in a cell, provided it covers over 50%”of the total cell area and has no other selection priorities set. If there are multiple polygons with the same area covered, then the polygon with the lowest FID is selected. There are other priorities that you can set, and those priorities always take precedence over area covered.

### Maximum Combined Area

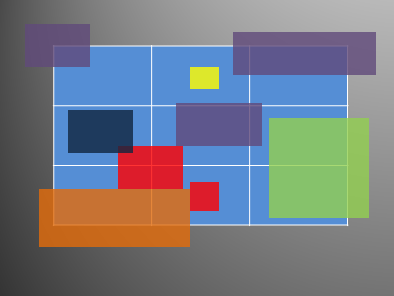
The maximum combined area method considers how much coverage a feature layer has within a cell. This means that, if one feature layer has two polygons inside the cell that cover more than 50%, but neither feature covers more than 50% alone, then neither of the features are selected. If more than one feature has the same size the lowest FID wins. Highest priorities are always selected first, and if the priorities of the same as well in the area with the lowest FID is once again selected.

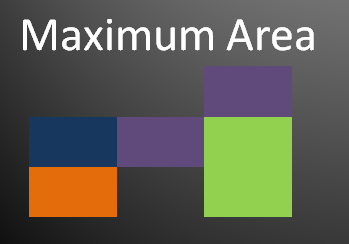
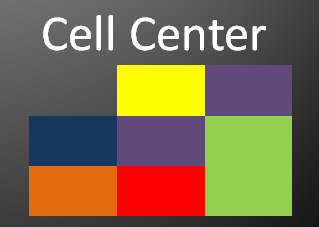
### Cell Center Method

In this method, the polygon that covers the center of the cell is selected as long as no user-set priorities are set to justify. If multiple polygons fall within the center of the cell, the polygon with the lowest FID is selected.

Consider the Input Polygons chart, and its’ associated Entry Table, as well as the methods of Maximum Area and Cell Center images provided. Note that even though the input is the same, choosing “the maximum area method” versus “the cell center method” creates significantly different output rasters.

**Input Polygons Entry Table**

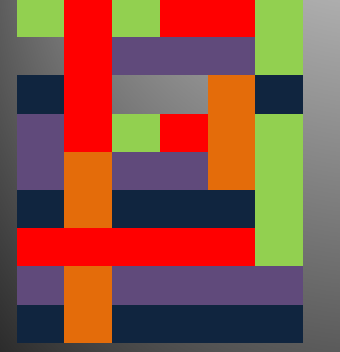
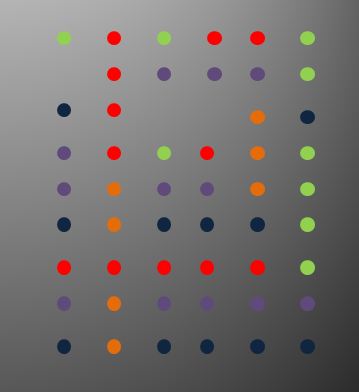
## Raster to Vector Conversion

It is possible to convert a raster to a point, line, or polygon. This allows the user to complete different analysis by having any vector format.

Raster to Point

When converting a raster to points, each individual cell in the raster is used to create a corresponding point. The point will be created at the center of the cell. Any cell size will work for this conversion. Outputted points will contain the value of the cell.

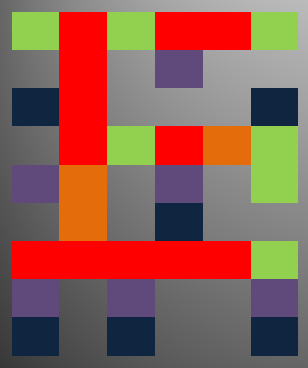
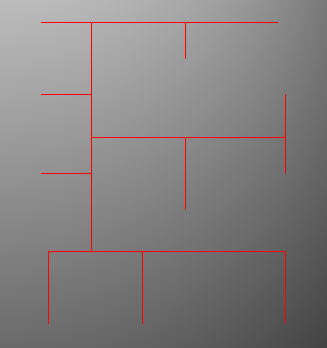
This is an example of a raster converted to a point. Note that each point that has been created maintains the same value of the cell it was derived from, and if a raster cell had no data, there was no point created.

## Raster to Line

When converting a raster to a line, any raster cell that has a value greater than zero will be successfully converted. The outputted lines will pass through the center of the cells. If there are no data values they do not become features.

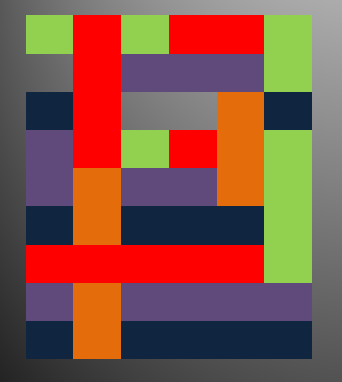
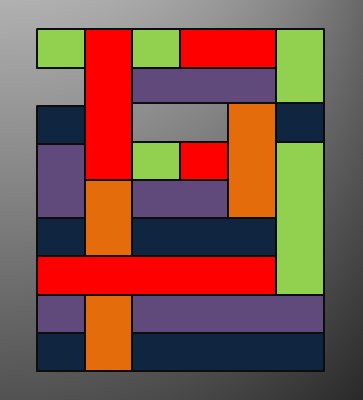
Here is an example of a raster that is the converted to a line. Note that the lines do not exist were cells had a no data value.

## Raster to Polygon

When converting a raster to a polygon, you can choose which attribute from the raster to use in the output feature class. The outputted polygons will be the same size as the inputted cells.

The input raster is on the left, and the outputted polygon is on the right. Again, note that where a cell had no value, no polygon is created. Additionally, note that cells that are adjacent that have the same value are combined to create a larger contiguous polygon.

## SUMMARY

## In this lesson you learned about raster data analysis and density surfaces. You learned why and when density maps would be created with examples to help you understand. Point density, line density, and kernel density were illustrated to show you the difference of each and how they are used. This lesson also explained converting between vector and raster data with images to show the processes. The conversion from polygon to raster was also covered including the three methods which are maximum area, maximum combined area, and cell center. The raster to vector conversion process was also explained with examples to further your knowledge on how this process occurs.

## ASSIGNMENTS

1. Lab: Raster Data Analysis – Density Surfaces

2. Quiz: Using Advanced Attribute and Spatial Queries for Data Exploration