Point Mapping Activity – Mapping Liver Disease Incidence in Northern England

Scenario:

You are working as a GIS analyst for a health board in northern England. You have been asked to help prepare a report on angiosarcoma, a malignant tumor of the blood vessels in the liver. One of the potential risk factors for angiosarcoma is exposure to polyvinyl chloride (PVC), either in gaseous form or dissolved in drinking water. Exposure to PVC is a known occupational risk for factory workers in the plastics industry and appropriate measures are in place to minimise the risks of exposure. However, there is also some suggestion that residents close to a waste incinerator, which has emitted PVC as fumes, may have experienced elevated levels of angiosarcoma over the past 20 years.

A case-control data set has been developed to investigate the extent of this problem, which has drawn together all cases of angiosarcoma diagnosed between 1980-2000, as well as healthy controls of similar age attending health centres over the same period.

The health board is preparing a report on the risks of angiosarcoma and you have been asked to produce a map of disease incidence that will form part of this report. After a review by members of the local health trust, the report will be made available to the general public over the internet.

Data set:

The spatial data available to you consist of three map layers:

- **northeast**: a generalized boundary of your health board area. Note that a small number of cases and controls fall outside this boundary because it has been generalized.
- **Livercases**: locations of individuals diagnosed with angiosarcoma of the liver between 1980 and 2000, geo-coded using residential address at time of diagnosis. These data are subject to confidentiality restrictions that prevent disclosure to the general public.
- **Livercontrols**: healthy controls of similar age to those diagnosed with angiosarcoma, who attended health centres for routine blood pressure testing. As with the angiosarcoma cases, these individuals have been geo-coded using residential address at the time of consultation. As with the case data, this information is subject to confidentiality restrictions that prevent disclosure.
- **Incinerator**: the location of the incinerator that previously emitted PVC fumes.

<u>Note 1</u>: The co-ordinates for this data (as used in the original study) set are all in metres and are not referenced to any geographical projection system. You may find

that this information is useful in planning your cartography for the data set. It is particularly useful to know this if you decide to use the 'point density' function here and wish to interpret its output

Note 2: although the scenario here is fictitious, the data used in this exercise are a public domain data set made available by Dr. Peter Diggle of Lancaster University. The original source data are available here:
http://www.maths.lancs.ac.uk/~diggle/pointpatterns/Datasets/

Task:

Using your knowledge of cartographic principles, produce a map of the local case: control ratio across the study area for inclusion in the health board's report. For your own record, write brief notes on the spatial patterns of angiosarcoma incidence that are apparent in the study area.

Hints:

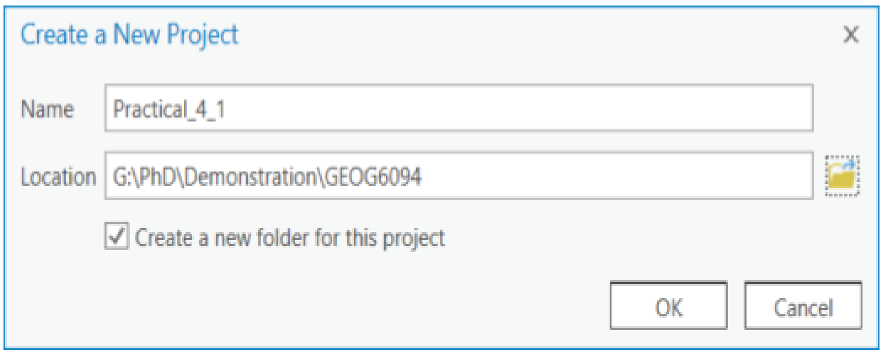
- Try heading for the 'spatial analyst tools' and the 'point density' tool within the 'density' set of tools here (this was a tool that we used with the John Snow data set). To start with, try running the tool on the 'livercases', accepting the default settings for the radius and output grid size (note: you can leave the 'population field' set to 'none'. This would only be used were we to have multiple cases georeferenced to each point, rather than just one, e.g. if we had four cases all referenced to the same point location, we might use a 'population field' that contained such counts). Make a note of the radius setting.
  - Try running 'point density' again on the 'livercontrols', again accepting the default setting for output grid cell size and using the same radius as you did above.
  - Next, try heading for the 'spatial analyst' tools again, select 'math', and then 'trigonometric' and then 'divide'. Now try dividing one of your output density grids by the other – this should give you a local case: control ratio.
  - Instead of using the 'point density' tool, try running the same operation using the 'kernel density' tool within the same 'density' group within the 'spatial analyst' tools. This works in a similar way, except that with 'point density', a point is treated in a binary ('on' / 'off') way, counting towards the local density of cases if it is inside the radius drawn around a given grid point on the map, and not counting if it is outside the radius. With 'kernel density', instead of there being a sudden change with a point being included / excluded as the radius is reached, a kernel allows a point's importance in the density calculation to decline more gradually as its distance from a grid point increases. You should see a smoother output

density as a result.
- Try experimenting with changing the radius setting in the calculation – how does this affect the output density?

Practical Instructions

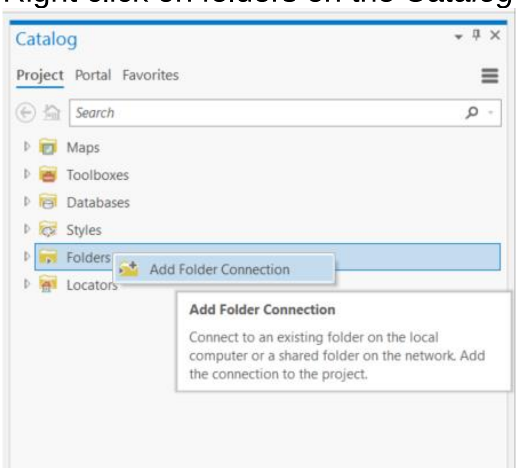
Start ArcGIS Pro and select *"Map"* to get a blank template.

Input your project name and location
Remember to uncheck *"Create a new folder for this project"* if you have your folders already.

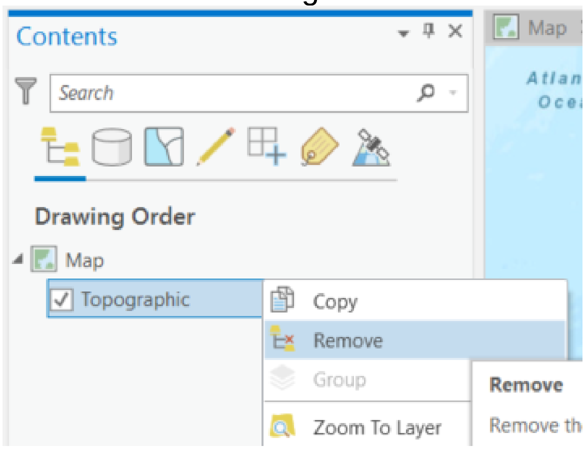


Avoid space in file and project names

Right click on folders on the *Catalogue* pane and select *Add folder connection*

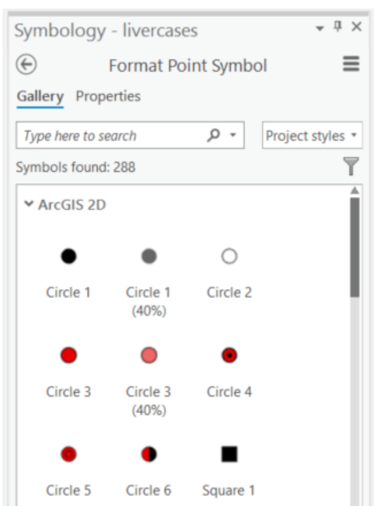


As stated earlier, the data is fictitious so you might want to take off the Topographic map background in the *Contents* pane. You can right click and *Remove* or just uncheck it. If you leave it, you'll realise the points fall somewhere in the sea after adding it.

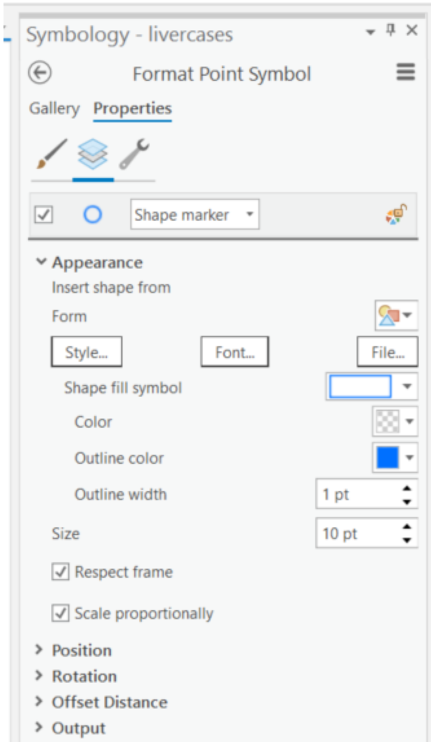


Browse the *Catalogue* pane to the location of your files and add the **Incinerator**, **livercases**. **livercontrols**, and **northeast** to your map canvas by clicking and dragging.

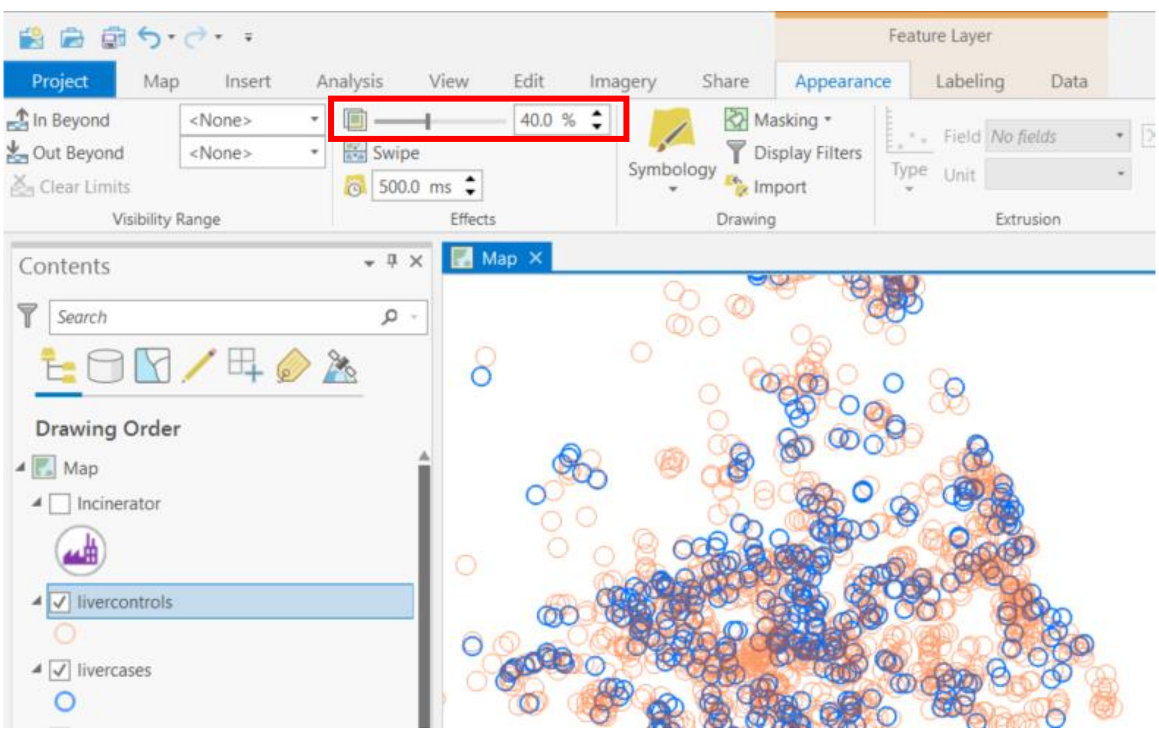
As the points are highly clustered, we can improve how we visualise them. Choose *Circle 2* as marker for both **livercases** and **livercontrols**.



For both layers, change the *Outline color*
Set *Outline width* to 1pt and *Apply* changes

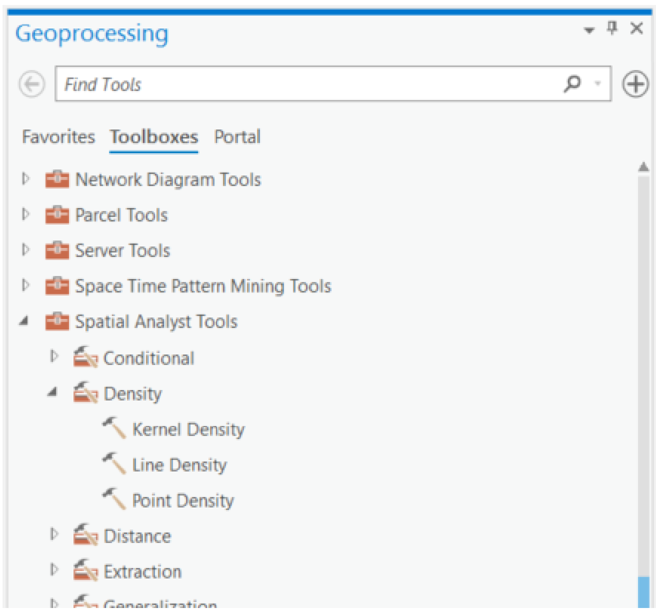


Now, make your topmost layer transparent to improve the visualisation
Select your topmost layer in the *Contents* pane, Go to the *Appearance* menu and set the transparency from the *Effects* section.

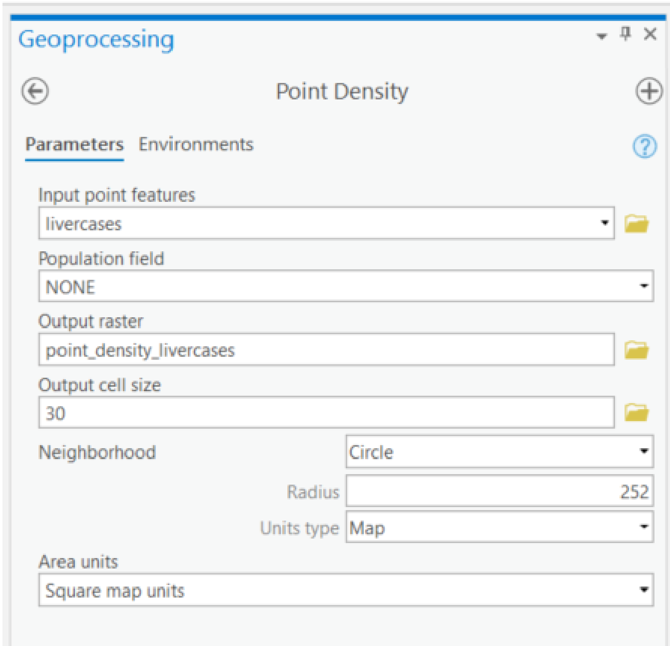


Note that Spatial Analyst is an extension or plug-in to ArcGIS Pro, so you will need to head for the *project* menu, then *licensing*, then *configure your licensing options* button to activate this extension for use, if not already activated. Otherwise, you may see error messages when running the tools below.

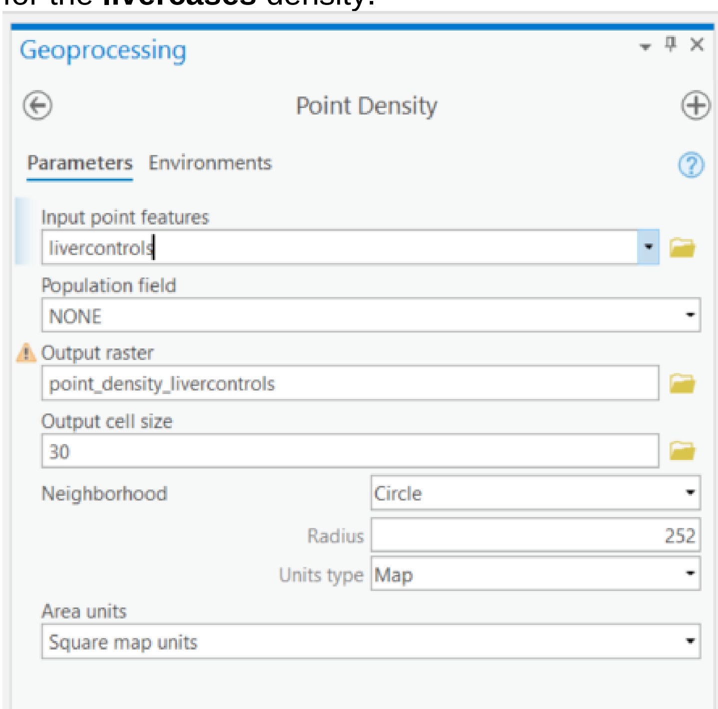
Go to the *geoprocessing toolbox* / *Spatial Analyst Tools* / *Point Density*



In the *Point Density* tool, select **livercases** as Input point features,
Choose an appropriate name and output location for your result,
Accept the default *Output cell size* and *Radius* (Note down these numbers for the next process)



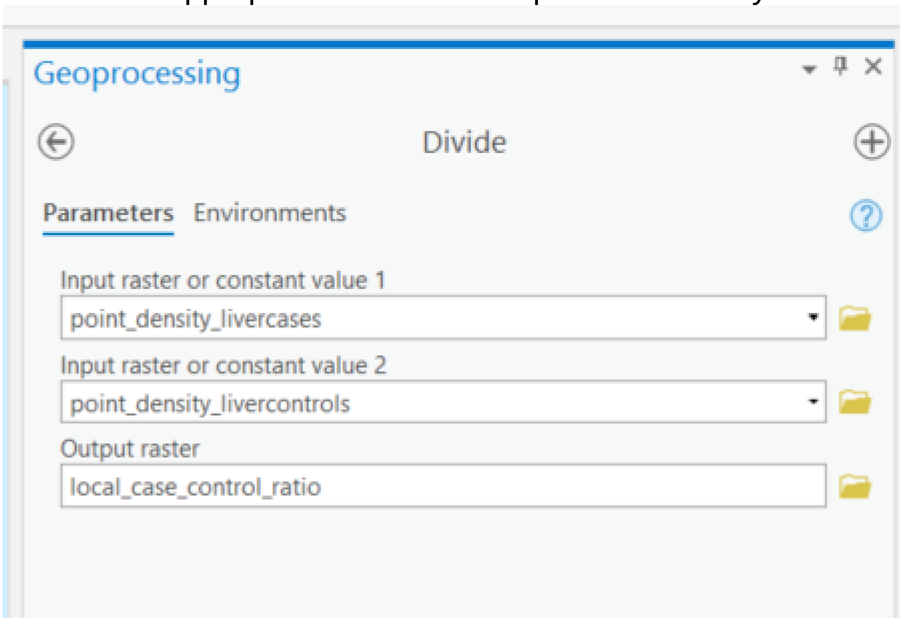
Run *Point Density* on **livercontrols** with same *Output cell size* and *Radius* used for the **livercases** density.

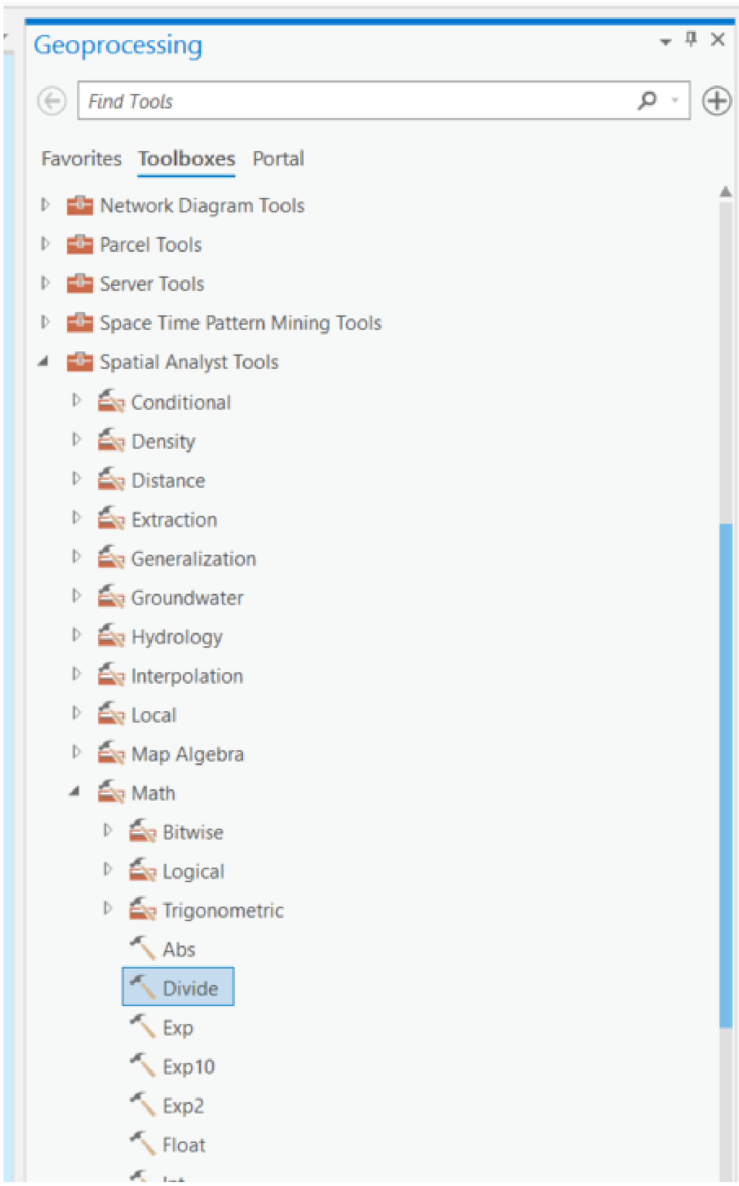


Now, we will try and estimate the local case-control ratio. We can do this by dividing the cases by controls. From our results above, we have two point density rasters, one for cases and the other for controls. These can be used to estimate the local case control.

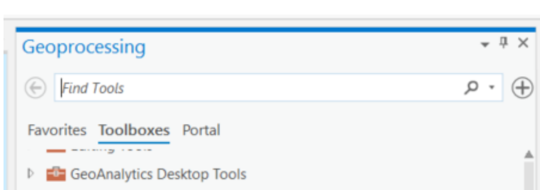
Go to the *geoprocessing toolbox* / *Spatial Analyst Tools* / *Math* / *Trigonometry* / *Divide*.

Select your **livercases** point density result as the first *input raster* and the **livercontrols** point density as the second *input raster*.
Choose an appropriate name and output location for your result and run the tool



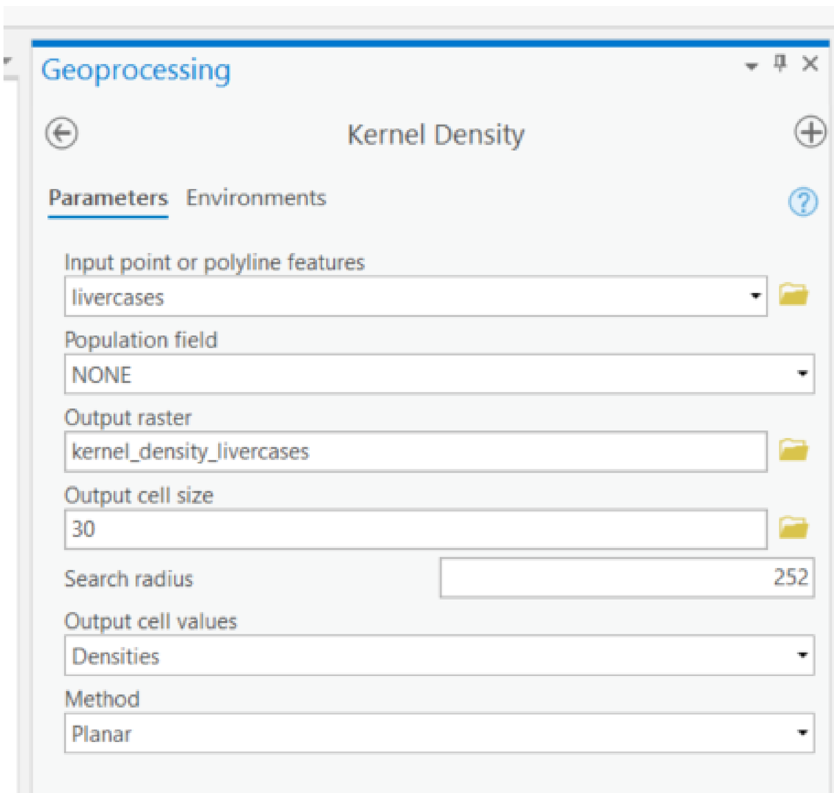


If you know the name of a geoprocessing tool, you can easily find them by searching. Try searching for a tool

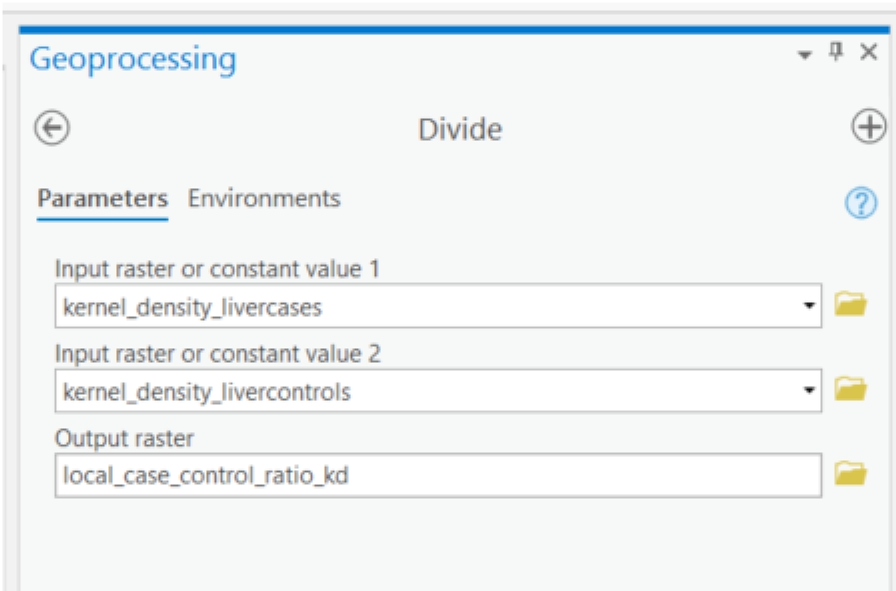


Among the Density set of tools where we selected *Point Density*, run the *Kernel Density tool* on the cases and controls and compare the results with the Point Density output.

Select **livercases** as *input point* feature in the *Kernel Density* tool.
Choose an appropriate name and output location for your result and run the tool
Specify similar *Output Cell Size* and *Radius* as used in the *Point Density* tool.
Leave all other default settings and *run* the tool.



You can divide the Kernel Density results to estimate the local Kernel Density case control ratio.


Geoprocessing
Divide
Parameters
Environments
Input raster or constant value 1
kernel_density_livercases
Input raster or constant value 2
kernel_density_livercontrols
Output raster
local_case_control_ratio_kd