

Introduction to GIS

Lab02 GIS Visualization Exercise 1 – Field Calculation in ArcGIS

Objectives of this exercise:

To learn how to create and calculate a new field and calculate geometry in a table with ArcGIS Pro

- Create a new field
- Calculate geometry
- Calculate field

To complete exercises, you need the following:

- ArcGIS Pro 3.3.1 (Basic, Standard, or Advanced)

The data needed for this exercise are under the folder Lab 02, named as Lab02Data.zip (download and unzip it to your own folder).

Exercise 1 Demonstration Video:

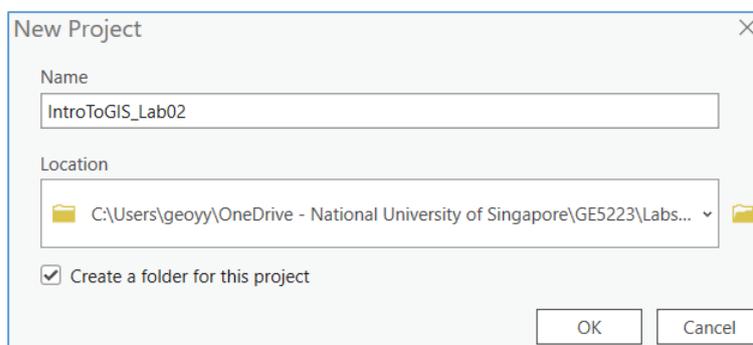
<https://mediaweb.ap.panopto.com/Panopto/Pages/Viewer.aspx?id=d37ce87c-8349-472c-a870-ae85001c20ec>

Create a new ArcGIS project

1. Start ArcGIS Pro and sign in if necessary.
2. On the start page, under **Blank Templates**, click **Map**. The Map template creates a new project containing a 2D map.



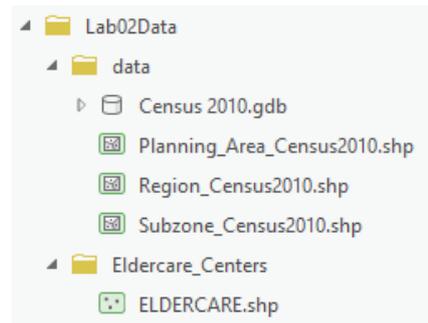
3. For the **New Project** dialog box, by default, projects are created in your <User Documents>\ArcGIS\Projects folder. To save a project to a different location, click the **Browse** button  and browse to the folder you want. Name the project **IntroToGIS_Lab02**.



4. Click **OK**. The new project opens with a map view showing a topographic basemap centred on Singapore.

Create a folder connection and add data

- In the **Catalog** pane, right-click **Folders** and choose **Add Folder Connection**. Create a folder connection to ...\\Lab02Data (the folder that contains the data for this lab). Expand folders and see what data we have.
- Add the files by dragging them to the map one by one:



Region_Census2010.shp,
Planning_Area_Census2010.shp
Subzone_Census2010

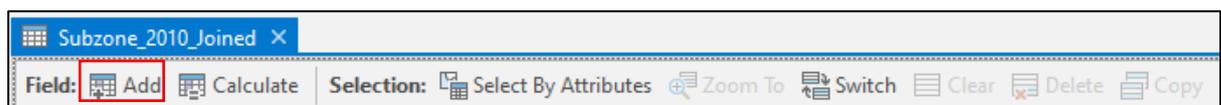
- Open the attribute table. In the **Contents** pane, right-click **Subzone_Census2010** and choose **Attribute Table**. Now you will see the attributes of features in **Subzone_Census2010**.

FID	Shape	OBJECTID	SUBZONE_NO	SUBZONE_N	SUBZONE_C	CA_IND	PLN_AREA_N	PLN_AREA_C	REGION_N	REGION_C	INC_CRC	FMEL_UPD_D	X_ADDR	Y_ADDR
0	Polygon	1	7	MAXWELL	DTSZ07	Y	DOWNTOWN CORE	DT	CENTRAL REGION	CR	5E387679E895F858	5/2/2014	29392.0489	29096.7515
1	Polygon	2	1	TANGLIN	ORSZ01	Y	ORCHARD	OR	CENTRAL REGION	CR	3ECC289D55537C009	5/2/2014	27182.8757	31905.7324
2	Polygon	3	2	BOULEVARD	ORSZ02	Y	ORCHARD	OR	CENTRAL REGION	CR	0937E2A5F34A1C53	5/2/2014	27916.9271	31967.0064
3	Polygon	4	3	SOMERSET	ORSZ03	Y	ORCHARD	OR	CENTRAL REGION	CR	1C1A038CE13A8B1	5/2/2014	28626.561	31494.9048
4	Polygon	5	3	PASIR RIS TOWN	PRSZ03	N	PASIR RIS	PR	EAST REGION	ER	37EAB455CA79089	5/2/2014	40755.8307	39341.7432
5	Polygon	6	2	MACPHERSON	GLSZ02	N	GEYLANG	GL	CENTRAL REGION	CR	732CC6D2DCC784CF	5/2/2014	33774.3483	34399.1614
6	Polygon	7	5	GEYLANG EAST	GLSZ05	N	GEYLANG	GL	CENTRAL REGION	CR	84A21DC728A53558	5/2/2014	35237.5581	33246.2579
7	Polygon	8	4	ALJUNIED	GLSZ04	N	GEYLANG	GL	CENTRAL REGION	CR	EAA2A236E41806C7	5/2/2014	33595.4531	32968.2268
8	Polygon	9	1	KALLANG WAY	GLSZ01	N	GEYLANG	GL	CENTRAL REGION	CR	B84D516ABCD68C9C	5/2/2014	32763.7117	34222.9932
9	Polygon	10	6	DEFU INDUSTRIAL P.	HSSZ06	N	HOUGANG	HG	NORTH-EAST REGION	NER	12D3314286C3A2DD	5/2/2014	34951.8462	37091.0827
10	Polygon	11	3	ROSYTH	HSSZ03	N	HOUGANG	HG	NORTH-EAST REGION	NER	A460D289939CAEE	5/2/2014	33270.6051	38329.6721
11	Polygon	12	4	LORONG AH SOD	HSSZ04	N	HOUGANG	HG	NORTH-EAST REGION	NER	214318D7AF76953A	5/2/2014	33933.1155	37657.886
12	Polygon	13	2	TRAFALGAR	HSSZ02	N	HOUGANG	HG	NORTH-EAST REGION	NER	58F81E95E815CC39	5/2/2014	33566.6192	39977.9867

- Take a few minutes to explore the attributes of the above three layers. After that, close all attribute tables.

Create a new field in the attribute table

- In the **Catalog** pane, drag the **Subzone_2010_Joined** file under **Census 2010.gdb** to the map.
- In the **Contents** pane, right-click **Subzone_2010_Joined** and choose **Attribute Table**. Now the **Attribute Table** is opened.
- On the **Attribute Table**, click **Add** , we can define the name and data type of the new field.



- Type in **Pop_Den_New** (representing the population density) as the **Name** and **Alias** and choose **Double** as the **Data Type**. Choose **Numeric** as the **Number Format** (keep the default settings unchanged).

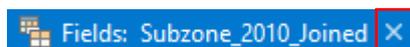
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Pop_Den_New	Pop_Den_New	Double	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Numeric
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13. In the **Fields** tab on the ribbon, click  to save the newly created field.

14. In the **Fields** tab on the ribbon, click  to create another new field with the **Name** and **Alias** of *Area_SQKM_New*, and the **Data type** of *Double*.

15. Click  to save the newly created field.

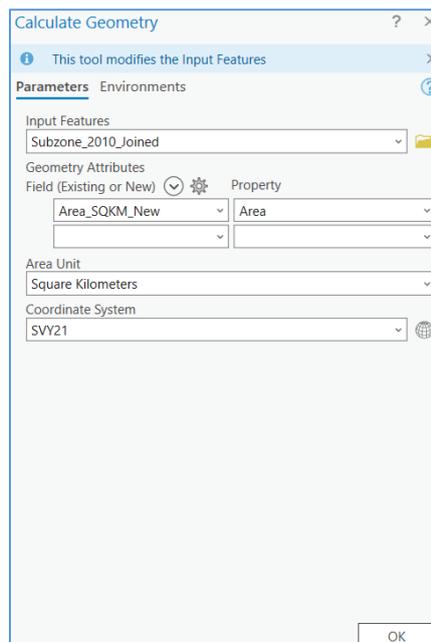
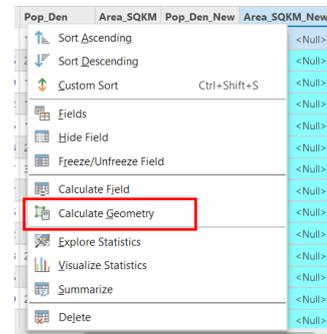
16. Click × to close the dialog box of adding field.



Calculate the geometry of features

17. Return to the Subzone_2010_Joined attribute table. Right-click the newly created field *Area_SQKM_New*, and choose **Calculate Geometry**. You will see that the **Calculate Geometry** dialog box opens.

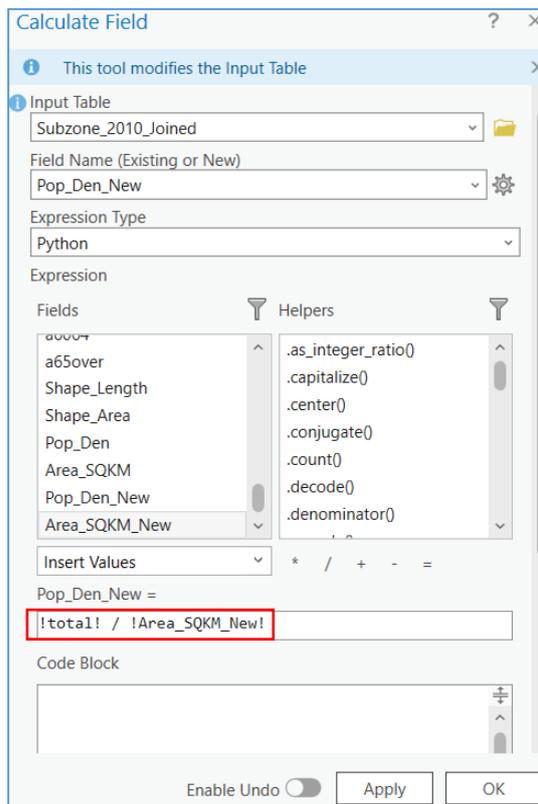
18. In the **Field (Existing or New)** drop-down list, *Area_SQKM_New* is selected automatically. From the **Property** drop-down list, choose **Area**. From the **Area Unit** drop-down list, choose **Square Kilometers**. In the **Coordinate System** box, select **Current Map [Map]** from the dropdown list, and then the Projected Coordinate System for Singapore, SVY21 will be selected automatically. You will revisit the concept of Coordinate Reference Systems in the subsequent lectures and labs.



19. Click OK. you will see that the area is calculated in square kilometres for each row.

Calculate field

20. In the **attribute table**, right-click the newly created field **Pop_Den_New**, and choose **Calculate Field**.
21. In the **Calculate Field** dialog box, type in (or by double clicking the **fields** and **operation signs**) the expression below:
!total! / !Area_SQKM_New!
22. Click **Apply**. And you will see the **Pop_Den_New** field is calculated automatically. Once the **Pop_Den_New** Field has been calculated, press “OK” to close the dialog box.
23. Save your project as **IntroToGIS_Lab02_Exercise01**.



Pop_Den_New	Area_SQKM_New
13765.440178	1.511612
23784.847497	1.263409
12616.497974	2.580431
14901.343549	2.945506
11805.897166	1.953939
22850.464461	1.507934
31207.541485	3.07368

Introduction to GIS

Lab02 GIS Visualization Exercise 2 – Choropleth Mapping

Objectives of this exercise:

- To learn how to design thematic maps using ArcGIS Pro

To complete exercises, you need the following:

- ArcGIS Pro 3.3.1 (Basic, Standard, or Advanced)

The data needed for this exercise are under the folder Lab 02

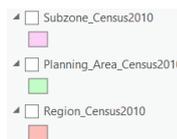
Exercise 2 Demonstration Video:

<https://mediaweb.ap.panopto.com/Panopto/Pages/Viewer.aspx?id=7ff37617-b1bd-4c98-93d4-ae9a008834df>

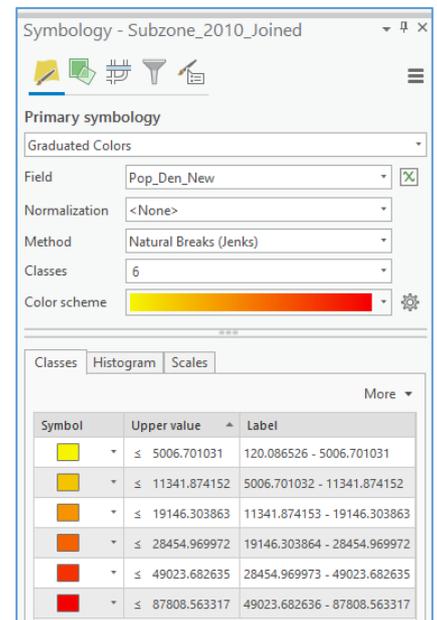
In **Exercise 01**, you have calculated the population density of different subzones of Singapore in 2010, which is the basis of choropleth mapping. Open **IntroToGIS_Lab02_Exercise01.aprx** and then save the project as **IntroToGIS_Lab02_Exercise02**.

Set the parameters for choropleth mapping

- In the **Contents** pane, right-click on the **Subzone_2010_Joined**, and choose **Symbology**. Now you should see the **Symbology** pane on the right.
- In the **Symbology** pane, under **Primary Symbology**  tab, in the **Primary symbology** drop-down list, choose **Graduated Colors**.
- Regarding **Field**, choose **Pop_Den_New** as the value.
- Regarding the classification **Method**, use the default **Natural Breaks (Jenks)**.
- Choose **6** as the number of **Classes**
- In the **Color scheme** drop-down list, click **Show name** box and choose **Yellow to Red** color.
- Turn off the following layers by unticking the boxes on the left side of the layer names.
 - Subzone_Census2010
 - Planning_Area_Census2010
 - Region_Census2010

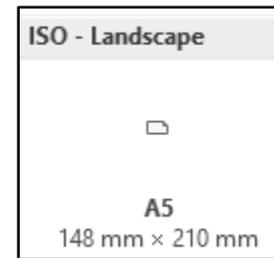


 Think about how to reduce the number of decimal places on the Label.



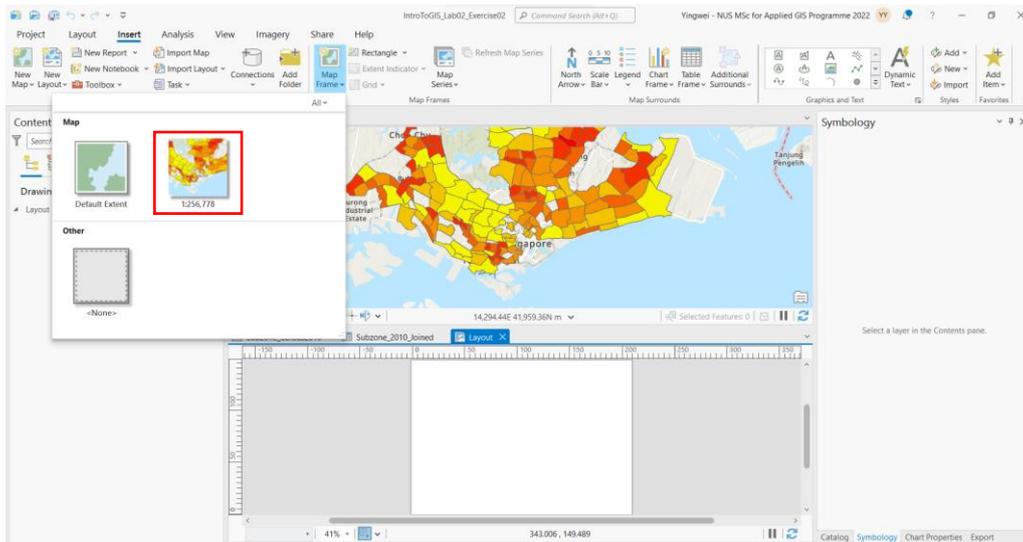
Insert a layout

- On the ribbon, click the **Insert** tab. In the **Project** group, click **New Layout** to show page size and orientation options. Choose **ISO – Landscape A5 148 × 210 mm**. A blank layout appears in the map area.



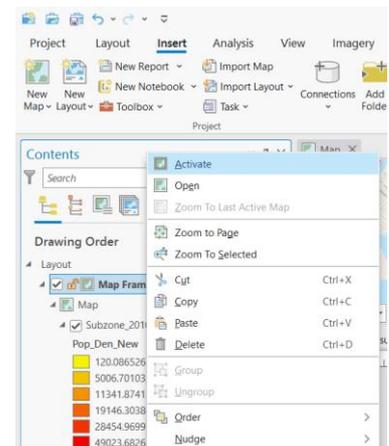
Insert a map frame

- Under the **Insert** tab, Click **Map Frame** button. Choose **Map** → 1: 256,778 (the ratio may be different).



- Click your mouse at any location on the blank layout. And you will see a map falls on the blank layout. Now you can adjust the size of the map and move it in the layout.

- In the **Contents** pane, right click **Map Frame** under the tab of **Layout**, and choose **Activate**.



- On the ribbon, under the **Map** tab, ensure the **Explore** tool  is active. Pan and zoom the map to an extent that you would like.

- On the ribbon, in the **Layout** tab, click the **Close Activation**  button. Now you will return to **Layout** editing mode.



Insert map elements

Next, we will add map elements including a **legend**, a **north arrow**, a **title**, and a **scale bar** to the layout. The legend explains the map's symbology. The north arrow indicates the direction of north. The scale bar provides a visual indication of the size of features. The title describes the main contents of the map.

14. Insert the **title**. On the ribbon, under the **Insert** tab, in the **Graphics and Text** group, find **Rectangle text** , and choose the **Rectangle text** .



15. Click your mouse at the top on the blank layout, you will see the text box. In the text box, type in the title of your own map (e.g., **Singapore Population Density Map**). Right-click the text box and select **Properties**. Now the font name and font size can be modified in the **Text** pane on the right.

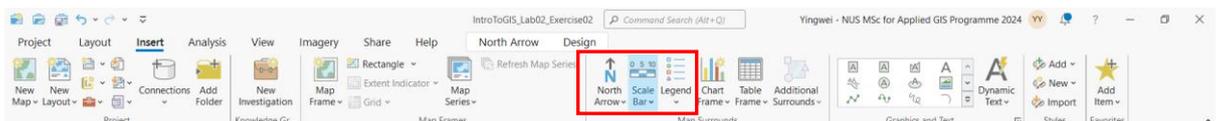
16. Insert the **legend**. On the ribbon, under the **Insert** tab, in the **Map Surrounds** group, click **Legend** .  Think about how to change the field name in the legend from **Pop_Den_New** to one that is more readable.

17. Click your mouse at any location in the mapping area. Resize the legend and move it to a suitable place in the layout. The properties of the legend can be modified in the **Legend** pane on the right (can be opened by right-clicking the legend and selecting **Properties**).

18. In the **Contents** pane, under **Layout** → **Legend**, ensure that you have unchecked the boxes of all layers except the **Subzone_2010_Joined** layer. In the **Legend** pane on the right, click on **Legend Items** → **Show properties**, the [multiple items] pane appears, and uncheck the **Layer name** box.

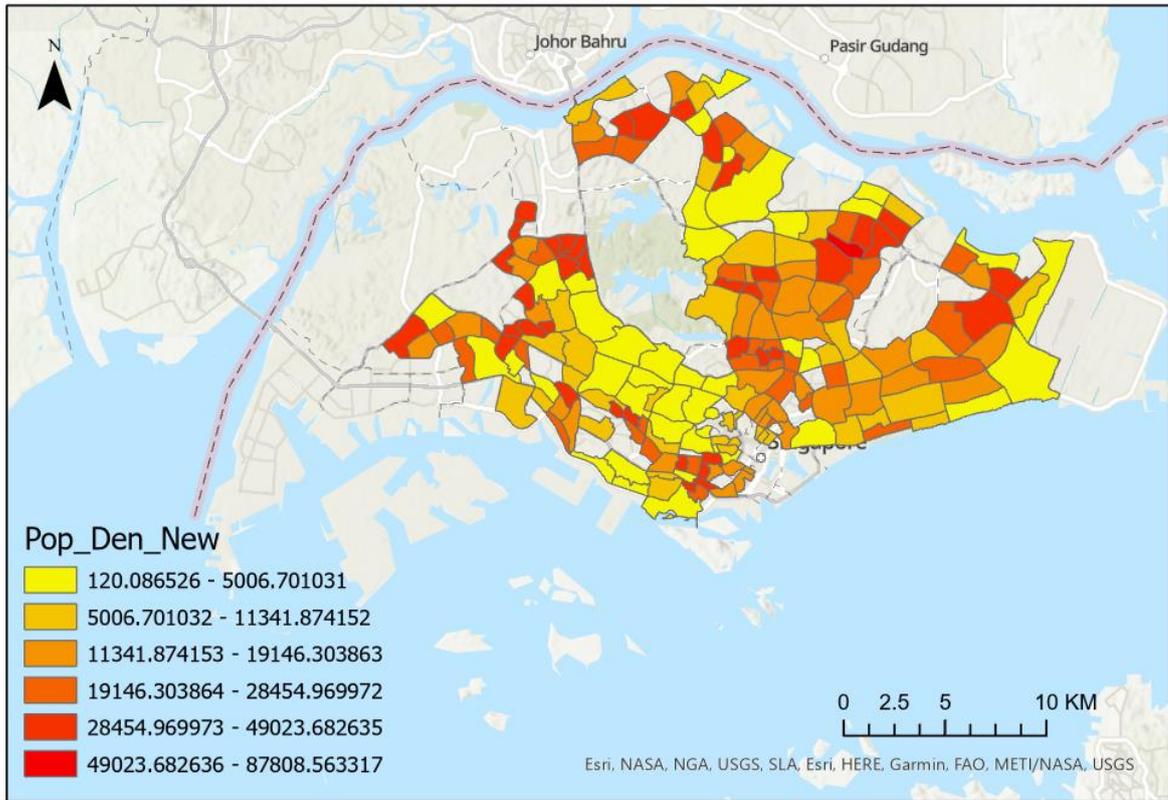
19. Insert the **North Arrow**. On the ribbon, under the **Insert** tab, in the **Map Surrounds** group, click **North Arrow** .

20. Insert the **Scale Bar**. On the ribbon, under the **Insert** tab, in the **Map Surrounds** group, click **Scale Bar** .



21. After the scale bar has been inserted, right-click the scale bar and select **Properties**. In the **Scale Bar** pane on the right, change the **Map Units** from **Miles** to **Kilometers** (if not in Kilometers), abbreviated to **KM** in the **Label Text**. Resize the length of the scale bar to 10 KM. You will see the layout as follows.

Singapore Population Density Map



Export the layout

Once the layout is finished, we can print it or export it to a file. The export file would generally have higher quality than the screenshot.

22. On the ribbon, click the **Share** tab. In the **Output** group, click **Export Layout** → The **Export Layout** pane appears.
23. Click the **File Type** drop-down menu and choose **JPEG (*.jpg)**.
24. Browse to the location where you want to save the file and type in a name you like in the **Name** box.
25. Set the **Resolution** as **300 DPI**. It is common that published papers require the resolution of colour figures at least 300 DPI.
26. Click the **Export** button. The layout is saved on the disk and you can open it now.

Q-1 Continuing from the steps above, please design a professional (with appropriate and necessary map elements) and aesthetically pleasing choropleth map. Export the map to a Tiff file (300 dpi) and insert the map into your Word document (3 marks). In addition, please identify the subzone with the lowest population density and provide its name and value (1 mark).

(Notes: A page layout (often referred to simply as a layout) is a collection of map elements organized on a virtual page designed for map printing. Common map elements include one or more map frames (each containing an ordered set of map layers), a scale bar, a north arrow, a map title, descriptive text, and a legend. For geographic reference, you can add grids or graticules.

Once added to a layout, elements can be selected, moved, and resized on the layout to achieve the desired look and feel. This behavior can be turned off by locking an element, preventing selection, moving, or resizing interactively on the layout. Switch between locked and unlocked views by clicking the Lock button  next to the element in the Contents pane.

Layouts can have a landscape (wide) or portrait (tall) orientation. They can be exported and used electronically and also printed. The page size varies depending on the specifications for the output. What you see on the layout is what you will get when you print or export the map to the same page size.

A page layout can also be used to author pages of a map book. If your map has multiple pages, consider using a map series.

More information can be found at this link: <https://pro.arcgis.com/en/pro-app/latest/help/layouts/layouts-in-arcgis-pro.htm>

Q-2 Please design a **Graduated Symbol map** based on the Subzone_2010_Joined layer with appropriate and necessary map elements. This map should reflect the populations of elderly people (**aged 50 and above**) for different subzones in Singapore. Export the map from the layout view to a Tiff file (300 dpi) and insert the map into your Word document (3 marks). In addition, please identify the subzone with the highest number of elderly people and state its name and value (1 mark).

Note that the demographic information is included in the attribute table. For example, the field a2024 refers to the number of people whose ages are between 20 and 24.

Lab02 GIS Visualization Exercise 3 – Other visualization techniques

Objectives of this exercise:

To learn how to design a heat map using ArcGIS Pro

To complete exercises, you need the following:

- ArcGIS Pro 3.3.1 (Basic, Standard, or Advanced)

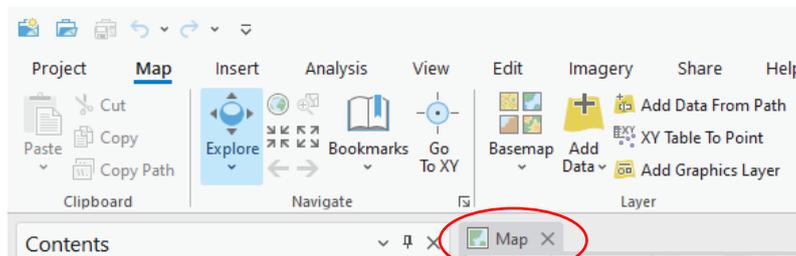
The data needed for this exercise are under the folder Lab02Data

Heat map symbology draws point features as a dynamic, representative surface of relative density. Use heat map symbology when you have many points that are close together and cannot be easily distinguished. Another characteristic of a heat map is that it is a continuous representation of density while point features can only represent discrete values.

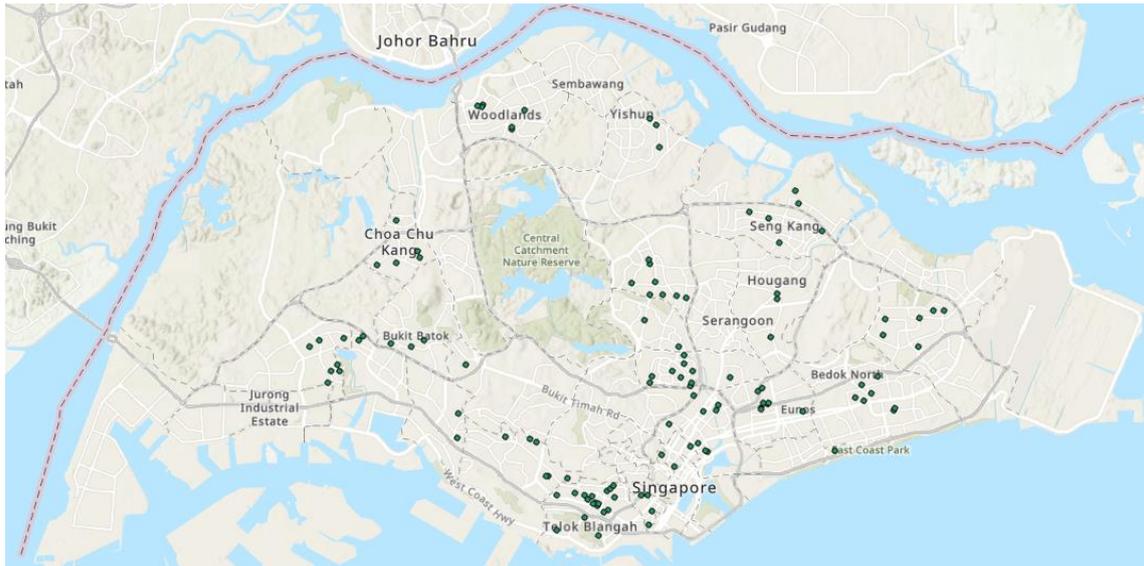
Since heat mapping is a representation of point distribution, it works best when there is a large number of point features, especially if their symbols overlap. When you have sparse distributions of points, consider drawing them with a different symbology option instead.

Create a heat map

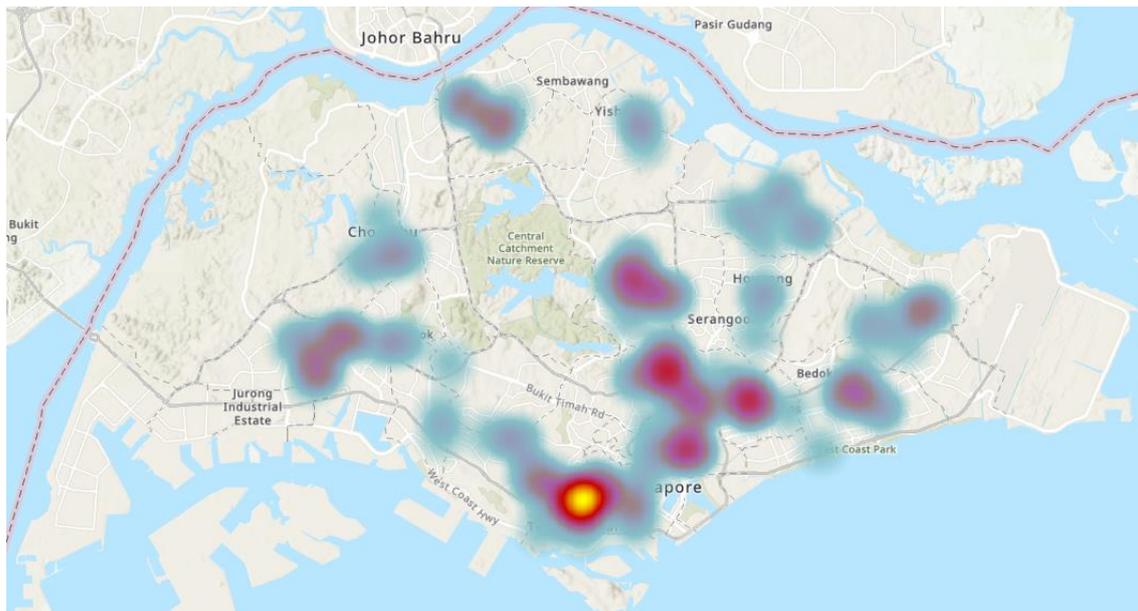
1. Open the **IntroToGIS_Lab02_Exercise02** and save it as **IntroToGIS_Lab02_Exercise03**.
2. Go to the Map view by clicking  **Map**.



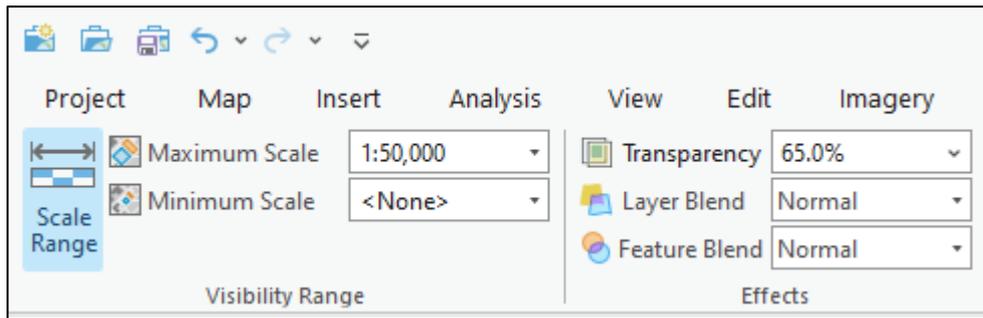
3. In the **Contents** pane, turn off all the layers except **World Topographic Map** and **World Hillshade**.
4. In the **Catalog** pane, expand the folder **Eldercare_Centers**, and drag the **ELDERCARE.shp** file to the map area. Now you will see the distribution of eldercare centers in Singapore as below. Each point represents one eldercare center.



5. In the **Contents** pane, right click the **ELDERCARE** layer and choose **Symbology**.
6. In the **Symbology** pane on the right, click the **Primary symbology** drop-down list, and choose **Heat Map**. The heat map displays, which represents the density of points.



7. On the ribbon, click the **Feature Layer** tab, In the **Effects** group, set the Layer Transparency  as 65% by typing in the number in the box on the right.
8. In the **Visibility Range** group, click the drop-down arrow next to **Scale Range** , and click **1:50,000** to set the **maximum scale** for the heat map. Note that zoom-in will result in a larger scale and zoom-out will result in a smaller scale. The scale of the view is shown in the bottom-left corner of the map view.
9. At larger scales ($\geq 1:50,000$), the pattern is too local and the heat map disappears.

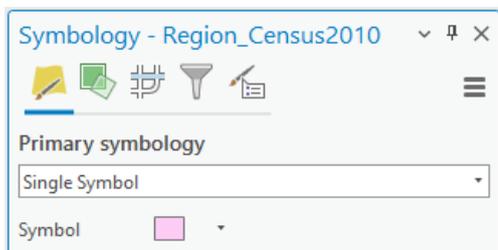


10. Zoom to explore the map, and pay attention to the change of the display scale.

11. Save the project.

Change symbols

12. In the **Contents** pane, turn on the **Region_Census2010** layer. Right-click the layer to choose **Symbology**. If it is not in the **Contents** list, add the data first. The **Symbology** pane on the right appears.



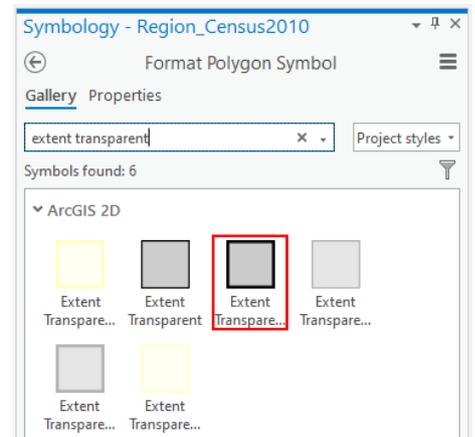
At the top of the pane, the **Primary symbology**  tab is selected. The default **Primary symbology** method is **Single Symbol**, which means that all features in the layer are drawn with the same symbol (color, shape).

13. In the **Symbology** pane, next to **Symbol**, click the **symbol** patch  (the color may look different). The pane changes to show symbol formatting options.

14. Under **Gallery**, in the search box, type in **extent transparent**, and press **Enter**. A total of 6 symbols are found.

15. Click the **Extent Transparent Wide** symbol to select it.

16. At the top of the pane, click the **Properties** tab.



The Properties tab has three graphical tabs under it. On the **Symbol**  tab you can change properties of the symbol. For example, you can change the fill color, outline color, and outline width of a polygon symbol.

17. Click the **Layers**  tab.

On this tab, you can change the properties of the graphical elements, or symbol layers, that comprise the symbol. This gives you more control over the symbol's appearance. This symbol is composed of two symbol layers: a stroke and a fill.

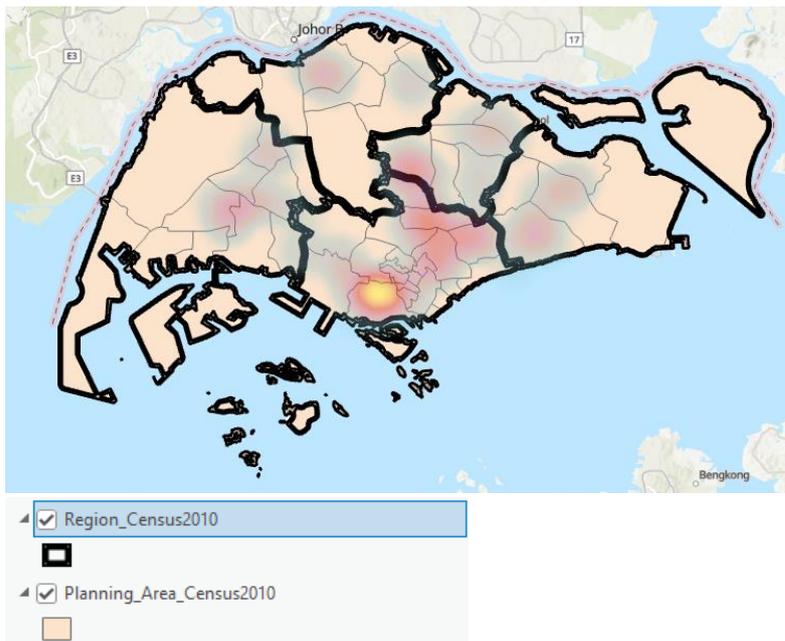
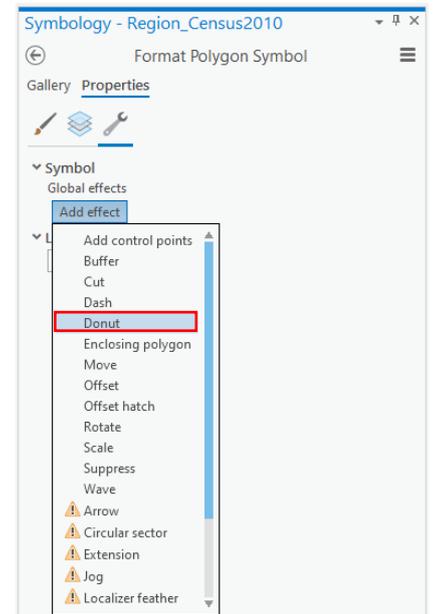
18. Click the **Structure**  tab.

On this tab, you can change the symbol's structure by adding and removing symbol layers. You can also apply effects. In this case, you'll add a donut effect to the fill layer. The donut effect restricts the gray fill to a ring at the edge of the polygon. The interior is transparent, like a donut hole.

19. Under **Appearance** under the **Symbol** tab , ensure that the **Outline color** is **Black** and change the **Outline width** to **2 pt**.

20. In the **Structure** tab , under **Symbol**, click **Add effect**. On the drop-down menu, choose **Donut**. Click the **Apply** button at the bottom, you will see the effect of **Donut**.

21. In **Content** Pane, turn on the **Planning_Area_Census2010** layer, and adjust the order of the layer if necessary so that the **Planning_Area_Census2010** layer serves as the background. You should see the heat map of eldercare centers as below (the color may look different). In the **Contents** pane, move the **Region_Census2010** layer to be above the **Planning_Area_Census2010** layer if you do not see the bold boundaries within Singapore.



*Heat map symbology displays the relative density of points as a dynamic raster visualization using a color scheme to indicate density values. Ideally, the color scheme is a smoothly varying set of colors, ranging from cool (sparse density of points) to hot (high density of points). The density definition, and therefore the color values, change as you zoom in and out. The density is calculated using **the kernel density method**, the same algorithm used by the **Kernel Density** geoprocessing tool.*

As can be seen from the heat map, eldercare centers are mostly clustered in the south part. However, in the west part of Singapore, there are few eldercare centers.