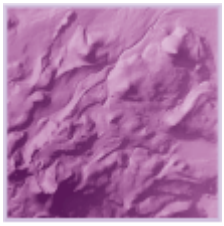
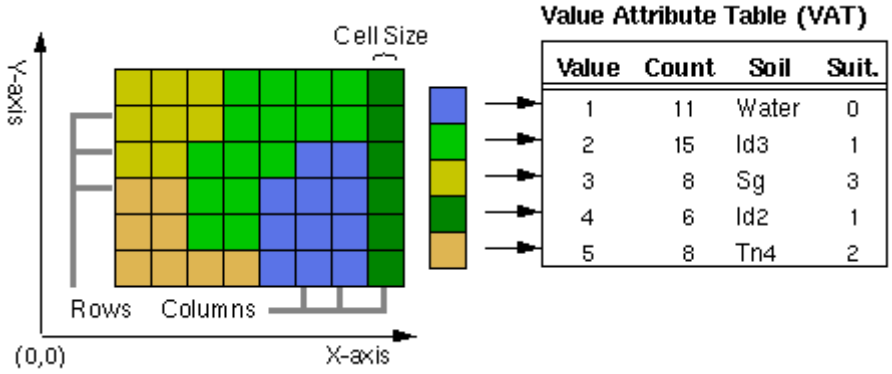
ES341 GIS Introduction to Raster Analysis

I. Raster Data Model
   a. Useful for spatially continuous data that changes across surfaces
      i. E.g. DEMs – digital elevation models, changing elevations
      ii. DEM = The representation of continuous elevation values over a topographic surface by a regular array of z-values, referenced to a common datum. DEMs are typically used to represent terrain relief.



   b. File Formats:
      i. *.dem – U.S. geological survey raster format for elevation models
      ii. *.grd – ESRI ArcMap grid format for raster models (NOTE: This is the default format in ArcGIS Spatial Analyst, when saving files, leaving the extension open defaults to the *grd format)
      iii. A grid is a raster data storage format native to ESRI. There are two types of grids: integer and floating point. Use integer grids to represent discrete data and floating-point grids to represent continuous data.



SPECIAL NOTE: TO WORK WITH GRID FILES IN ARCMAP, FILE AND FOLDERS NAMES MUST BE 13 CHARACTERS AND LESS, WITH NO SPACES (I.E. NOT SPACES IN THE PATHNAME OR FOLDERS)

II. Grid Data
   a. X-Y cells that contain cell values (e.g. elevation, precipitation)
      i. Floating point vs. Integer Values
      ii. NoData in a grid: Every cell in a grid has a value assigned to it; however, cells without actual values can be assigned NoData on the grid representing that theme.

iii. NoData and 0 (zero) are not the same; 0 is a valid value. For this reason, NoData cells cannot be used in calculating the statistics in a grid's STA table.

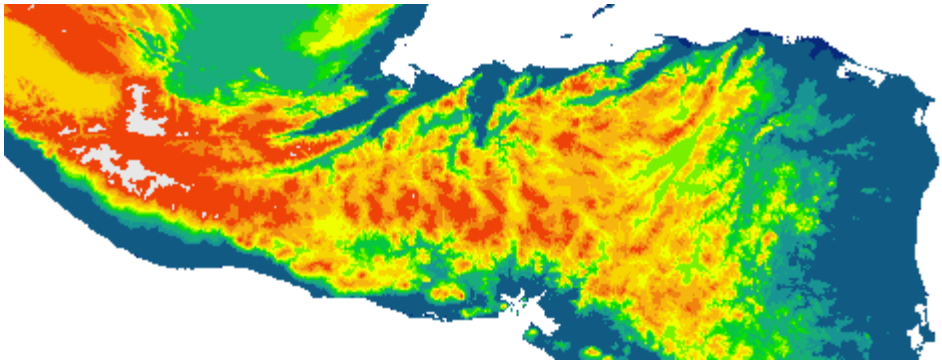
b. Raster Coordinates
   i. Geographic projection and datum used
   ii. Resolution of cells – size of each cell expressed in ground units
   iii. Georeferencing – grids are referenced based on the X,Y coordinate of the upper left most cell in the grid (northwest corner)
   iv. Georeference – cells calibrated to real-world coordinates

III. Rendering and Symbolizing Raster Grid Data

a. Stretched—The Stretched renderer displays continuous raster cell values across a gradual ramp of colors. Use the Stretched renderer to draw a single band of continuous data.
   i. The Stretched renderer works well when you have a large range of values to display such as in spectral imagery, aerial photographs, or elevation models.

b. RGB Composite—Use RGB Composite for a multiband raster layer.

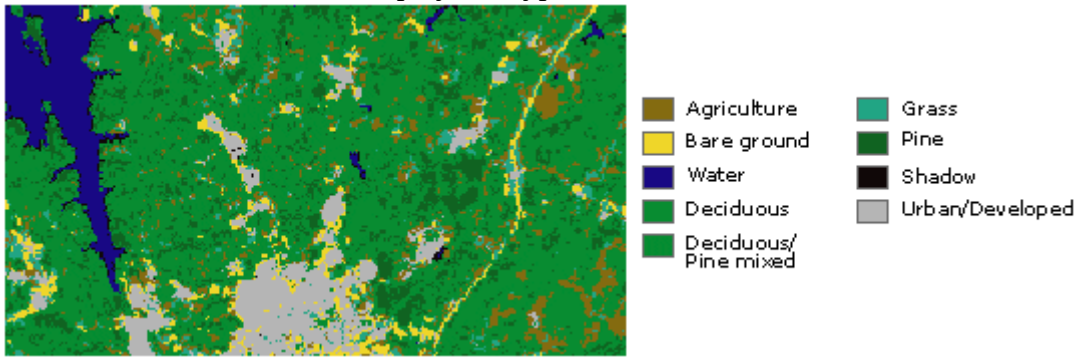
c. Classified—The Classified renderer is used with a single-band raster layer. The Classified method displays thematic rasters by grouping cell values into classes.
   i. Use this type of thematic classification on continuous phenomena, such as slope, distance, or suitability, where you want to classify the range into a small number of classes and assign colors to those classes.



ii. Types of Classification Methods:

1. Manual—User defines and sets the class breaks. Use this choice if, for example, you want to emphasize particular patterns by placing breaks at important threshold values or if you need to comply with a particular standard that demands certain class breaks.
2. Equal Interval—The range of cell values is divided into equally sized classes where you specify the number of classes. Use this method to emphasize the relative amount of attribute values compared to other values. It is best applied to familiar data ranges such as percentages and temperature.
3. Defined Interval—You specify an interval to divide the range of cell values, and ArcMap determines the number of classes.
4. Quantile—Each class contains an equal number of cells. Use this method with linearly distributed data.
5. Natural Breaks (Jenks)—The class breaks are determined statistically by finding adjacent feature pairs between which there is a relatively large difference in data value.
6. Standard Deviation—Shows you the amount a cell's value varies from the mean.

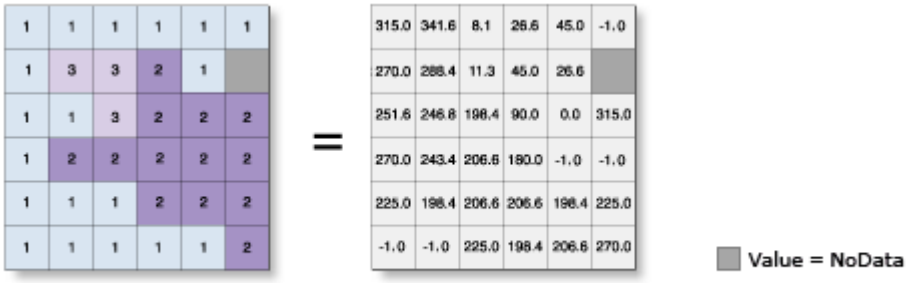
d. Unique Values—Use Unique Values when you want each value in the raster layer to be displayed individually. For instance, discrete categories representing particular objects on the earth's surface, such as those in a thematic raster layer, which could display soil types or land use.



IV. Spatial Analyst

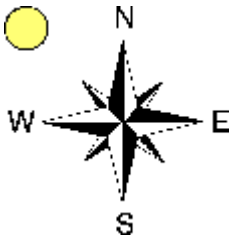
a. ArcMap extension that allows raster-based analysis and management of grid data
   i. Tools – Extensions – Check on the “Spatial Analyst” extension
   ii. ArcTool Box

1. pull down the “Spatial Analyst Tools”
2. “Surface Tools”for use in analyzing terrain components
    a. Aspect-Derives aspect from a raster surface. Aspect identifies the downslope direction of the maximum rate of change in value from each cell to its neighbors. Aspect can be thought of as the slope direction. The values of the output raster will be the compass direction of the aspect.

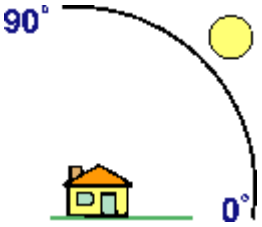


    b. Contour- Creates contours or isolines from a raster surface.

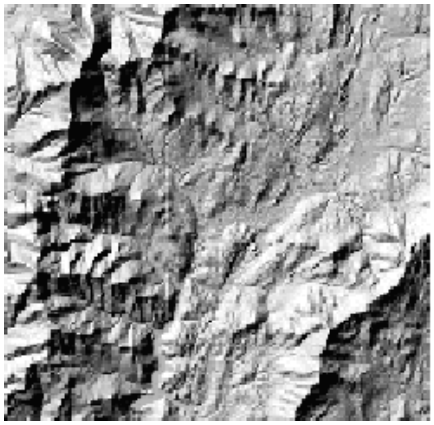
    c. Hillshade- tool obtains the hypothetical illumination of a surface by determining illumination values for each cell in a raster.
        i. set a position for a hypothetical light source and calculating the illumination values of each cell in relation to neighboring cells.
        ii. The azimuth is the angular direction of the sun, measured from north in clockwise degrees from 0 to 360. An azimuth of 90 is east. The default is 315 (NW).



        iii. The altitude is the slope or angle of the illumination source above the horizon. The units are in degrees, from 0 (on the horizon) to 90 (overhead). The default is 45 degrees.

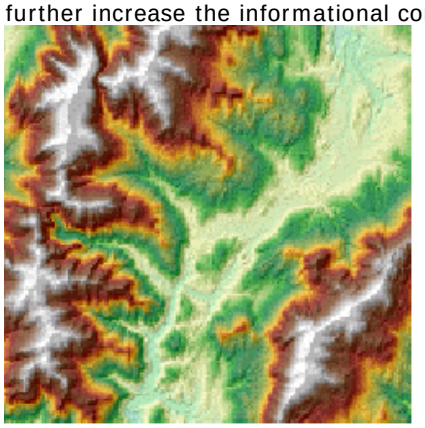


The hillshade below has an azimuth of 315 and an altitude of 45 degrees.

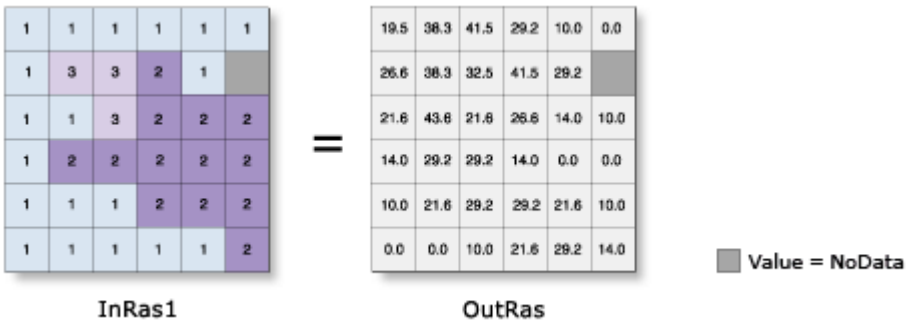


Using hillshade for display

By placing an elevation raster on top of a created hillshade and making the elevation raster transparent, you can create realistic images of the landscape. Add other layers, such as roads, streams, or vegetation, to further increase the informational content in the display.



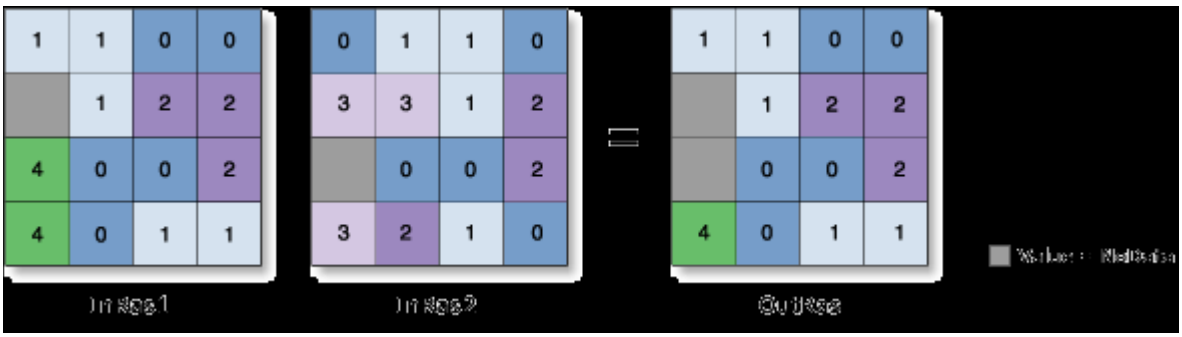
d. Slope - Identifies the rate of maximum change in z-value from each cell.



e. Viewshed- Determines the raster surface locations visible to a set of observer features.

3. "Extraction Tools" – for use in sampling subsets of grids, sorting by either the cells' attributes or their spatial location.
   a. Extracting cells by attribute is accomplished through a "where clause". For example, your analysis may require an extraction of cells higher than 100 meters in elevation from an elevation raster.
   b. Extracts the cells of a raster based on a polygon.

   c. Extract by Mask – Extracts the cells of a raster that correspond to the areas defined by a mask.



4. "Hydrology Tools" – for use in deriving water flow parameters from an elevation grid

V. Raster Analysis

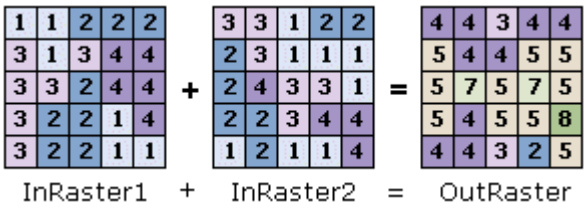
a. Map Algebra – mathematical manipulation within and between raster grids, allows value-added transformation of grid data

i. Uses raster grids covering same area, of same grid resolution, and same projection

ii. Mathematical and logical operations on grid overlays

1. e.g. adding/subtracting cell values between two grids
2. True or False conditions using grid overlays

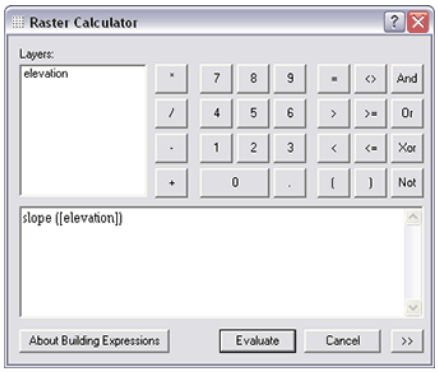
Example – matrix addition of two grids



b. Raster Calculator is a tool to perform mathematical calculations using operators and functions, set up selection queries, or type in Map Algebra syntax.

i. Inputs can be raster datasets or raster layers, coverages, shapefiles, tables, constants, and numbers.

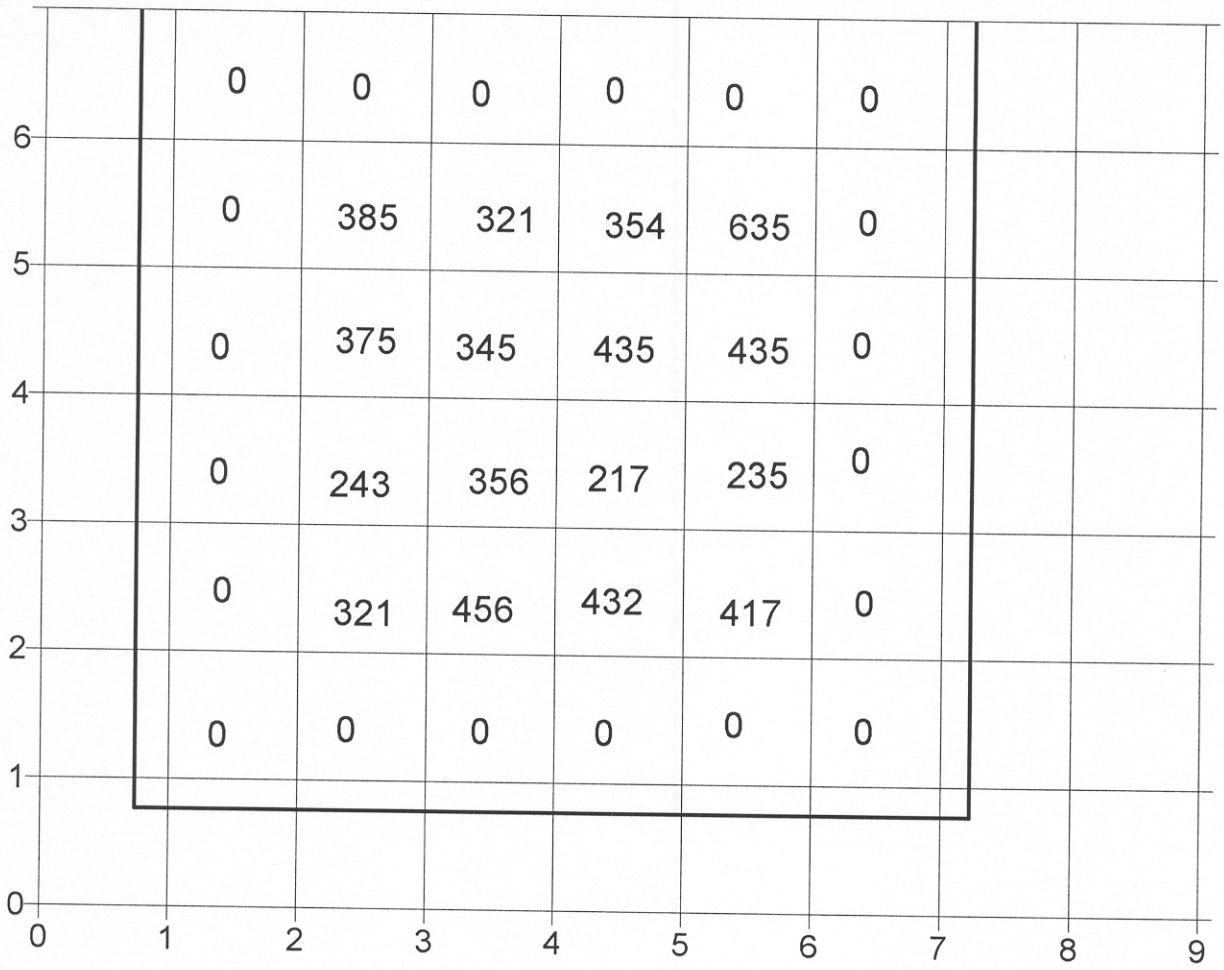
ii. To access the Raster Calculator, select it from the Spatial Analyst toolbar menu. In the dialog, you can enter Map Algebra into the expression box.



Paper and Pencil Work with Map Algebra

Work the following map algebra problems with grid 1 and 2 on the following pages (use only the grid cells highlighted in the box). Place your results on the blank grid answer sheets.

grid 1 x grid 2
grid 1 / grid 2
grid 1 + grid 2
grid 1 - grid 2
log (grid 1)
grid 1 x 333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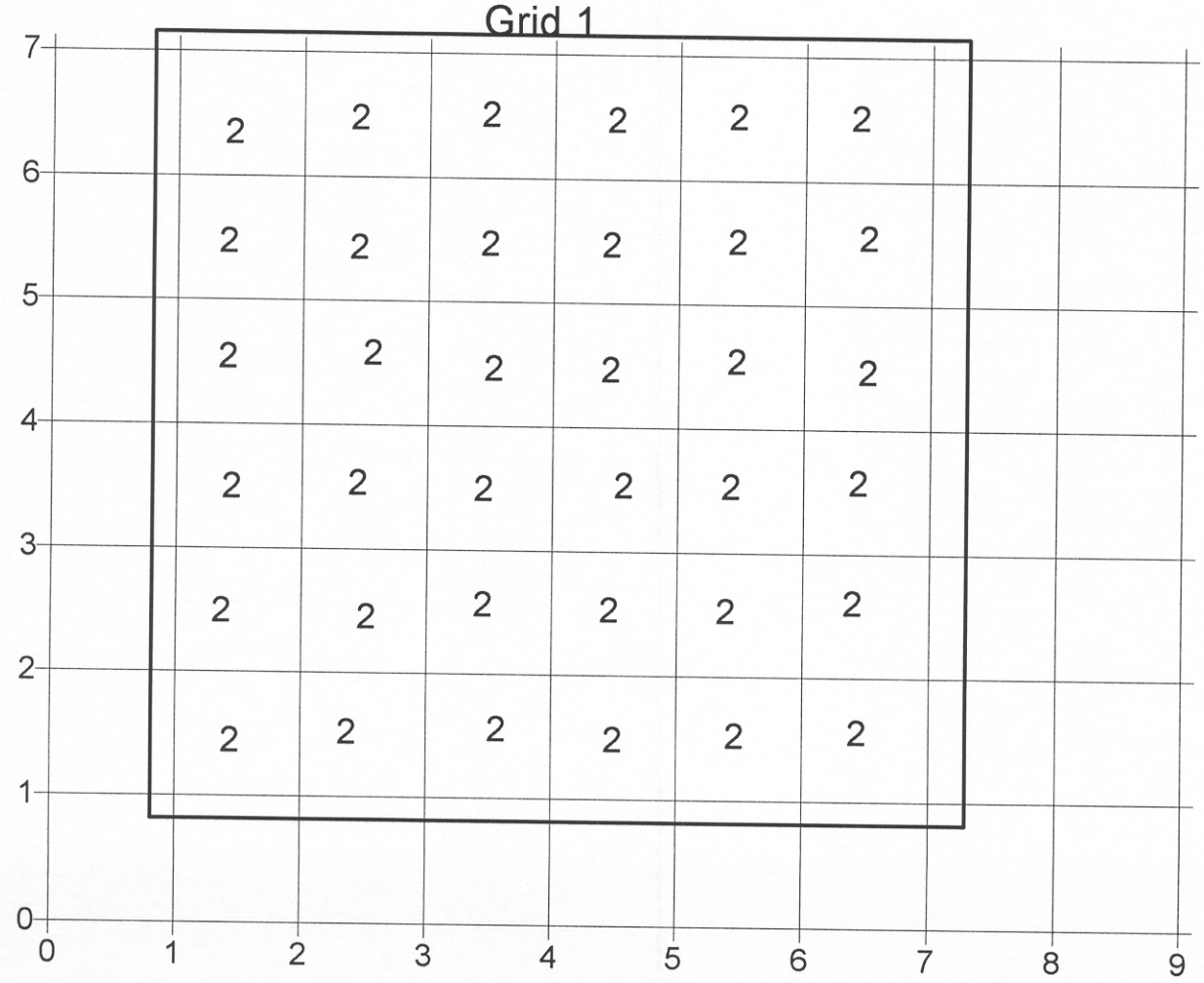
Grid 1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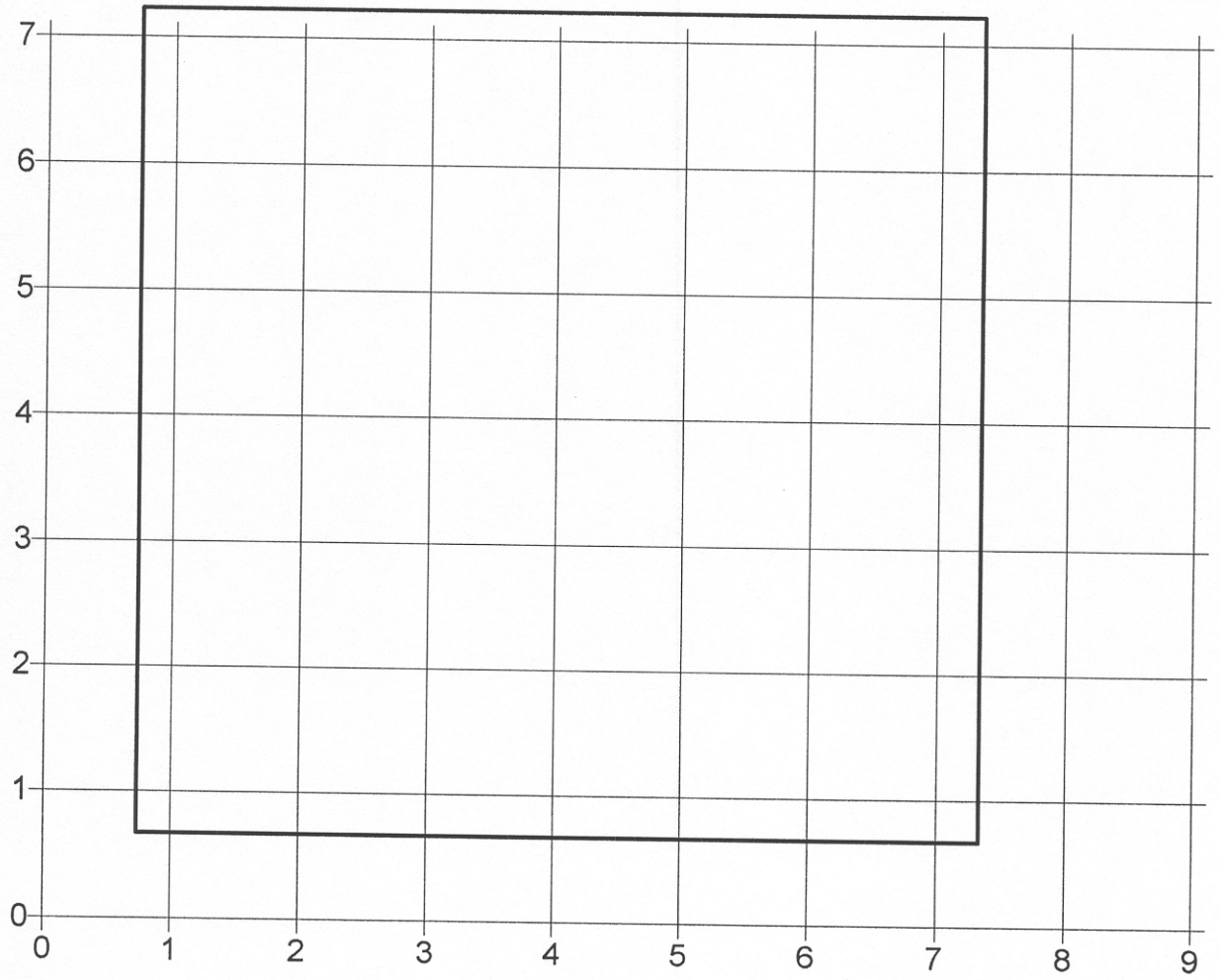
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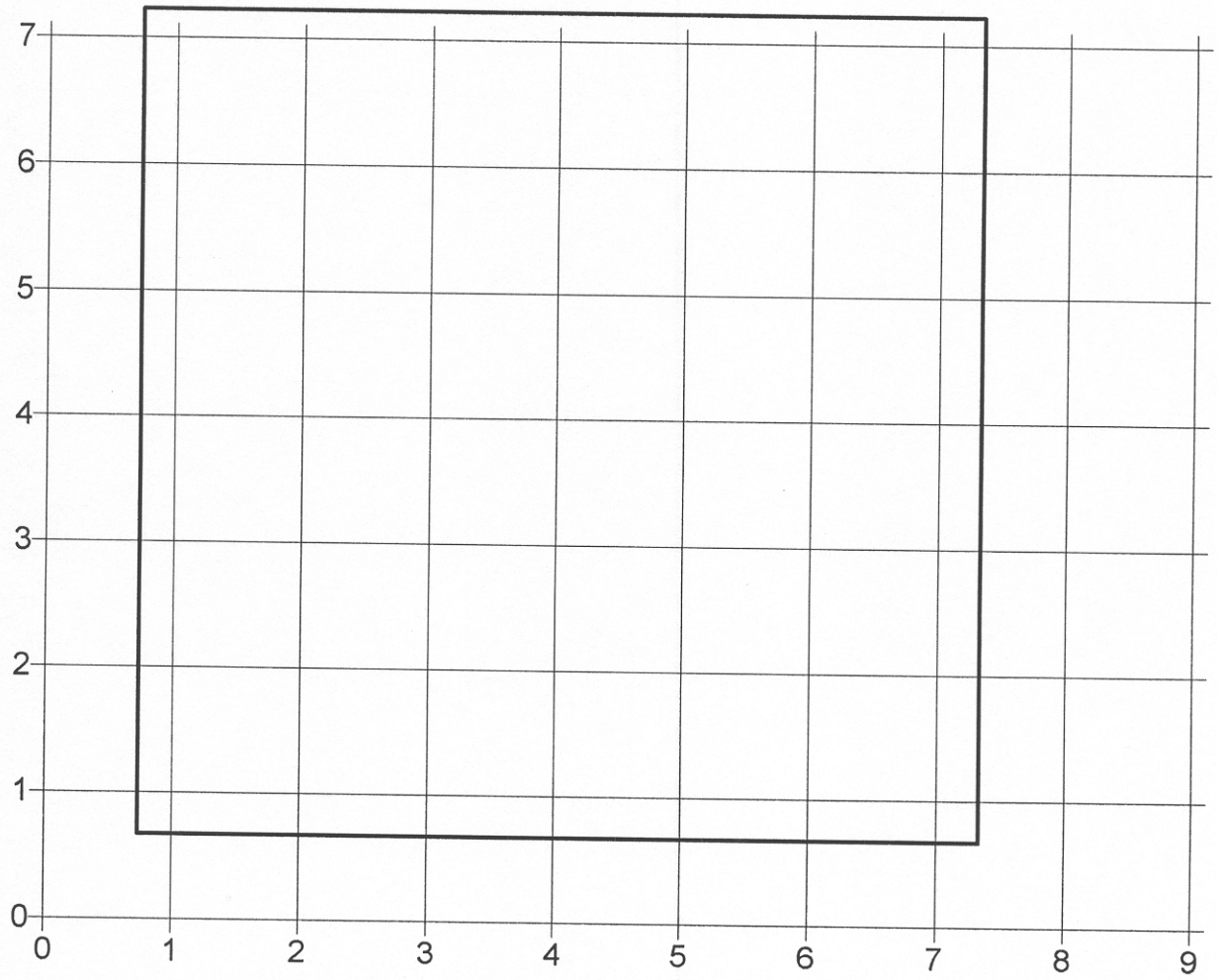
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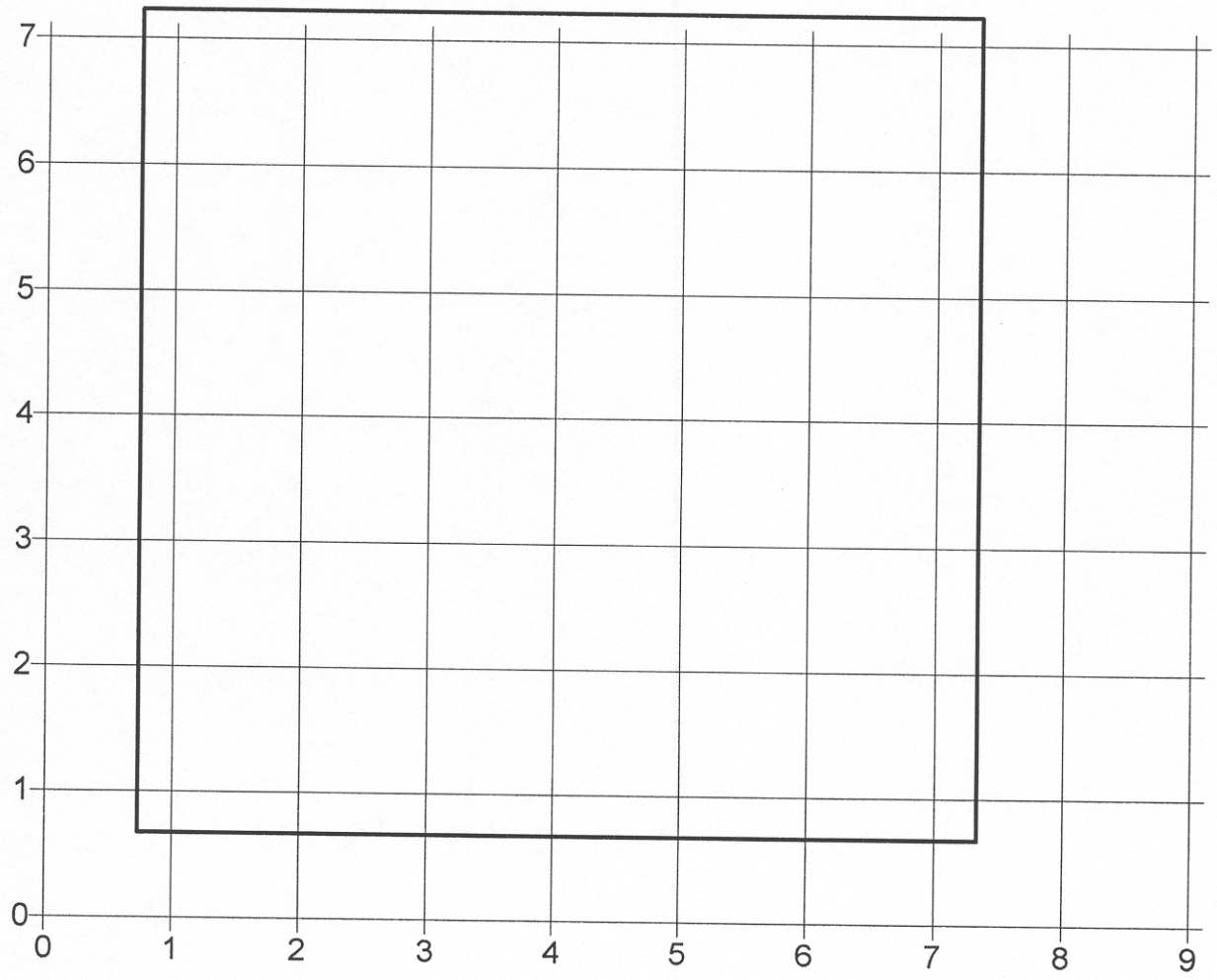
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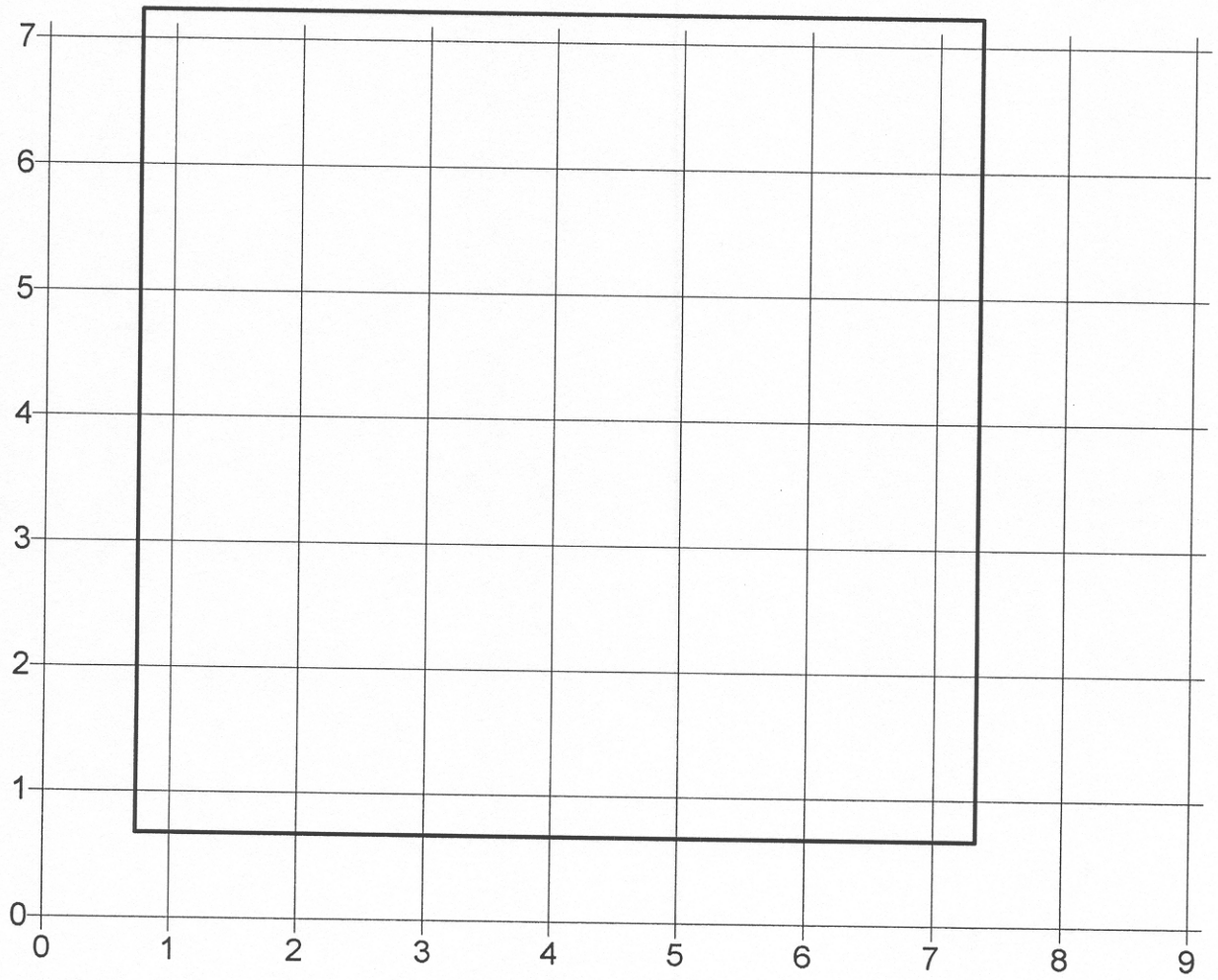
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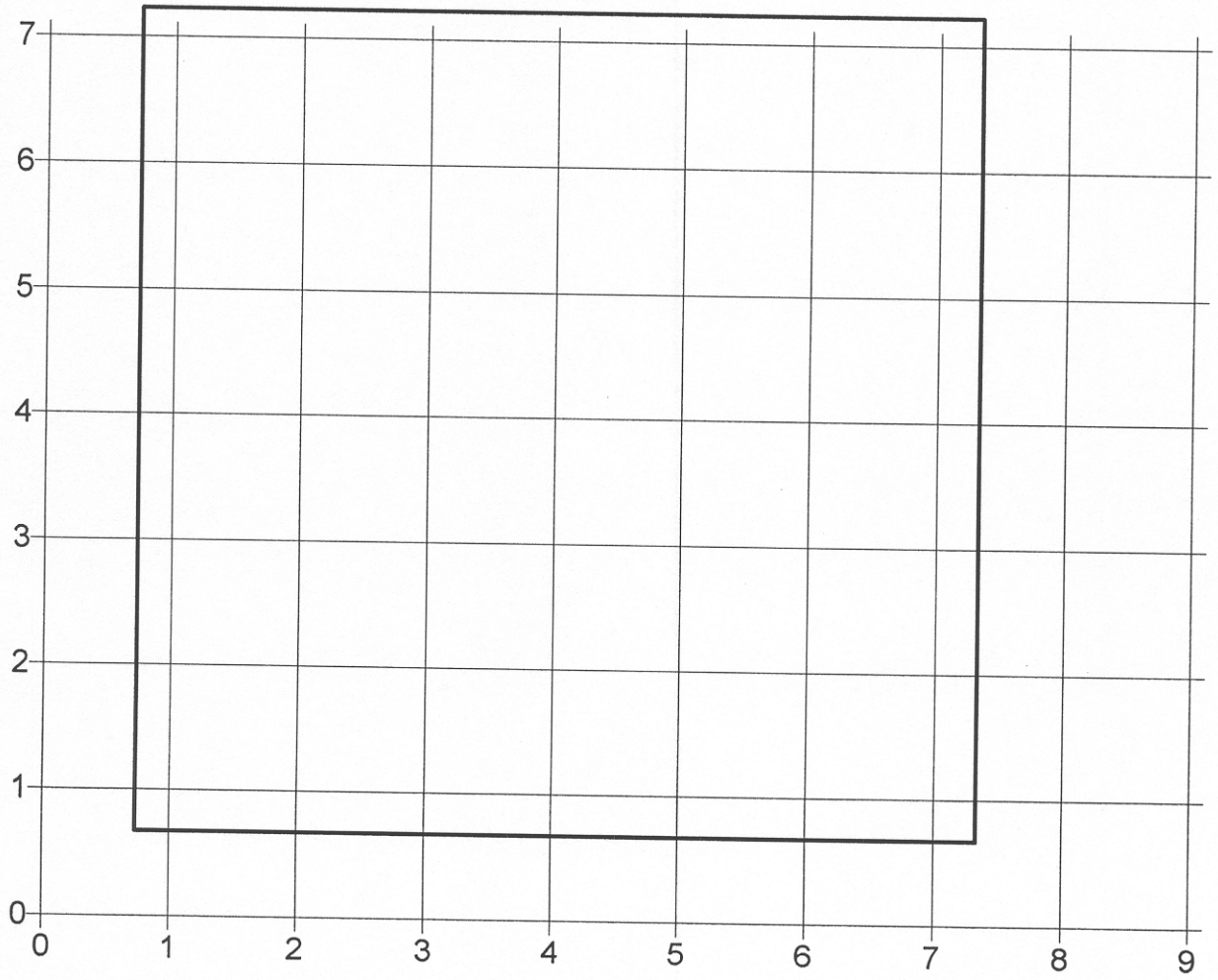
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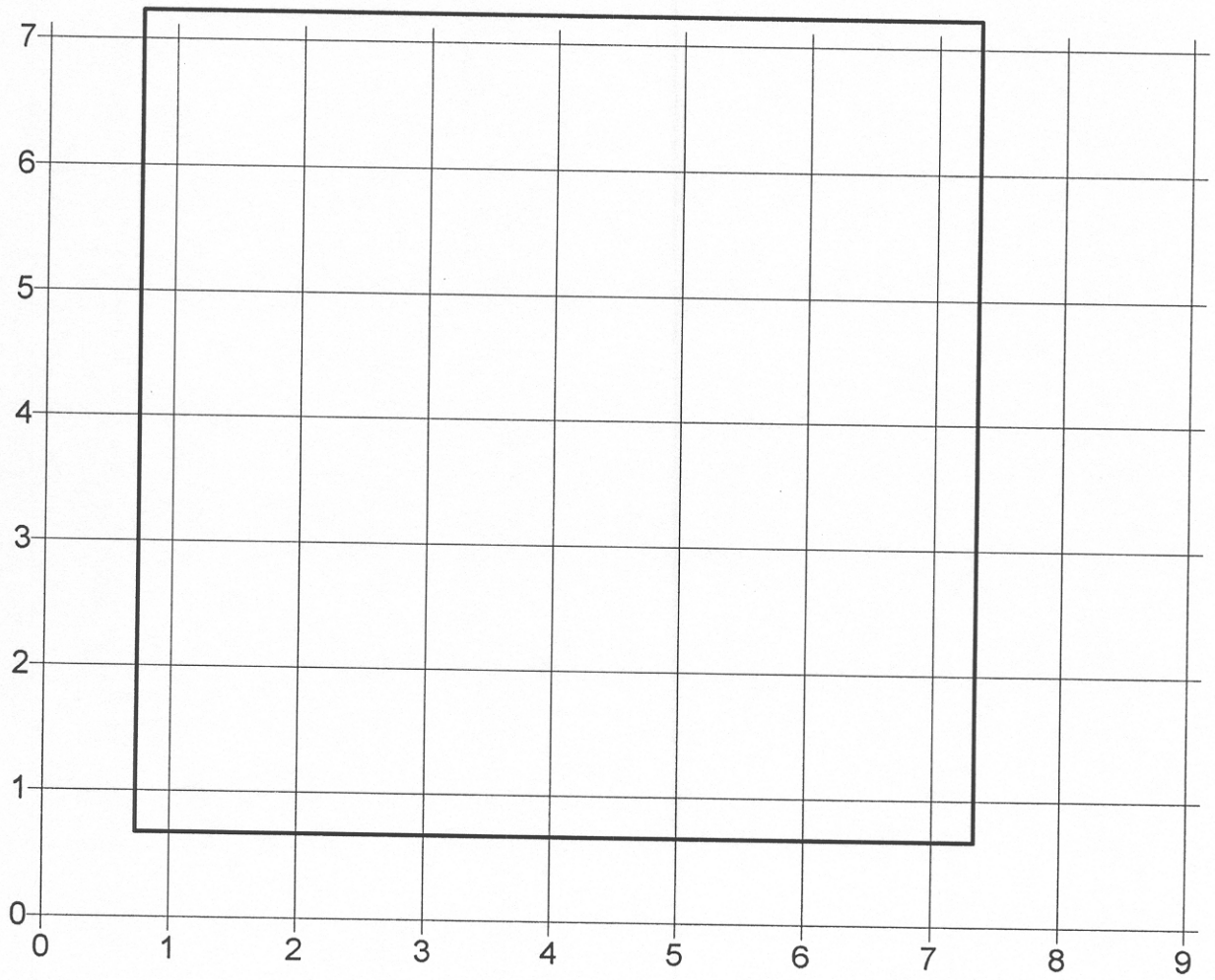
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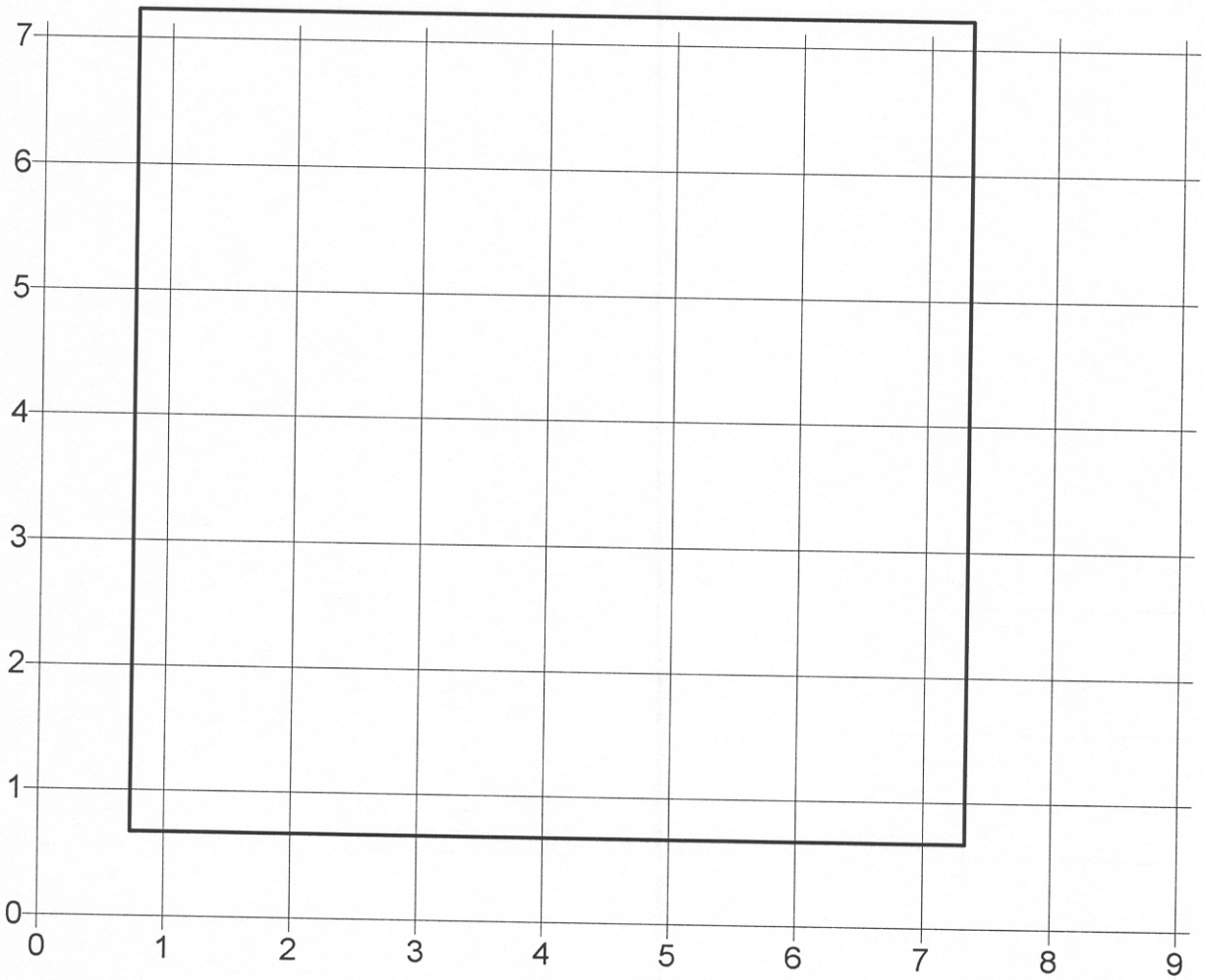
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