

COMS 4753
Assignment 3
Daisy Ye
yy3131

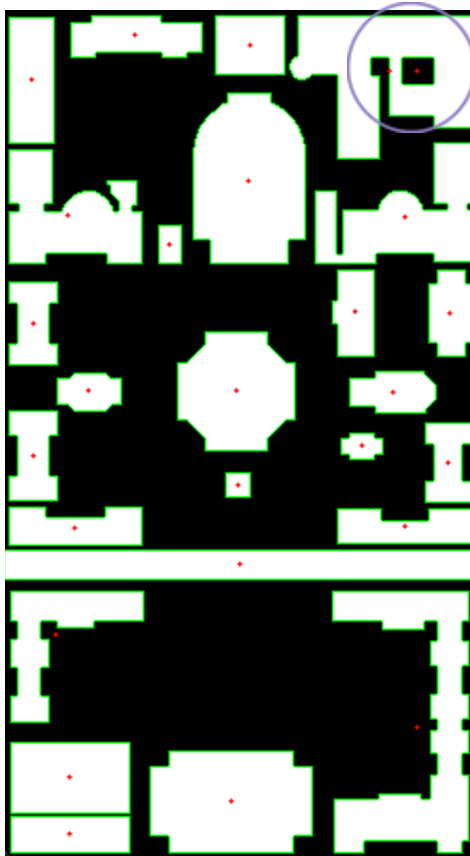
Step 1: Raw Data

1. Algorithm Explanation

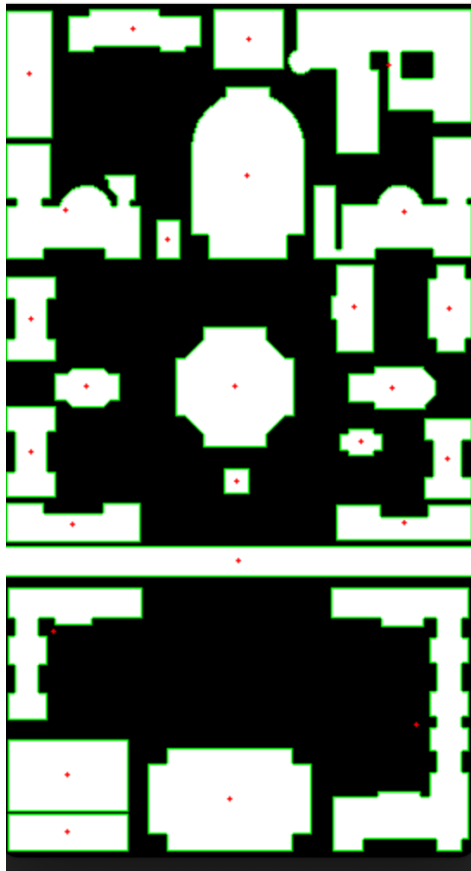
I first processed the Table.txt file to create a dictionary where the key is the building number, and the value is the building name.

Then I started calculating the area of each building by going through each pixel of the label image and checking if the pixel is zero or not, and if it is not, which building it belongs to. I stored the area of each image in a dictionary similar to the one above.

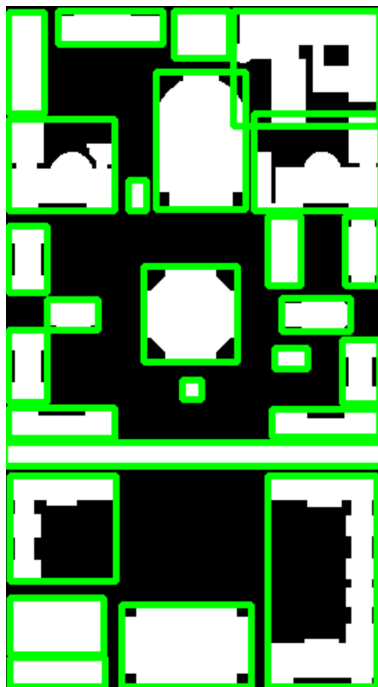
Afterward, I calculated the center of mass and the minimum bounding rectangle in the same for loop. I first converted the campus image to grayscale and calculated the contours. Then, I went through the contours one by one and eliminate the contour that has a child contour within in. In the picture below, the highlighted part is a squarish empty space inside a building that does not count.



Therefore, by using the hierarchical relationship between the contours, I ignored that contour and computed its center of mass. The resulting image is below where red is the center of mass and green is the contour:



While going through each contour, I also calculated the minimum bounding rectangle by using the `minAreaRect` function. I then used `boxPoints` to find the four corners of the rectangle and the diagonal, which are all stored in a dictionary. The bounding rectangles look like this:



Lastly, I calculated the intersection of the bounding rectangles by using the shapely library. Between every two buildings, I created their polygons using the corner coordinates from the step above and calculated the intersection of the polygons. If the intersection area is larger than zero, then the two rectangles have an overlap. The result of this step is also stored in a dictionary.

I printed out the result by accessing the dictionaries with the building number as the key.

2. Result

```
Building #9: Pupin
  Center of Mass: (76.13, 14.96)
  Area: 1640
  Min Bounding Rect and diagonal: (39,3) to (115,27) with diagonal 79.7
  Intersection Buildings: None
Building #19: SchapiroCEPSR
  Center of Mass: (143.0, 20.0)
  Area: 1435
  Min Bounding Rect and diagonal: (123,3) to (163,37) with diagonal 52.5
  Intersection Buildings: None
Building #28: Mudd&EngTerrace&Fairchild&CS
  Center of Mass: (224.11, 35.1)
  Area: 5831
  Min Bounding Rect and diagonal: (166,3) to (272,86) with diagonal 134.63
  Intersection Buildings: ['Schermerhorn', 'Uris']
Building #38: NorthwestCorner
  Center of Mass: (16.0, 40.5)
  Area: 1998
  Min Bounding Rect and diagonal: (3,4) to (29,77) with diagonal 77.49
  Intersection Buildings: None
Building #47: Uris
  Center of Mass: (142.53, 99.39)
  Area: 5753
  Min Bounding Rect and diagonal: (110,47) to (175,146) with diagonal 118.43
  Intersection Buildings: ['Mudd&EngTerrace&Fairchild&CS']
Building #57: Schermerhorn
  Center of Mass: (233.72, 120.57)
  Area: 3911
  Min Bounding Rect and diagonal: (181,77) to (273,147) with diagonal 115.6
  Intersection Buildings: ['Mudd&EngTerrace&Fairchild&CS']
Building #66: Chandler&Havemeyer
  Center of Mass: (37.46, 119.67)
  Area: 3613
  Min Bounding Rect and diagonal: (3,81) to (80,147) with diagonal 101.41
  Intersection Buildings: None
Building #76: OldComputerCenter
  Center of Mass: (96.5, 136.0)
  Area: 322
  Min Bounding Rect and diagonal: (90,125) to (103,147) with diagonal 25.55
  Intersection Buildings: None
```

Building #85: Avery
Center of Mass: (204.06, 175.98)
Area: 1164
Min Bounding Rect and diagonal: (191,151) to (215,201) with diagonal 55.46
Intersection Buildings: None

Building #94: Fayerweather
Center of Mass: (259.62, 176.0)
Area: 1182
Min Bounding Rect and diagonal: (247,151) to (272,201) with diagonal 55.9
Intersection Buildings: None

Building #104: Mathematics
Center of Mass: (17.0, 182.0)
Area: 1191
Min Bounding Rect and diagonal: (3,158) to (31,206) with diagonal 55.57
Intersection Buildings: None

Building #113: LowLibrary
Center of Mass: (135.0, 221.5)
Area: 3898
Min Bounding Rect and diagonal: (101,187) to (169,256) with diagonal 96.88
Intersection Buildings: None

Building #123: StPaulChapel
Center of Mass: (226.69, 222.02)
Area: 1087
Min Bounding Rect and diagonal: (201,210) to (251,234) with diagonal 55.46
Intersection Buildings: None

Building #132: EarlHall
Center of Mass: (49.61, 221.87)
Area: 759
Min Bounding Rect and diagonal: (31,211) to (68,233) with diagonal 43.05
Intersection Buildings: None

Building #142: Lewisohn
Center of Mass: (17.0, 259.0)
Area: 1307
Min Bounding Rect and diagonal: (3,233) to (31,285) with diagonal 59.06
Intersection Buildings: None

Building #151: Philosophy
Center of Mass: (258.32, 263.0)
Area: 1085
Min Bounding Rect and diagonal: (245,240) to (272,286) with diagonal 53.34
Intersection Buildings: None

Building #161: Buell
Center of Mass: (208.0, 253.5)
Area: 340
Min Bounding Rect and diagonal: (196,246) to (220,261) with diagonal 28.3
Intersection Buildings: None
Building #170: AlmaMater
Center of Mass: (136.0, 276.0)
Area: 225
Min Bounding Rect and diagonal: (129,269) to (143,283) with diagonal 19.8
Intersection Buildings: None
Building #179: Dodge
Center of Mass: (41.5, 301.13)
Area: 1590
Min Bounding Rect and diagonal: (3,289) to (80,311) with diagonal 80.08
Intersection Buildings: None
Building #189: Kent
Center of Mass: (233.0, 300.93)
Area: 1470
Min Bounding Rect and diagonal: (194,290) to (272,310) with diagonal 80.52
Intersection Buildings: None
Building #198: CollegeWalk
Center of Mass: (137.0, 322.5)
Area: 4950
Min Bounding Rect and diagonal: (0,314) to (274,331) with diagonal 274.53
Intersection Buildings: None
Building #208: Journalism&Furnald
Center of Mass: (30.58, 363.77)
Area: 2615
Min Bounding Rect and diagonal: (4,338) to (81,414) with diagonal 108.19
Intersection Buildings: None
Building #217: Hamilton&Hartley&Wallach&JohnJay
Center of Mass: (240.37, 417.24)
Area: 5855
Min Bounding Rect and diagonal: (191,338) to (270,490) with diagonal 171.3
Intersection Buildings: None
Building #236: Lerner
Center of Mass: (38.5, 446.5)
Area: 2940
Min Bounding Rect and diagonal: (4,426) to (72,467) with diagonal 79.4
Intersection Buildings: None

Building #246: ButlerLibrary
Center of Mass: (132.0, 460.41)
Area: 5282
Min Bounding Rect and diagonal: (85,431) to (179,490) with diagonal 110.98
Intersection Buildings: None
Building #255: Carman
Center of Mass: (38.5, 479.5)
Area: 1540
Min Bounding Rect and diagonal: (4,469) to (73,490) with diagonal 72.12
Intersection Buildings: None

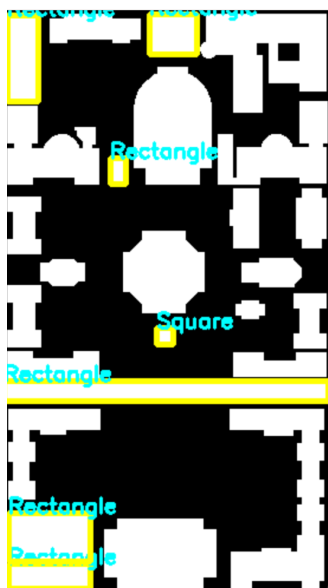
Step 2: “What”

1. Algorithm Explanation

Size is determined by both area and the length of the diagonal line of the minimum bounding rectangle. The smallest and the largest buildings are purely determined by area, or the number of pixels the building occupies. The length of the diagonal line determines which size bucket a building falls into. I tried many different thresholds. If the diagonal line is less than 90, it counts as small, and if its diagonal line is more than 120, it counts as large. Everything in between is medium-sized. However, I realized that in this case, Uris would be medium-sized even though it should be large. Therefore, I decreased the threshold for large to 110. Then, I realized that Lerner should be medium-sized instead of small. Therefore, I decreased the threshold for medium-size to 75. However, in this case, Pupin would be medium-sized while Carman will be small. In the photo though, they look similar in size and should be both medium-sized. Therefore, I decreased the threshold for medium-size to 70.

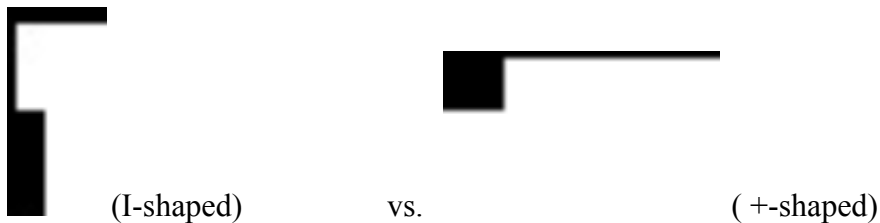
The aspect ratio is determined by the minimum bounding rectangle only. I computed the ratio between the smaller one out of the width and the length of the rectangle and the larger one. This is because the aspect ratio of the building is not respective to its orientation. Then I chose two constants NARROW and MED_WIDTH to categorize the buildings. If a value is smaller than NARROW, it is narrow. If the value is between NARROW and MED_WIDTH, it is medium-width, otherwise, it is wide. I first tried Narrow = 0.25; MED_width = 0.5, which categorized some buildings that are medium-width as wide. I then adjusted NARROW to 0.33 and MED_WIDTH to 0.66, and the result is acceptable.

Geometry is determined by a combination of factors. First, I determined the shapes of those figures whose contour resembles a rectangle or square. This is achieved by taking an approximation of the contour and then checking if the length of the approximation is 4. The ones that pass this test are in the picture below:



Then, I created an image for each building that has only itself in it. I then go through a procedure to check if it is an “I-shape”, if not then if it is a “C-shape”, if not then if it is an “L-shape”, if not then if it is “rectangular”, and if not then it is “asymmetrical”. The logic behind this is that I-shape is the most selective one. Those who pass the C-shaped test can still be “I-shaped”, so it makes sense to go from the most-selective shape to the least-selective shape.

To check if a building is I-shaped, I tried checking if it is vertically and horizontally symmetrical. And then I checked if the I-shape can turn into an L-shape by folding it twice. Symmetry is checked by checking if each pixel on the left side of the vertical symmetry line is the same as each pixel on the other side. After folding the shape horizontally and then vertically, the resulting image is a quarter of its original size and should look like an “L”. However, at this stage, the building can either be “I-shaped” or “+-shaped”. Therefore, my program also checks if the width of the “L” is longer than its length.



To check if a building is C-shaped, I first eliminated the buildings that are neither horizontally nor vertically symmetrical. This is because C-shaped is symmetrical. Then, I rotated the image by 90 degrees because the C-shape can be laying flat or vertically. Then, for both the original image and the rotated image, I folded the shape horizontally and call another function that checks if the image is L-shaped. This is because for a C-shaped building, once it is folded in half, it will result in an L-shaped figure.

The logic to check if a building is L-shaped is that an L-shaped building, with the correct orientation and folding, should be able to produce a hollow rectangle. This is because if I combine the mirror image of an L-shaped building, it will result in a figure that looks like a gate. Then if I take a mirror image of the gate shape and combine it with itself, it will lead to that hollow rectangle. Therefore, in my code, I cropped the input image so that the image is the size of its bounding rectangle. Then I flip it regarding its vertical symmetry line and then again regarding its horizontal symmetry line. In the end, I check if the hollow shape in the middle is a rectangle or not to determine if the shape is L-shaped or not.





(this is what Dodge looks like afterward)

To check if a building is rectangular, I checked how different the remaining buildings are from their minimum bounding rectangles. I counted the number of pixels that are different and computed the ratio between that number and the building area, and see if the result surpasses the ratio.

The rest of the buildings are categorized as asymmetrical.

2. Overall Result

```
Pupin ['medium-size', 'narrow', 'rectangular']
SchapiroCEPSR ['small', 'wide', 'rectangular']
Mudd&EngTerrace&Fairchild&CS ['large', 'wide', 'asymmetrical']
NorthwestCorner ['medium-size', 'medium-width', 'rectangular']
Uris ['large', 'medium-width', 'rectangular']
Schermerhorn ['large', 'wide', 'asymmetrical']
Chandler&Havemeyer ['medium-size', 'wide', 'asymmetrical']
OldComputerCenter ['small', 'medium-width', 'rectangular']
Avery ['small', 'medium-width', 'rectangular']
Fayerweather ['small', 'medium-width', 'rectangular']
Mathematics ['small', 'medium-width', 'I-shaped']
LowLibrary ['medium-size', 'wide', 'square']
StPaulChapel ['small', 'medium-width', 'rectangular']
EarlHall ['small', 'medium-width', 'rectangular']
Lewisohn ['small', 'medium-width', 'I-shaped']
Philosophy ['small', 'medium-width', 'I-shaped']
Buell ['small', 'medium-width', 'rectangular']
AlmaMater ['smallest', 'wide', 'square']
Dodge ['medium-size', 'narrow', 'C-shaped']
Kent ['medium-size', 'narrow', 'C-shaped']
CollegeWalk ['large', 'narrow', 'rectangular']
Journalism&Furnald ['medium-size', 'wide', 'L-shaped']
Hamilton&Hartley&Wallach&JohnJay ['largest', 'medium-width', 'C-shaped']
Lerner ['medium-size', 'medium-width', 'rectangular']
ButlerLibrary ['large', 'medium-width', 'rectangular']
Carman ['medium-size', 'narrow', 'rectangular']
```

3. Confusion

```
Pupin ['medium-size', 'narrow', 'rectangular']
    buildings with same description
    ['Carman']
SchapiroCEPSR ['small', 'wide', 'rectangular']
    buildings with same description
    []
Mudd&EngTerrace&Fairchild&CS ['large', 'wide', 'asymmetrical']
    buildings with same description
    ['Schermerhorn']
NorthwestCorner ['medium-size', 'medium-width', 'rectangular']
    buildings with same description
    ['Lerner']
Uris ['large', 'medium-width', 'rectangular']
    buildings with same description
    ['ButlerLibrary']
Schermerhorn ['large', 'wide', 'asymmetrical']
    buildings with same description
    ['Mudd&EngTerrace&Fairchild&CS']
Chandler&Havemeyer ['medium-size', 'wide', 'asymmetrical']
    buildings with same description
    []
OldComputerCenter ['small', 'medium-width', 'rectangular']
    buildings with same description
    ['Avery', 'Fayerweather', 'StPaulChapel', 'EarlHall', 'Buell']
Avery ['small', 'medium-width', 'rectangular']
    buildings with same description
    ['OldComputerCenter', 'Fayerweather', 'StPaulChapel', 'EarlHall', 'Buell']
Fayerweather ['small', 'medium-width', 'rectangular']
    buildings with same description
    ['OldComputerCenter', 'Avery', 'StPaulChapel', 'EarlHall', 'Buell']
Mathematics ['small', 'medium-width', 'I-shaped']
    buildings with same description
    ['Lewisohn', 'Philosophy']
```

```

LowLibrary ['medium-size', 'wide', 'square']
    buildings with same description
    []
StPaulChapel ['small', 'medium-width', 'rectangular']
    buildings with same description
    ['OldComputerCenter', 'Avery', 'Fayerweather', 'EarlHall', 'Buell']
EarlHall ['small', 'medium-width', 'rectangular']
    buildings with same description
    ['OldComputerCenter', 'Avery', 'Fayerweather', 'StPaulChapel', 'Buell']
Lewisohn ['small', 'medium-width', 'I-shaped']
    buildings with same description
    ['Mathematics', 'Philosophy']
Philosophy ['small', 'medium-width', 'I-shaped']
    buildings with same description
    ['Mathematics', 'Lewisohn']
Buell ['small', 'medium-width', 'rectangular']
    buildings with same description
    ['OldComputerCenter', 'Avery', 'Fayerweather', 'StPaulChapel', 'EarlHall']
AlmaMater ['smallest', 'wide', 'square']
    buildings with same description
    []
Dodge ['medium-size', 'narrow', 'C-shaped']
    buildings with same description
    ['Kent']
Kent ['medium-size', 'narrow', 'C-shaped']
    buildings with same description
    ['Dodge']
CollegeWalk ['large', 'narrow', 'rectangular']
    buildings with same description
    []
Journalism&Furnald ['medium-size', 'wide', 'L-shaped']
    buildings with same description
    []

```

```

Hamilton&Hartley&Wallach&JohnJay ['largest', 'medium-width', 'C-shaped']
    buildings with same description
    []
Lerner ['medium-size', 'medium-width', 'rectangular']
    buildings with same description
    ['NorthwestCorner']
ButlerLibrary ['large', 'medium-width', 'rectangular']
    buildings with same description
    ['Uris']
Carman ['medium-size', 'narrow', 'rectangular']
    buildings with same description
    ['Pupin']

```

4. Minimization

- a. SchapiroCEPSR: Small and wide building
- b. Chandler&Havemeyer: Medium-sized and asymmetrical building
- c. Low Library: Medium-size, square building
- d. Alma Mater: Smallest structure
- e. College Walk: Large narrow structure

- f. Journalism&Furnald: L-shaped building
- g. Hamilton&Hartley&Wallach&JohnJay: Largest building

Justification for how it is minimized:

For each building, it can only be minimized if it doesn't have another building with the same description. So for example, Butler cannot be minimized because it shares the description with Uris. After eliminating those that cannot be minimized, I check if each building can be described in two or even one words. For example, Alma mater can be described with the smallest because the description "smallest" is used on this structure only. The same applies to Journalism and Furnald as it is the only L-shaped building. However, for Schapiro CEPSR for example, it cannot be described as small or wide or rectangular, because there are multiple buildings that are small or wide or rectangular. Therefore, I checked if it can be described with two words. If I choose "small" and "rectangular", it will then be confused with Old Computer Center as it is also small and rectangular. But if I use small and wide, no other building has those characteristics, and therefore, it can be minimized.

Step 3: "Where"

1. Algorithm Explanation

To determine verticality and horizontality, I used the minimum bounding box and the dimension of the images. I divided the image horizontally into five sections and vertically into five sections. For each minimum bounding rectangle, I go through each point of the rectangle and check which horizontal and vertical sections it belongs to. Afterward, I first process those buildings that are the leftmost, rightmost, uppermost, and lowermost. Then for the buildings that don't have a full vertical and horizontal description, I check which description the four points of the MBR most agree with.

To test the orientation of the building, I used the MBR and the shape of the building. I believe that if the building is rectangular (not square), it has to have an orientation. Therefore, I first checked whether the building is rectangular or not, and if it is, I check which side is longer and determine the orientation from there. If the building is not rectangular, I first check if it counts as non-oriented by checking the ratio between the difference between its width and height and its shorter side. If that value is below a certain ratio, it means that the difference between its width and height is very minimal, and therefore it is non-oriented. If the building is not non-oriented, I then check which side is longer in the MBR to determine orientation.

2. Geometry

```
Pupin ['uppermost', 'left', 'horizontally-oriented']
SchapiroCEPSR ['uppermost', 'mid-width', 'horizontally-oriented']
Mudd&EngTerrace&Fairchild&CS ['uppermost', 'rightmost', 'non-oriented']
NorthwestCorner ['uppermost', 'leftmost', 'vertically-oriented']
Uris ['upper', 'mid-width', 'vertically-oriented']
Schermerhorn ['rightmost', 'upper', 'horizontally-oriented']
Chandler&Havemeyer ['leftmost', 'upper', 'non-oriented']
OldComputerCenter ['upper', 'mid-width', 'vertically-oriented']
Avery ['mid-height', 'right', 'vertically-oriented']
Fayerweather ['rightmost', 'mid-height', 'vertically-oriented']
Mathematics ['leftmost', 'mid-height', 'vertically-oriented']
LowLibrary ['mid-height', 'mid-width', 'non-oriented']
StPaulChapel ['mid-height', 'right', 'horizontally-oriented']
EarlHall ['mid-height', 'left', 'horizontally-oriented']
Lewisohn ['leftmost', 'mid-height', 'vertically-oriented']
Philosophy ['rightmost', 'mid-height', 'vertically-oriented']
Buell ['mid-height', 'right', 'horizontally-oriented']
AlmaMater ['mid-height', 'mid-width', 'non-oriented']
Dodge ['leftmost', 'mid-height', 'horizontally-oriented']
Kent ['rightmost', 'mid-height', 'horizontally-oriented']
CollegeWalk ['leftmost', 'lower', 'horizontally-oriented']
Journalism&Furnald ['leftmost', 'lower', 'non-oriented']
Hamilton&Hartley&Wallach&JohnJay ['lowermost', 'rightmost', 'vertically-oriented']
Lerner ['leftmost', 'lower', 'horizontally-oriented']
ButlerLibrary ['lowermost', 'mid-width', 'horizontally-oriented']
Carman ['lowermost', 'leftmost', 'horizontally-oriented']
```

3. Confusion

```
Pupin ['uppermost', 'left', 'horizontally-oriented']
    buildings with same description
    []
SchapiroCEPSR ['uppermost', 'mid-width', 'horizontally-oriented']
    buildings with same description
    []
Mudd&EngTerrace&Fairchild&CS ['uppermost', 'rightmost', 'non-oriented']
    buildings with same description
    []
NorthwestCorner ['uppermost', 'leftmost', 'vertically-oriented']
    buildings with same description
    []
Uris ['upper', 'mid-width', 'vertically-oriented']
    buildings with same description
    ['OldComputerCenter']
Schermerhorn ['rightmost', 'upper', 'horizontally-oriented']
    buildings with same description
    []
Chandler&Havemeyer ['leftmost', 'upper', 'non-oriented']
    buildings with same description
    []
OldComputerCenter ['upper', 'mid-width', 'vertically-oriented']
    buildings with same description
    ['Uris']
Avery ['mid-height', 'right', 'vertically-oriented']
    buildings with same description
    []
Fayerweather ['rightmost', 'mid-height', 'vertically-oriented']
    buildings with same description
    ['Philosophy']
Mathematics ['leftmost', 'mid-height', 'vertically-oriented']
    buildings with same description
    ['Lewisohn']
LowLibrary ['mid-height', 'mid-width', 'non-oriented']
    buildings with same description
    ['AlmaMater']
```

```

StPaulChapel ['mid-height', 'right', 'horizontally-oriented']
    buildings with same description
    ['Buell']
EarlHall ['mid-height', 'left', 'horizontally-oriented']
    buildings with same description
    []
Lewisohn ['leftmost', 'mid-height', 'vertically-oriented']
    buildings with same description
    ['Mathematics']
Philosophy ['rightmost', 'mid-height', 'vertically-oriented']
    buildings with same description
    ['Fayerweather']
Buell ['mid-height', 'right', 'horizontally-oriented']
    buildings with same description
    ['StPaulChapel']
AlmaMater ['mid-height', 'mid-width', 'non-oriented']
    buildings with same description
    ['LowLibrary']
Dodge ['leftmost', 'mid-height', 'horizontally-oriented']
    buildings with same description
    []
Kent ['rightmost', 'mid-height', 'horizontally-oriented']
    buildings with same description
    []
CollegeWalk ['leftmost', 'lower', 'horizontally-oriented']
    buildings with same description
    ['Lerner']
Journalism&Furnald ['leftmost', 'lower', 'non-oriented']
    buildings with same description
    []
Hamilton&Hartley&Wallach&JohnJay ['lowermost', 'rightmost', 'vertically-oriented']
    buildings with same description
    []
Lerner ['leftmost', 'lower', 'horizontally-oriented']
    buildings with same description
    ['CollegeWalk']

```

```

ButlerLibrary ['lowermost', 'mid-width', 'horizontally-oriented']
    buildings with same description
    []
Carman ['lowermost', 'leftmost', 'horizontally-oriented']
    buildings with same description
    []

```

4. Minimization

- a. Pupin: Uppermost left building
- b. SchapiroCEPSR: Uppermost mid-width building
- c. Mudd&EngTerrace&Fairchild&CS: Uppermost rightmost building
- d. NorthwestCorner: Uppermost leftmost building
- e. Schermerhorn: Rightmost upper building
- f. Chandler&Havemeyer: Leftmost upper building
- g. Avery: right vertically-oriented building

- h. EarlHall: mid-height left building
- i. Dodge: leftmost midheight building
- j. Journalism&Furnald: lower non-oriented building
- k. Hamilton&Hartley&Wallach&JohnJay: lowermost rightmost building
- l. ButlerLibrary: lowermost mid-width building
- m. Carman: lowermost leftmost building

Justification for how it is minimized:

For each building, it can only be minimized if it doesn't have another building with the same description. So for example, Lerner cannot be minimized because it shares the description with College Walk. After eliminating those that cannot be minimized, I check if each building can be described in two or even one words. In this case, none of the buildings can be described with only one word because there are multiple leftmost, rightmost, uppermost, and lowermost buildings. And there are multiple non-oriented, horizontally-oriented, and vertically-oriented buildings. However, some options can be described in two words. For example, Pupin is uppermost, left, and horizontally oriented. If I choose "horizontally-oriented" and "left", it will then be confused with Earl Hall as it is also small and rectangular. But if I use "uppermost" and "left", no other building has those characteristics, and therefore, it can be minimized. However, for a building like Kent, even though it is unique, it cannot be minimized. This is because Philosophy is "rightmost" and "mid-height", Schermerhorn is "rightmost" and "horizontally-oriented", and Dodge is "mid-height" and "horizontally-oriented". So if any of its characteristics is minimized, it will create more confusion.

Step 4: "How"

1. Algorithm Explanation

In order to determine if two buildings are near each other, I first look at if their minimum bounding rectangles intersect. And if they do, they are considered close to each other. So this is a symmetric relationship. For those buildings that do not have intersecting MBR, I find the minimum distance between their contours and divide that number by the area of the source building. I see if that number surpasses a certain threshold. This is an asymmetric relationship because the bigger the source building is, the easier it is to be close to it. And the smaller the source building is, the harder it is to be close to it.

The equation to see if two buildings are NOT close to each other is if it passes the following test:

```
10*min_d/area[S] > 0.15:
```

I tried multiple values in order to get this optimal threshold. I first tried 0.1 and that is categorizing too many buildings as not close to the source building. And I basically incremented by 0.01 until I found this value.

2. Nearness

```
Pupin
  if it is source: ['SchapiroCEPSR', 'NorthwestCorner']
  if it is target: ['SchapiroCEPSR', 'Mudd&EngTerrace&Fairchild&CS', 'NorthwestCorner', 'Uris']
SchapiroCEPSR
  if it is source: ['Pupin', 'Mudd&EngTerrace&Fairchild&CS', 'Uris']
  if it is target: ['Pupin', 'Mudd&EngTerrace&Fairchild&CS', 'Uris']
Mudd&EngTerrace&Fairchild&CS
  if it is source: ['Pupin', 'SchapiroCEPSR', 'Uris', 'Schermerhorn', 'Avery', 'Fayerweather']
  if it is target: ['SchapiroCEPSR', 'Uris', 'Schermerhorn']
NorthwestCorner
  if it is source: ['Pupin', 'Chandler&Havemeyer']
  if it is target: ['Pupin', 'Uris', 'Chandler&Havemeyer']
Uris
  if it is source: ['Pupin', 'SchapiroCEPSR', 'Mudd&EngTerrace&Fairchild&CS', 'NorthwestCorner', 'Schermerhorn', 'Chandler&Havemeyer', 'OldComputerCenter', 'Avery', 'Fayerweather', 'Mathematics', 'LowLibrary', 'StPaulChapel', 'EarlHall']
  if it is target: ['SchapiroCEPSR', 'Mudd&EngTerrace&Fairchild&CS', 'Schermerhorn', 'Chandler&Havemeyer', 'LowLibrary']
Schermerhorn
  if it is source: ['Mudd&EngTerrace&Fairchild&CS', 'Uris', 'Avery', 'Fayerweather', 'LowLibrary']
  if it is target: ['Mudd&EngTerrace&Fairchild&CS', 'Uris', 'Avery', 'Fayerweather', 'LowLibrary']
Chandler&Havemeyer
  if it is source: ['NorthwestCorner', 'Uris', 'OldComputerCenter', 'Mathematics']
  if it is target: ['NorthwestCorner', 'Uris', 'Mathematics', 'LowLibrary']
OldComputerCenter
  if it is source: []
  if it is target: ['Uris', 'Chandler&Havemeyer', 'LowLibrary']
Avery
  if it is source: ['Schermerhorn', 'StPaulChapel']
  if it is target: ['Mudd&EngTerrace&Fairchild&CS', 'Uris', 'Schermerhorn', 'LowLibrary', 'StPaulChapel']
Fayerweather
  if it is source: ['Schermerhorn', 'StPaulChapel']
  if it is target: ['Mudd&EngTerrace&Fairchild&CS', 'Uris', 'Schermerhorn', 'StPaulChapel']
Mathematics
  if it is source: ['Chandler&Havemeyer', 'EarlHall']
  if it is target: ['Uris', 'Chandler&Havemeyer', 'EarlHall']
LowLibrary
  if it is source: ['Uris', 'Schermerhorn', 'Chandler&Havemeyer', 'OldComputerCenter', 'Avery', 'StPaulChapel', 'EarlHall', 'Buell', 'AlmaMater', 'Dodge', 'Kent', 'CollegeWalk']
  if it is target: ['Uris', 'Schermerhorn', 'CollegeWalk']
StPaulChapel
  if it is source: ['Avery', 'Fayerweather', 'Philosophy', 'Buell']
  if it is target: ['Uris', 'Avery', 'Fayerweather', 'LowLibrary', 'Philosophy']
EarlHall
  if it is source: ['Mathematics', 'Lewisohn']
  if it is target: ['Uris', 'Mathematics', 'LowLibrary', 'Lewisohn']
Lewisohn
  if it is source: ['EarlHall', 'Dodge']
  if it is target: ['EarlHall', 'Dodge', 'CollegeWalk']
Philosophy
  if it is source: ['StPaulChapel', 'Kent']
  if it is target: ['StPaulChapel', 'Kent', 'CollegeWalk', 'Hamilton&Hartley&Wallach&JohnJay']
Buell
  if it is source: []
  if it is target: ['LowLibrary', 'StPaulChapel', 'CollegeWalk', 'Hamilton&Hartley&Wallach&JohnJay']
AlmaMater
  if it is source: []
  if it is target: ['LowLibrary', 'CollegeWalk', 'Hamilton&Hartley&Wallach&JohnJay']
Dodge
  if it is source: ['Lewisohn', 'CollegeWalk']
  if it is target: ['LowLibrary', 'Lewisohn', 'CollegeWalk', 'Journalism&Furnald']
Kent
  if it is source: ['Philosophy', 'CollegeWalk']
  if it is target: ['LowLibrary', 'Philosophy', 'CollegeWalk', 'Hamilton&Hartley&Wallach&JohnJay']
CollegeWalk
  if it is source: ['LowLibrary', 'Lewisohn', 'Philosophy', 'Buell', 'AlmaMater', 'Dodge', 'Kent', 'Journalism&Furnald', 'Hamilton&Hartley&Wallach&JohnJay']
  if it is target: ['LowLibrary', 'Dodge', 'Kent', 'Journalism&Furnald', 'Hamilton&Hartley&Wallach&JohnJay']
Journalism&Furnald
  if it is source: ['Dodge', 'CollegeWalk', 'Lerner']
  if it is target: ['CollegeWalk', 'Lerner', 'ButlerLibrary']
```

```

Hamilton&Hartley&Wallach&JohnJay
  if it is source: ['Philosophy', 'Buell', 'AlmaMater', 'Kent', 'CollegeWalk', 'ButlerLibrary']
  if it is target: ['CollegeWalk', 'ButlerLibrary']
Lerner
  if it is source: ['Journalism&Furnald', 'ButlerLibrary', 'Carman']
  if it is target: ['Journalism&Furnald', 'ButlerLibrary', 'Carman']
ButlerLibrary
  if it is source: ['Journalism&Furnald', 'Hamilton&Hartley&Wallach&JohnJay', 'Lerner', 'Carman']
  if it is target: ['Hamilton&Hartley&Wallach&JohnJay', 'Lerner', 'Carman']
Carman
  if it is source: ['Lerner', 'ButlerLibrary']
  if it is target: ['Lerner', 'ButlerLibrary']

```

3. Confusion

- a. The source that is near to the most number of targets:
 - i. Uris
- b. The source that is near to the least number of targets:
 - i. OldComputerCenter, Buell, AlmaMater
- c. The target that is near to the most number of sources:
 - i. Uris, Schermerhorn, Avery, StPaulChapel, CollegeWalk
- d. The target that is near to the least number of sources:
 - i. Carman, Hamilton&Hartley&Wallach&JohnJay

4. Minimization

Note: underlined option is the landmark source

- a. **Pupin**
 - i. ['SchapiroCEPSR', 'Mudd&EngTerrace&Fairchild&CS', 'NorthwestCorner', 'Uris']
- b. **SchapiroCEPSR**
 - i. ['Pupin', 'Mudd&EngTerrace&Fairchild&CS', 'Uris']
- c. **Mudd&EngTerrace&Fairchild&CS**
 - i. ['SchapiroCEPSR', 'Uris', 'Schermerhorn']
- d. **NorthwestCorner**
 - i. ['Pupin', 'Uris', 'Chandler&Havemeyer']
- e. **Uris**
 - i. ['SchapiroCEPSR', 'Mudd&EngTerrace&Fairchild&CS', 'Schermerhorn', 'Chandler&Havemeyer', 'LowLibrary']
- f. **Schermerhorn**
 - i. ['Mudd&EngTerrace&Fairchild&CS', 'Uris', 'Avery', 'Fayerweather', 'LowLibrary']
- g. **Chandler&Havemeyer**
 - i. ['NorthwestCorner', 'Uris', 'Mathematics', 'LowLibrary']
- h. **OldComputerCenter**
 - i. ['Uris', 'Chandler&Havemeyer', 'LowLibrary']
- i. **Avery**

- i. ['Mudd&EngTerrace&Fairchild&CS', 'Uris', 'Schermerhorn', 'LowLibrary', 'StPaulChapel']
- j. **Fayerweather**
 - i. ['Mudd&EngTerrace&Fairchild&CS', 'Uris', 'Schermerhorn', 'StPaulChapel']
- k. **Mathematics**
 - i. ['Uris', 'Chandler&Havemeyer', 'EarlHall']
- l. **LowLibrary**
 - i. ['Uris', 'Schermerhorn', 'CollegeWalk']
- m. **StPaulChapel**
 - i. ['Uris', 'Avery', 'Fayerweather', 'LowLibrary', 'Philosophy']
- n. **EarlHall**
 - i. ['Uris', 'Mathematics', 'LowLibrary', 'Lewisohn']
- o. **Lewisohn**
 - i. ['EarlHall', 'Dodge', 'CollegeWalk']
- p. **Philosophy**
 - i. ['StPaulChapel', 'Kent', 'CollegeWalk', 'Hamilton&Hartley&Wallach&JohnJay']
- q. **Buell**
 - i. ['LowLibrary', 'StPaulChapel', 'CollegeWalk', 'Hamilton&Hartley&Wallach&JohnJay']
- r. **AlmaMater**
 - i. ['LowLibrary', 'CollegeWalk', 'Hamilton&Hartley&Wallach&JohnJay']
- s. **Dodge**
 - i. ['LowLibrary', 'Lewisohn', 'CollegeWalk', 'Journalism&Furnald']
- t. **Kent**
 - i. ['LowLibrary', 'Philosophy', 'CollegeWalk', 'Hamilton&Hartley&Wallach&JohnJay']
- u. **CollegeWalk**
 - i. ['LowLibrary', 'Dodge', 'Kent', 'Journalism&Furnald', 'Hamilton&Hartley&Wallach&JohnJay']
- v. **Journalism&Furnald**
 - i. ['CollegeWalk', 'Lerner', 'ButlerLibrary']
- w. **Hamilton&Hartley&Wallach&JohnJay**
 - i. ['CollegeWalk', 'ButlerLibrary']
- x. **Lerner**
 - i. ['Journalism&Furnald', 'ButlerLibrary', 'Carman']
- y. **ButlerLibrary**
 - i. ['Hamilton&Hartley&Wallach&JohnJay', 'Lerner', 'Carman']
- z. **Carman**

i. ['Lerner', 'ButlerLibrary']

Justification for how it is minimized:

For each building, I checked if it has a source that is near to the most number of buildings, which is Uris in this case. If it has Uris as one of its sources, the Uris will be its “landmark” source. Then for those that do not have Uris, I checked among the ones it has, which is the most frequent source and marked that as the “landmark” source.

Step 5: Total Description

1. Total Description

NOTE: this is generated by the program but it is hard to read through the terminal so I copied and pasted it.

Pupin

medium-size , narrow , and rectangular structure located on the uppermost and left side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

SchapiroCEPSR

small , wide , and rectangular structure located on the uppermost and mid-width side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Mudd&EngTerrace&Fairchild&CS

large , wide , and asymmetrical structure located on the uppermost and rightmost side of campus and non-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

NorthwestCorner

medium-size , medium-width , and rectangular structure located on the uppermost and leftmost side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Uris

large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Schermerhorn

large , wide , and asymmetrical structure located on the rightmost and upper side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Chandler&Havemeyer

medium-size , wide , and asymmetrical structure located on the leftmost and upper side of campus and non-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

OldComputerCenter

small , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Avery

small , medium-width , and rectangular structure located on the mid-height and right side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Fayerweather

small , medium-width , and rectangular structure located on the rightmost and mid-height side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Mathematics

small , medium-width , and I-shaped structure located on the leftmost and mid-height side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

LowLibrary

medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

StPaulChapel

small , medium-width , and rectangular structure located on the mid-height and right side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

EarlHall

small , medium-width , and rectangular structure located on the mid-height and left side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Lewisohn

small , medium-width , and I-shaped structure located on the leftmost and mid-height side of campus and vertically-oriented

it is close to CollegeWalk which is a large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

Philosophy

small , medium-width , and I-shaped structure located on the rightmost and mid-height side of campus and vertically-oriented

it is close to CollegeWalk which is a large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

Buell

small , medium-width , and rectangular structure located on the mid-height and right side of campus and horizontally-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

AlmaMater

smallest , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Dodge

medium-size , narrow , and C-shaped structure located on the leftmost and mid-height side of campus and horizontally-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Kent

medium-size , narrow , and C-shaped structure located on the rightmost and mid-height side of campus and horizontally-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

CollegeWalk

large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Journalism&Furnald

medium-size , wide , and L-shaped structure located on the leftmost and lower side of campus and non-oriented

it is close to CollegeWalk which is a large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

Hamilton&Hartley&Wallach&JohnJay

largest , medium-width , and C-shaped structure located on the lowermost and rightmost side of campus and vertically-oriented

it is close to CollegeWalk which is a large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

Lerner

medium-size , medium-width , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

it is close to ButlerLibrary which is a large , medium-width , and rectangular structure located on the lowermost and mid-width side of campus and horizontally-oriented

ButlerLibrary

large , medium-width , and rectangular structure located on the lowermost and mid-width side of campus and horizontally-oriented

it is close to Hamilton&Hartley&Wallach&JohnJay which is a largest , medium-width , and C-shaped structure located on the lowermost and rightmost side of campus and vertically-oriented

Carman

medium-size , narrow , and rectangular structure located on the lowermost and leftmost side of campus and horizontally-oriented

it is close to ButlerLibrary which is a large , medium-width , and rectangular structure located on the lowermost and mid-width side of campus and horizontally-oriented

2. Confusion

- a. No total description is confusing

3. Minimization

Pupin

Longest

medium-size , narrow , and rectangular structure located on the uppermost and left side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Uppermost left structure

Justification

Pupin's "where" description can be minimized, which means that this minimized property alone can distinguish it from all other buildings. Indeed, the only building that is uppermost and not leftmost or mid-width is Pupin.

SchapiroCEPSR

Longest

small , wide , and rectangular structure located on the uppermost and mid-width side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Uppermost and mid-width structure

Justification

Because Schapiro CEPSP is the only building in the center of campus that is uppermost, it is enough to describe it with two words. Adding its closeness to Uris is more confusing because so many buildings are close to Uris.

Mudd&EngTerrace&Fairchild&CS

Longest

large , wide , and asymmetrical structure located on the uppermost and rightmost side of campus and non-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Uppermost and rightmost structure

Justification

In terms of verticality and horizontality. Buildings that are on the four corners of campus are unique. There cannot be two leftmost uppermost buildings. Therefore, Mudd&EngTerrace&Fairchild&CS can just be described by their verticality and horizontality.

NorthwestCorner

Longest

medium-size , medium-width , and rectangular structure located on the uppermost and leftmost side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Uppermost and leftmost structure

Justification

In terms of verticality and horizontality. Buildings that are on the four corners of campus are unique. There cannot be two leftmost uppermost buildings. Therefore, Northwest can just be described by its verticality and horizontality.

Uris

Longest

large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Shortest

Large, upper, mid-width building

Justification

In both “what” and “where”, Uris’s descriptions are non-unique and not minimizable. Therefore, its shortest description is longer. Its “where” is almost unique, but because the old computer center is also “upper” and “mid-width” and “vertically-oriented”, it is confusing. However, by adding large, it is enough to tell them apart. The near is not needed because too many buildings are close to Low library.

Schermerhorn

Longest

large , wide , and asymmetrical structure located on the rightmost and upper side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Asymmetrical building located on the rightmost upper part of campus

Justification

Schermerhorn “where” description can be minimized, which means that this minimized property alone can distinguish it from all other buildings. Indeed, the only building that is rightmost and not uppermost or mid-height is Schermerhorn. However, in my opinion, Fayerweather can also be considered upper and rightmost. Therefore, adding the description “asymmetrical” will help to distinguish Schermerhorn from Fayerweather as Fayerweather is rectangular.

Chandler&Havemeyer

Longest

medium-size , wide , and asymmetrical structure located on the leftmost and upper side of campus and non-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Asymmetrical building located on the leftmost and upper part of campus

Justification

Chandler&Havemeyer's "where" description can be minimized, which means that this minimized property alone can distinguish it from all other buildings. Indeed, the only building that is leftmost and upper is Chandler&Havemeyer. However, in my opinion, Mathematics can also be considered upper and leftmost. Therefore, adding the description "asymmetrical" will help to distinguish Chandler&Havemeyer from Mathematics as Mathematics is rectangular.

OldComputerCenter

Longest

small , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Rectangular, upper, mid-width building

Justification

As mentioned in the description of Uris, Uris and the Old computer center share the same "where" description. However, what distinguishes them apart is the fact that the old computer center is rectangular. Therefore, by adding that description, it eliminates confusion.

Avery

Longest

small , medium-width , and rectangular structure located on the mid-height and right side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Right, vertically-oriented building

Justification

Avery's "where" description can be minimized, which means that this minimized property alone can distinguish it from all other buildings. Indeed, the only building that is right and vertically-oriented is Avery.

Fayerweather

Longest

small , medium-width , and rectangular structure located on the rightmost and mid-height side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Rectangular structure located on the rightmost side of campus

Justification

Fayerweather does not have any properties that can be minimized. This is because its “where” is the same as Philosophy’s. However, by adding rectangular, it can successfully be distinguished from Philosophy as it is I-shaped. Moreover, because it is the only rectangular rightmost building, those qualities alone are enough.

Mathematics

Longest

small , medium-width , and I-shaped structure located on the leftmost and mid-height side of campus and vertically-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Leftmost I-shaped structure that is close to Uris, which is a large, upper, mid-width building

Justification

Math does not have any properties that can be minimized. This is because its “where” is the same as Lewisohn’s. However, Lewisohn is not close to Uris. Therefore, by adding the shortest description of Uris, they are distinguished apart.

LowLibrary

Longest

medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Medium size square building

Justification

There are only two square structures, Low library and Alma mater. By adding medium-size, low library is distinguished from alma mater.

StPaulChapel

Longest

small , medium-width , and rectangular structure located on the mid-height and right side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Horizontally-oriented structure that is located on the right side of campus that is close to Uris, which is a large, upper, mid-width building

Justification

StPaul Chapel and Buell share the same “where” and “what”. The only thing that set them apart is where they are near to. Therefore, after highlighting the shared characteristics between StPaul Chapel and Buell, it is important to highlight how it is close to Uris rather than College Walk.

EarlHall

Longest

small , medium-width , and rectangular structure located on the mid-height and left side of campus and horizontally-oriented

it is close to Uris which is a large , medium-width , and rectangular structure located on the upper and mid-width side of campus and vertically-oriented

Shortest

Mid-height left building

Justification

Earl Hall’s “where” description can be minimized, which means that this minimized property alone can distinguish it from all other buildings. Indeed, the only building that is left and mid-height is Earl Hall.

Lewisohn

Longest

small , medium-width , and I-shaped structure located on the leftmost and mid-height side of campus and vertically-oriented

it is close to CollegeWalk which is a large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

Shortest

Leftmost I-shaped structure that is close to College Walk, which is a large narrow structure

Justification

Lewisohn does not have any properties that can be minimized. This is because its “where” is the same as Math’s. However, Math is not close to College Walk. Therefore, by adding the shortest description of College Walk, they are distinguished apart.

Philosophy

Longest

small , medium-width , and I-shaped structure located on the rightmost and mid-height side of campus and vertically-oriented

it is close to CollegeWalk which is a large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

Shortest

Rightmost I-shaped structure that is close to College Walk, which is a large narrow structure

Justification

There are I-shaped buildings on both sides of the campus. Therefore, it is impossible to have the description as “I-shaped structure that is close to College Walk” as Lewisohn also satisfies this requirement. However, by adding rightmost, the options are narrowed down to Philosophy.

Buell

Longest

small , medium-width , and rectangular structure located on the mid-height and right side of campus and horizontally-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Shortest

Horizontally-oriented structure that is located on the right side of campus that is close to College Walk, which is a large narrow structure

Justification

As mentioned before, Buell and St.Paul have the same “where” and “what” description. Therefore, it is important to mention how it is close to College Walk. Moreover, “horizontally-oriented” and “right side of campus” are two characteristics that are enough to narrow down the options to Buell and St. Paul’s.

AlmaMater

Longest

smallest , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Shortest

smallest structure

Justification

In terms of size, there is only one smallest building. Therefore, Alma mater can just be minimized to the smallest.

Dodge

Longest

medium-size , narrow , and C-shaped structure located on the leftmost and mid-height side of campus and horizontally-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Shortest

C-shaped leftmost building

Justification

There are only three C-shaped building and only one of them is on the left side. Therefore, these two characteristics are enough.

Kent

Longest

medium-size , narrow , and C-shaped structure located on the rightmost and mid-height side of campus and horizontally-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Shortest

Medium-sized C-shaped building that is located on the rightmost side of campus

Justification

Two of the C-shaped buildings are rightmost, and two of the C-shaped buildings are medium-sized. Therefore, in order to characterize Kent, both “rightmost” and “medium-sized” are needed. Moreover, the nearTo is not important in this case because Hamilton&Hartley&Wallach&JohnJay, which is also C-shaped, is close to College walk too.

CollegeWalk

Longest

large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

it is close to LowLibrary which is a medium-size , wide , and square structure located on the mid-height and mid-width side of campus and non-oriented

Shortest

Large narrow structure

Justification

College Walk’s “what” description can be minimized, which means that this minimized property alone can distinguish it from all other buildings. Indeed, the only building that is large and narrow is College Walk.

Journalism&Furnald

Longest

medium-size , wide , and L-shaped structure located on the leftmost and lower side of campus and non-oriented

it is close to CollegeWalk which is a large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

Shortest

L-shaped structure

Justification

Journalism & Furnald is the only structure that is L-shaped. Because this property is unique, it is enough to describe the building.

Hamilton&Hartley&Wallach&JohnJay

Longest

largest , medium-width , and C-shaped structure located on the lowermost and rightmost side of campus and vertically-oriented

it is close to CollegeWalk which is a large , narrow , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

Shortest

Largest structure

Justification

In terms of size, there is only one largest building. Therefore, Hamilton&Hartley&Wallach&JohnJay can just be minimized to the largest.

Lerner

Longest

medium-size , medium-width , and rectangular structure located on the leftmost and lower side of campus and horizontally-oriented

it is close to ButlerLibrary which is a large , medium-width , and rectangular structure located on the lowermost and mid-width side of campus and horizontally-oriented

Shortest

Rectangular structure located on the leftmost and lower side of campus

Justification

The only two structures that are located on the leftmost and lower side of campus are Lerner Hall and Journalism&Furnald. The important difference between them is that Journalism&Furnald is L-shaped while Lerner is rectangular. Therefore, by adding “rectangular”, they can be successfully distinguished.

ButlerLibrary

Longest

large , medium-width , and rectangular structure located on the lowermost and mid-width side of campus and horizontally-oriented

it is close to Hamilton&Hartley&Wallach&JohnJay which is a largest , medium-width , and C-shaped structure located on the lowermost and rightmost side of campus and vertically-oriented

Shortest

Lower most mid-width structure

Justification

Describe Butler with “lowermost, mid-width” is enough and unconfusing because it is the only building that satisfies this criterion. Adding its “what” and “near” descriptions will only make it more confusing.

Carman

Longest

medium-size , narrow , and rectangular structure located on the lowermost and leftmost side of campus and horizontally-oriented

it is close to ButlerLibrary which is a large , medium-width , and rectangular structure located on the lowermost and mid-width side of campus and horizontally-oriented

Shortest

Lowermost and leftmost structure

Justification

In terms of verticality and horizontality. Buildings that are on the four corners of campus are unique. There cannot be two leftmost uppermost buildings. Therefore, Carman can just be described by its verticality and horizontality.