

Lecture 6: Creating a simplicial complex from data.

in a series of preparatory lectures for the Fall 2013 online course
MATH:7450 (22M:305) Topics in Topology: Scientific and Engineering
Applications of Algebraic Topology

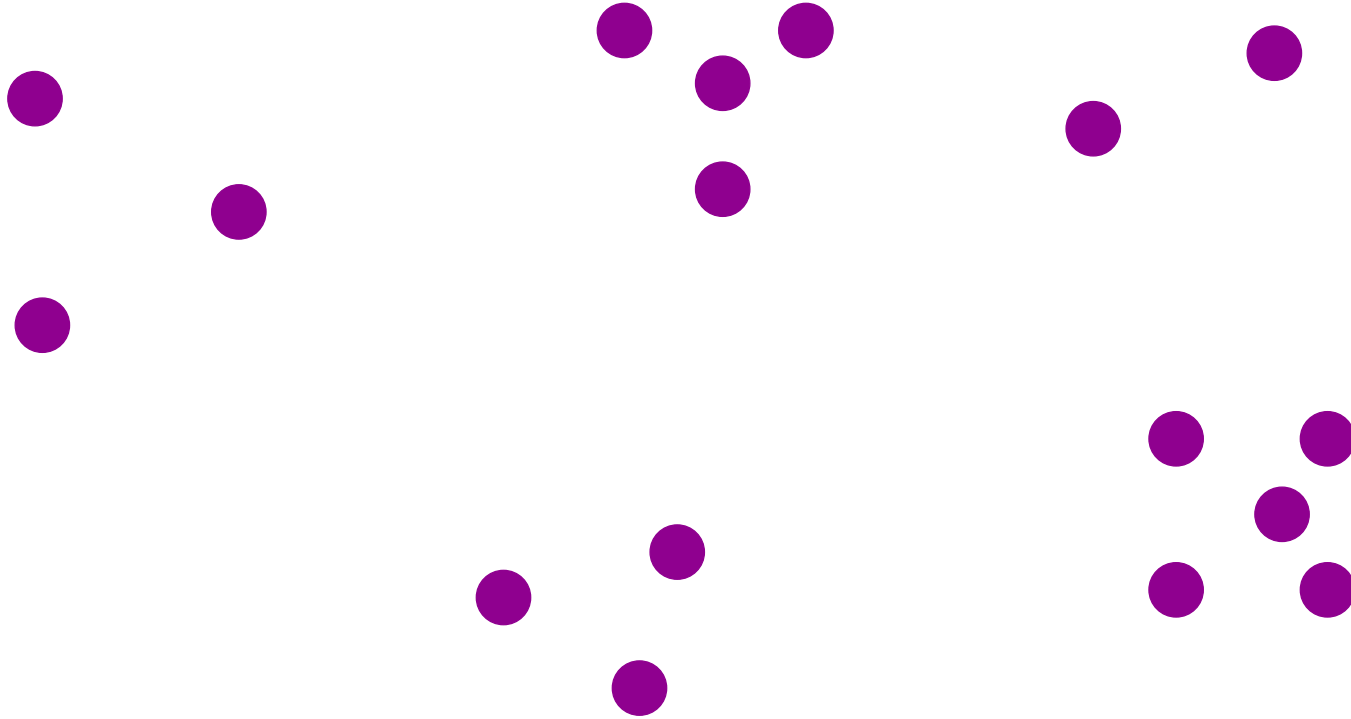
Target Audience: Anyone interested in **topological data analysis**
including graduate students, faculty, industrial researchers in
bioinformatics, biology, business, computer science, cosmology,
engineering, imaging, mathematics, neurology, physics, statistics, etc.

Isabel K. Darcy

Mathematics Department/Applied Mathematical & Computational Sciences
University of Iowa

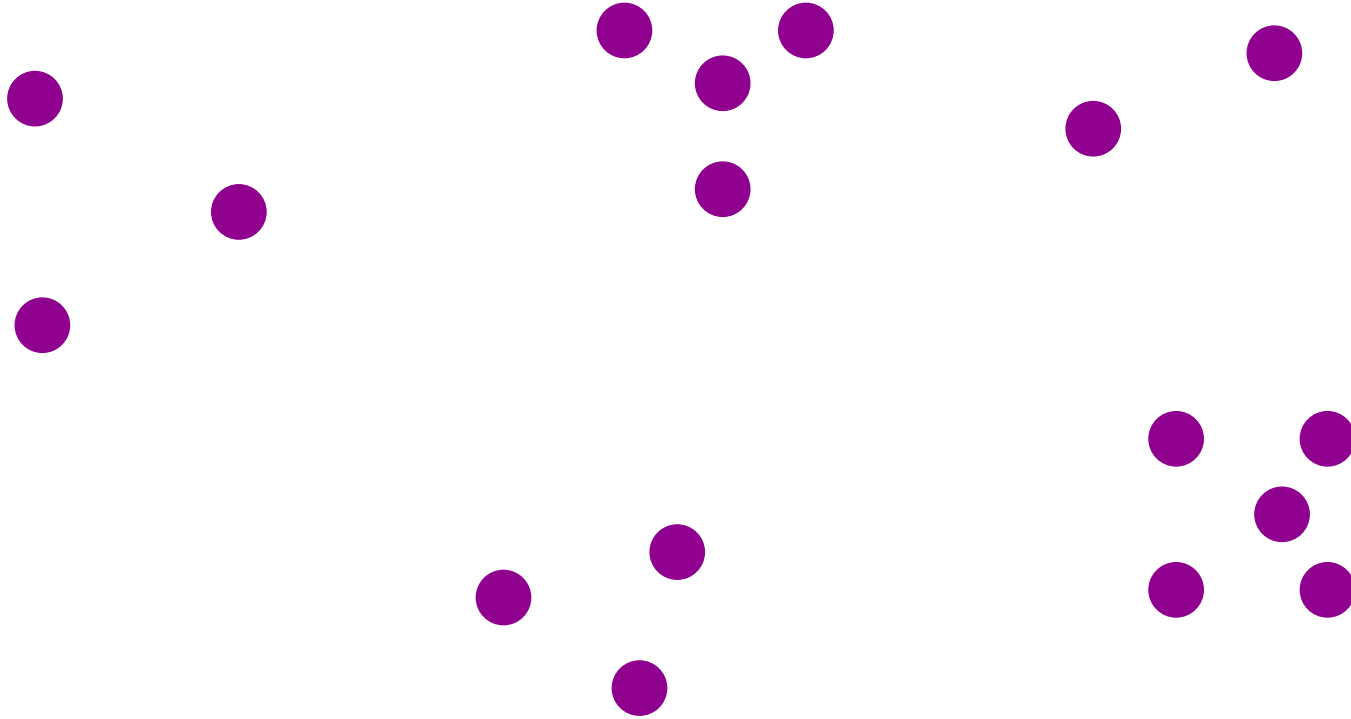
<http://www.math.uiowa.edu/~idarcy/AppliedTopology.html>

Creating a simplicial complex



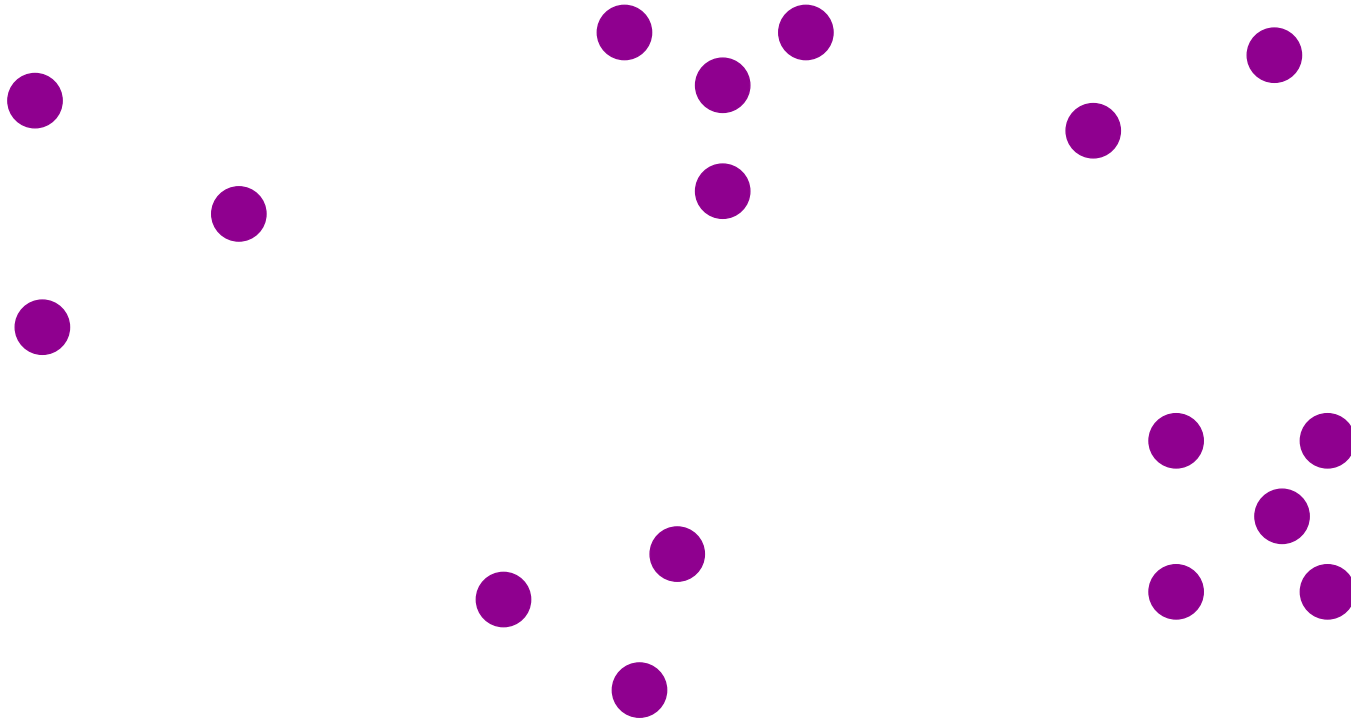
Step 0.) Start by adding 0-dimensional vertices
(0-simplices)

Creating a simplicial complex



Step 0.) Start by adding data points
= 0-dimensional vertices (0-simplices)

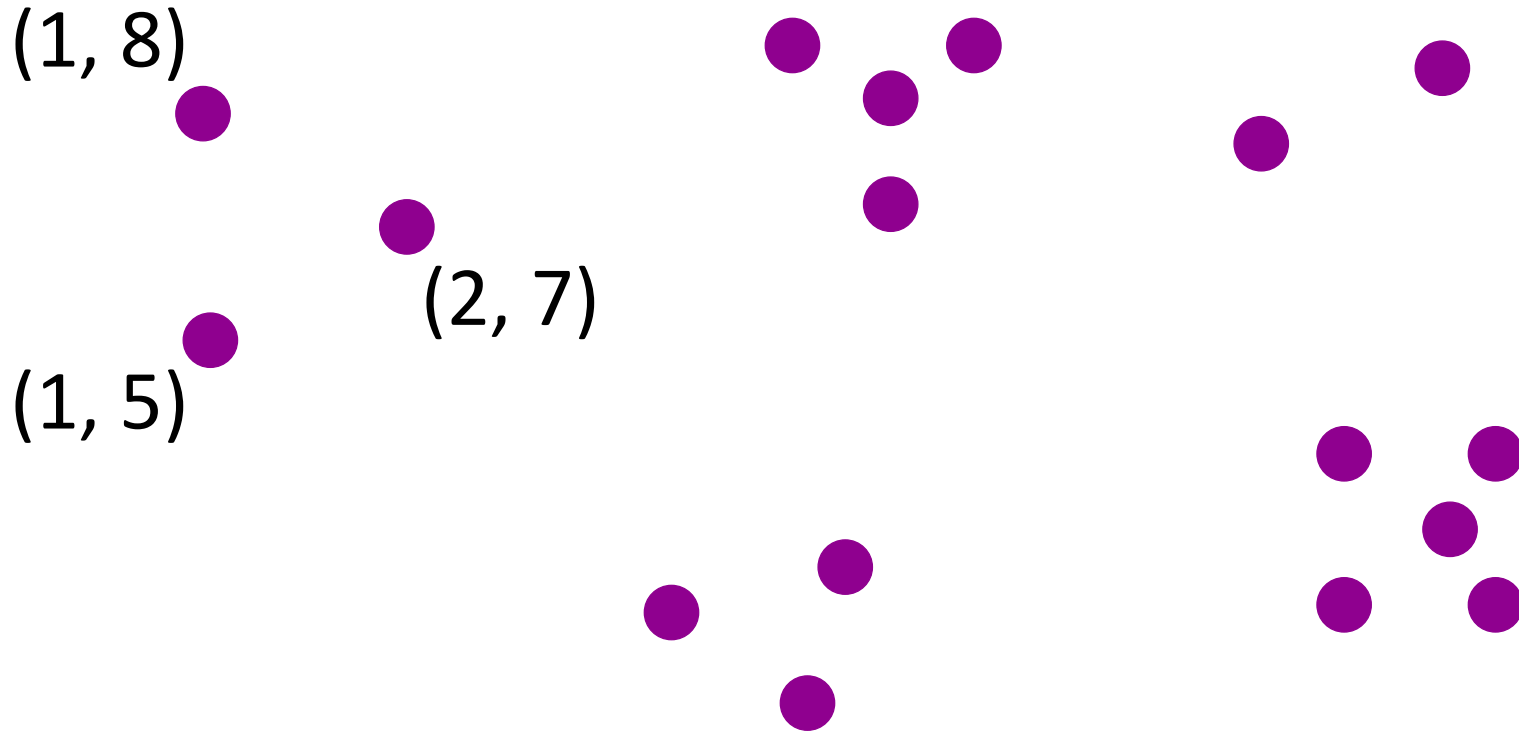
Creating a simplicial complex



0.) Start by adding 0-dimensional data points

Note: we only need a definition of closeness between data points. The data points do not need to be actual points in \mathbb{R}^n

Creating a simplicial complex



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Creating a simplicial complex

(dog, happy)



(wolf, mirthful)



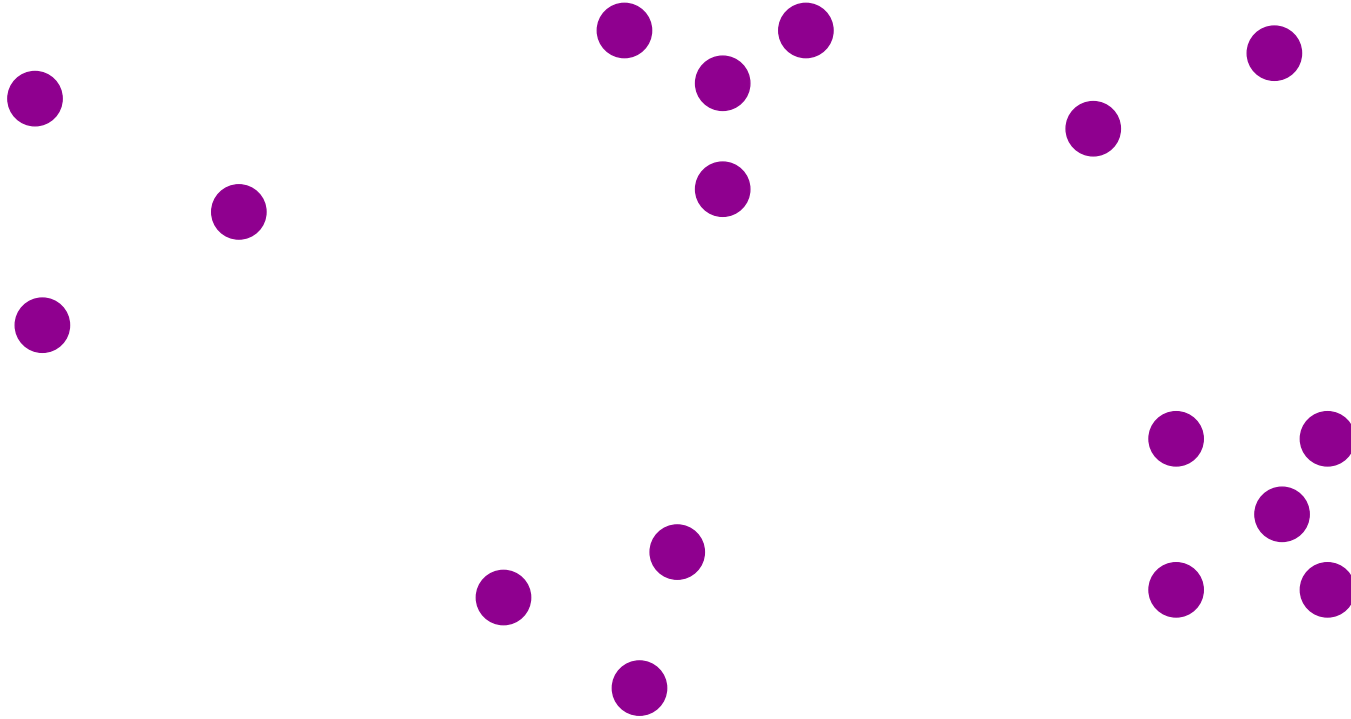
(dog, content)



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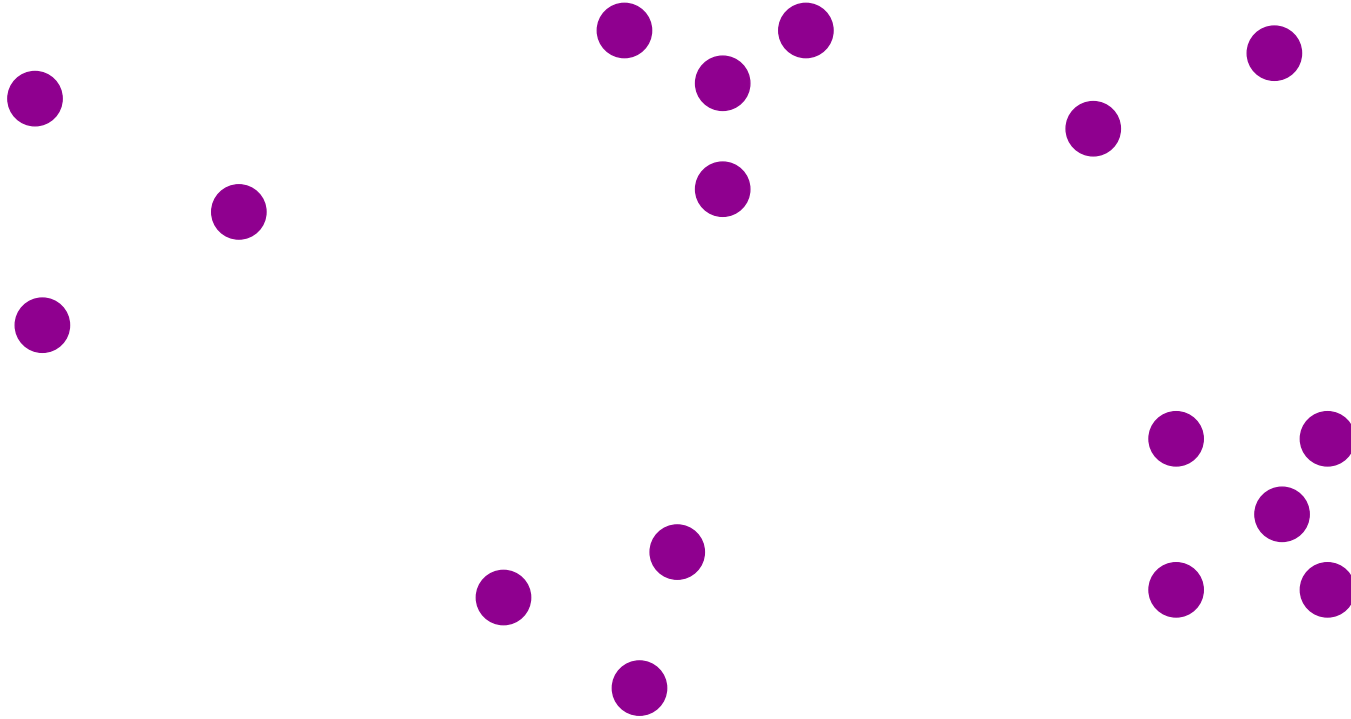
Creating a simplicial complex



1.) Adding 1-dimensional edges (1-simplices)

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Creating a simplicial complex



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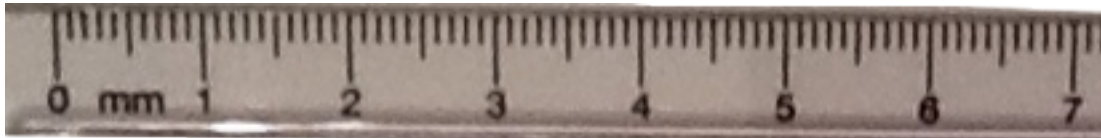
Add an edge between data points that are “close”

Creating a simplicial complex



1.) Adding 1-dimensional edges (1-simplices)

Add an edge between data points that are “close”



Creating a simplicial complex



1.) Adding 1-dimensional edges (1-simplices)

Let $T = \text{Threshold}$

Connect vertices v and w with an edge iff
the distance between v and w is less than T

Creating a simplicial complex

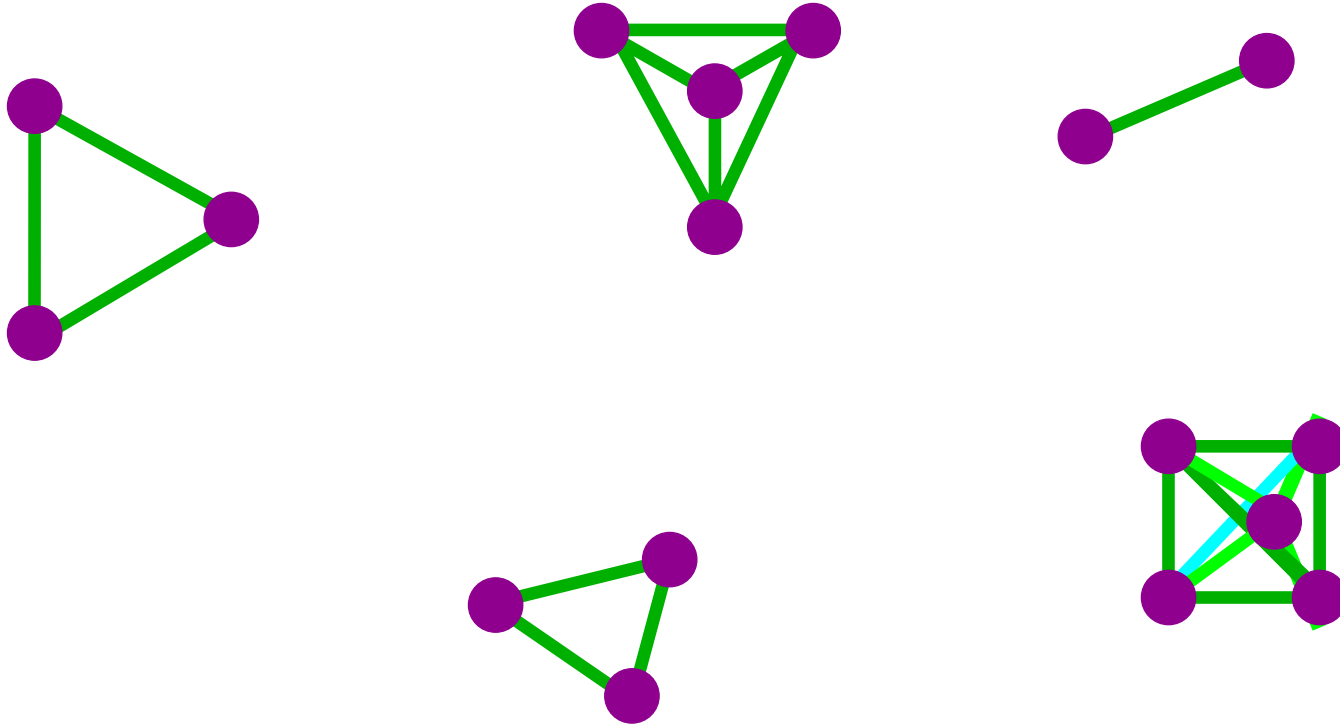


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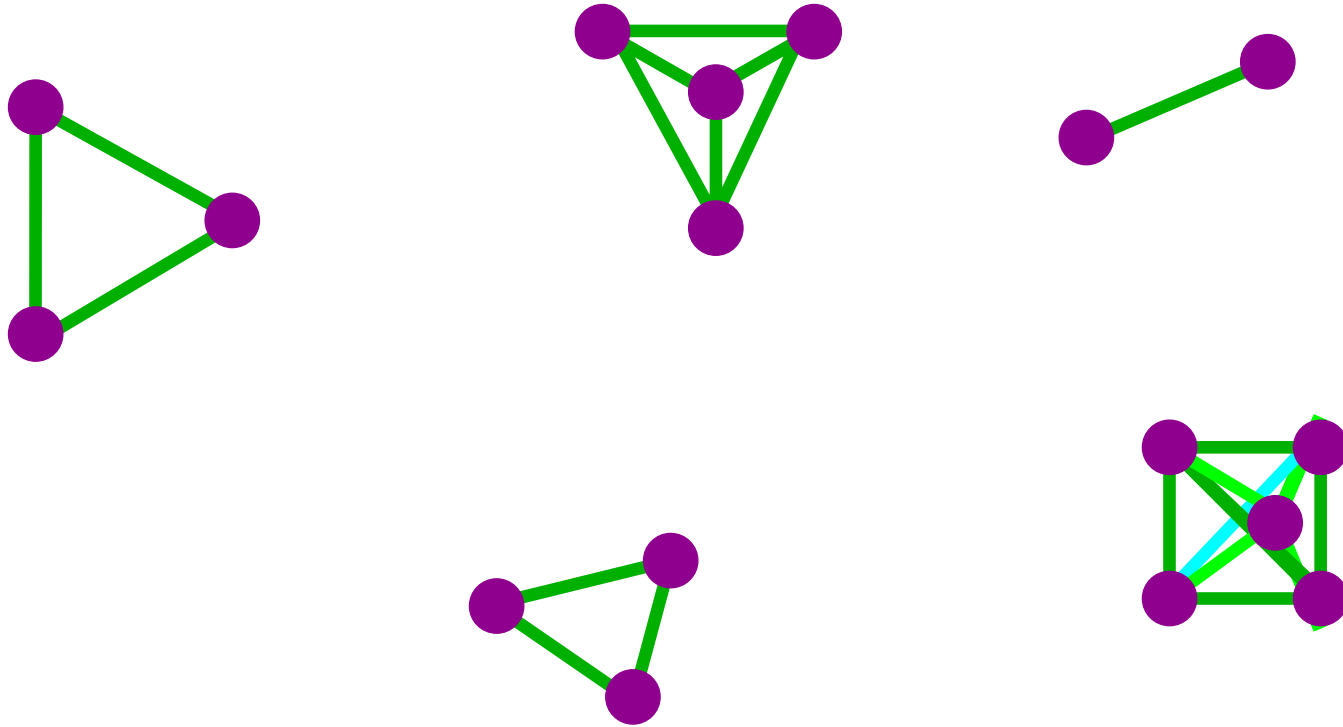
Creating a simplicial complex



1.) Adding 1-dimensional edges (1-simplices)

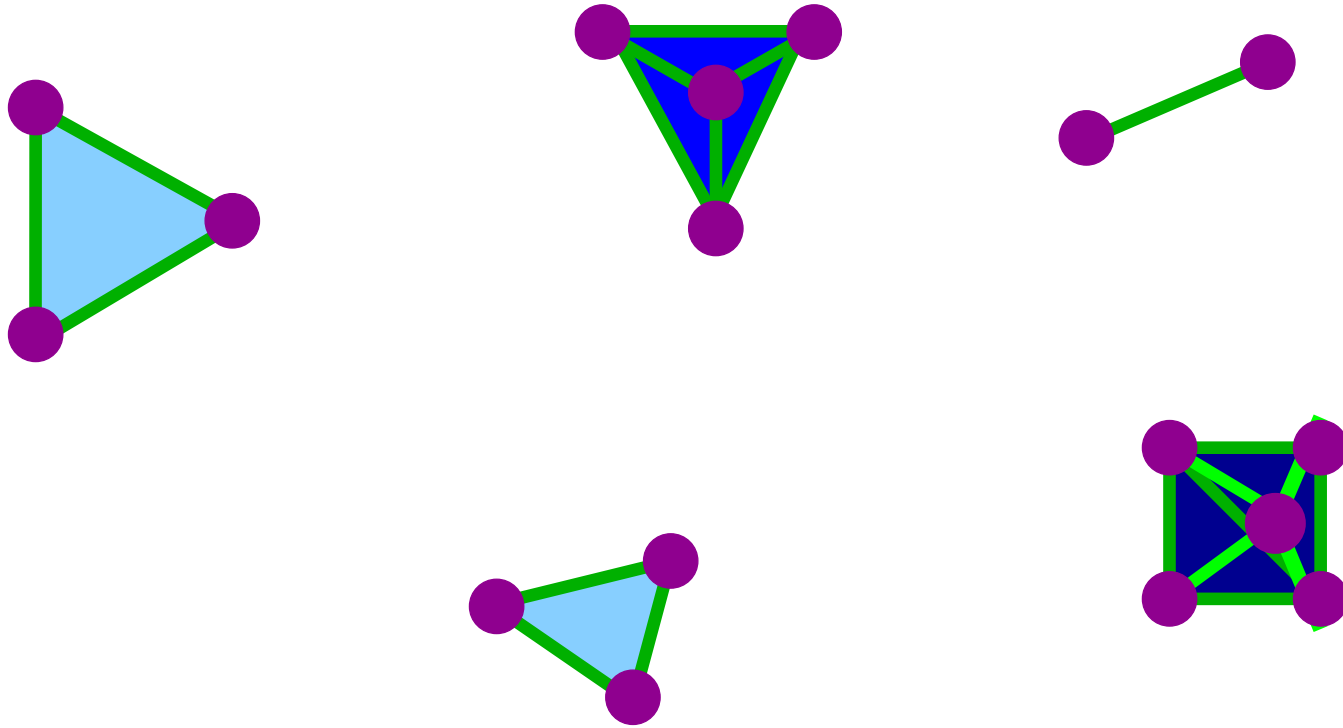
Add an edge between data points that are “close”

Creating the Vietoris-Rips simplicial complex



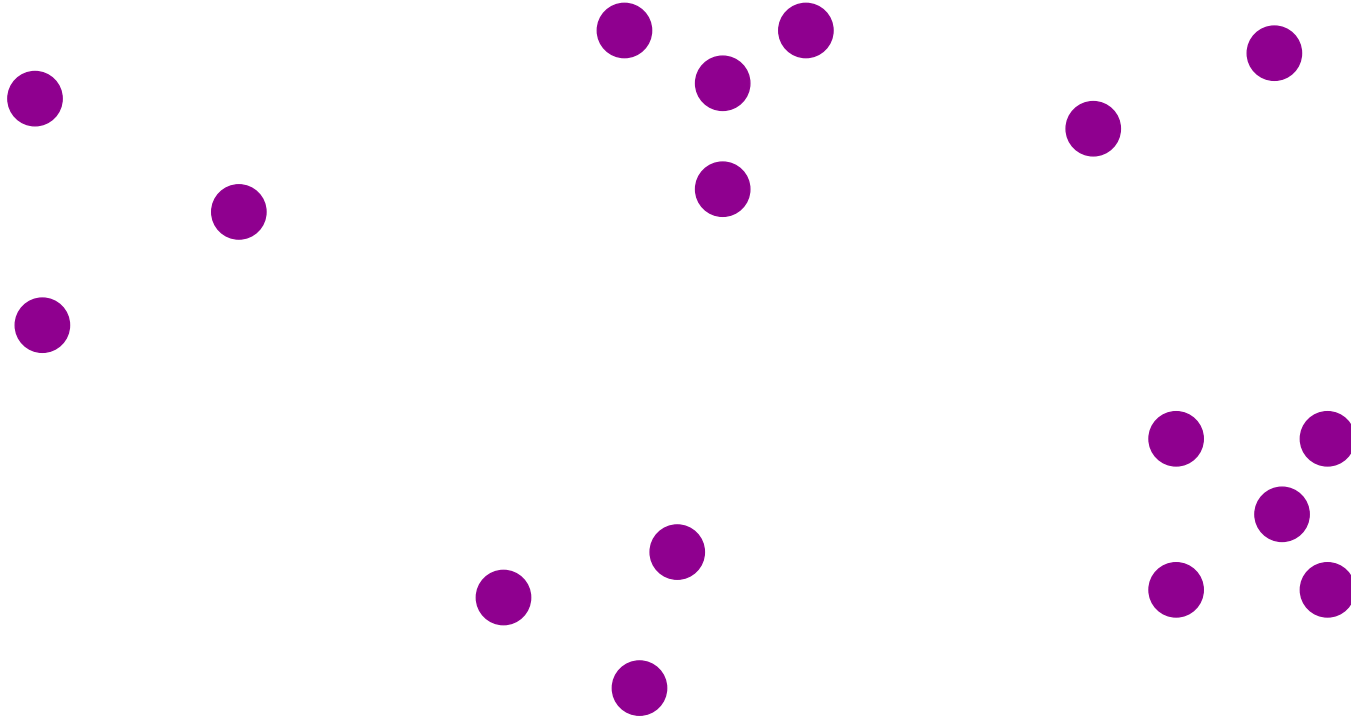
2.) Add all possible simplices of dimension > 1 .

Creating the Vietoris Rips simplicial complex



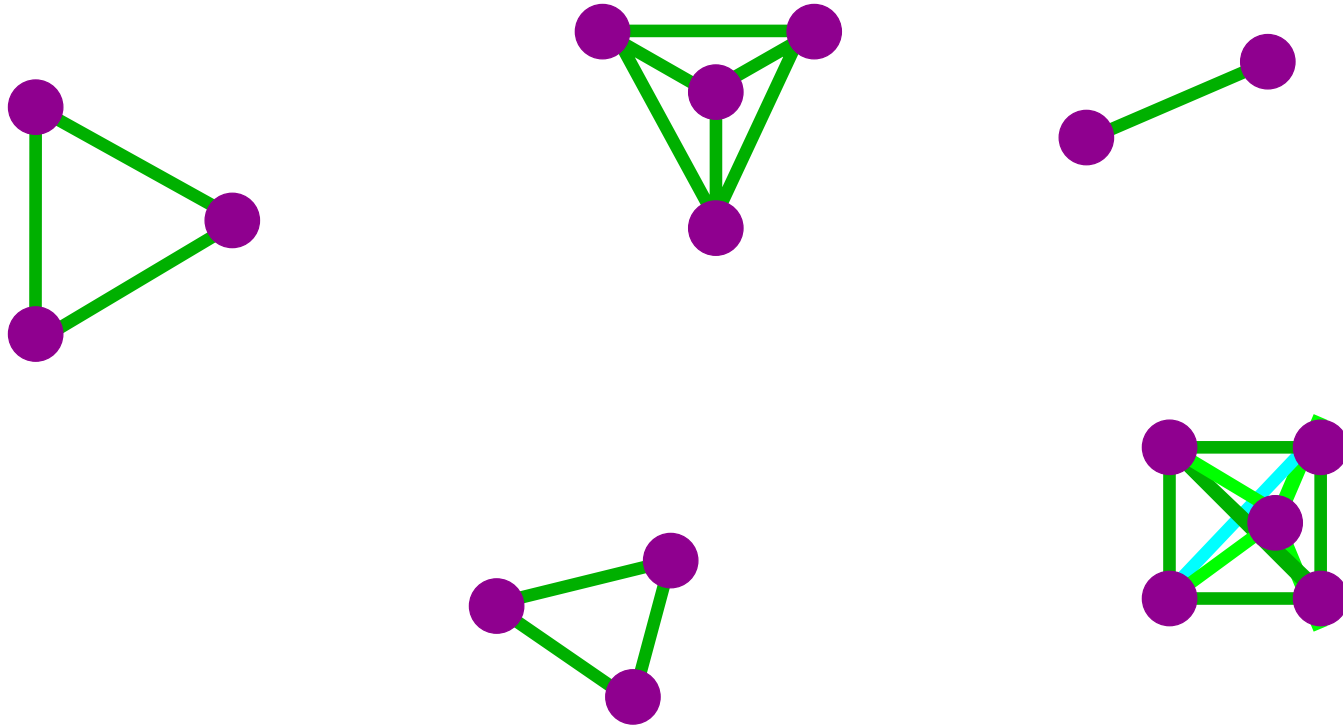
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Creating the Vietoris Rips simplicial complex



Step 0.) Start by adding data points
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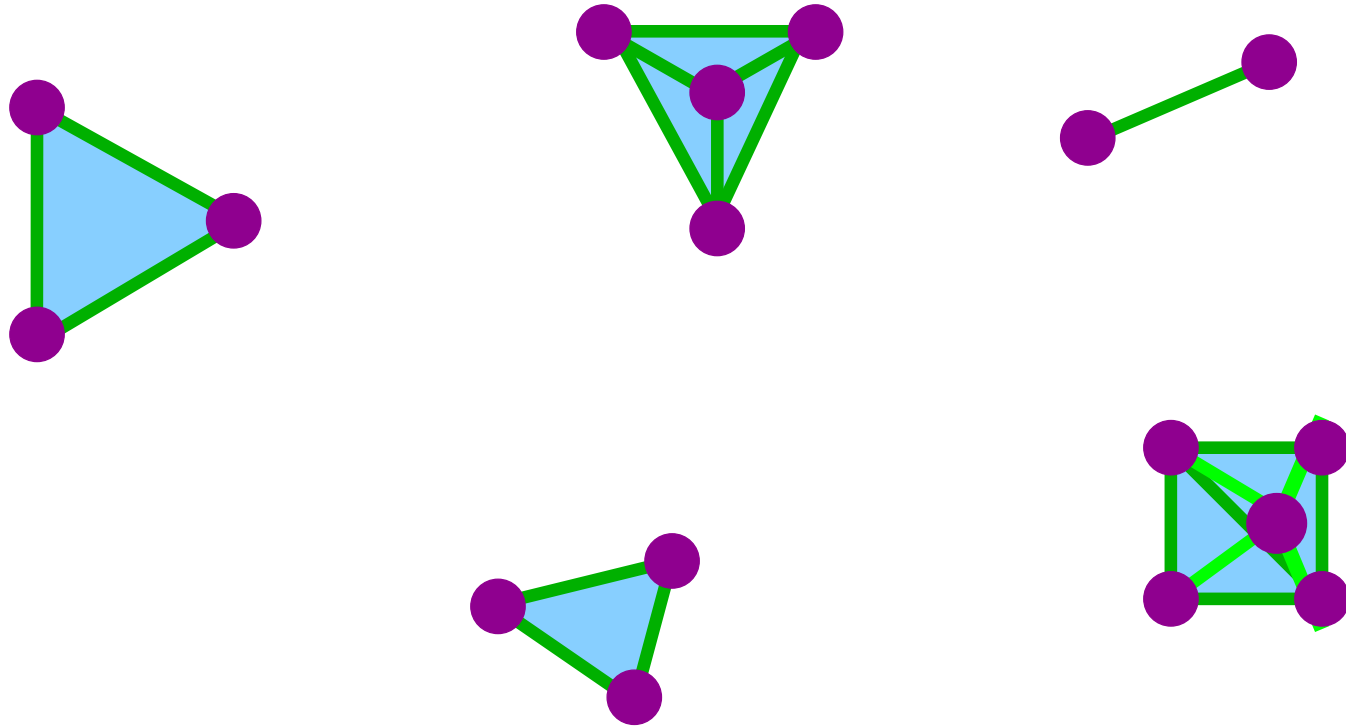
Creating the Vietoris Rips simplicial complex



1.) Adding 1-dimensional edges (1-simplices)

Add an edge between data points that are “close”

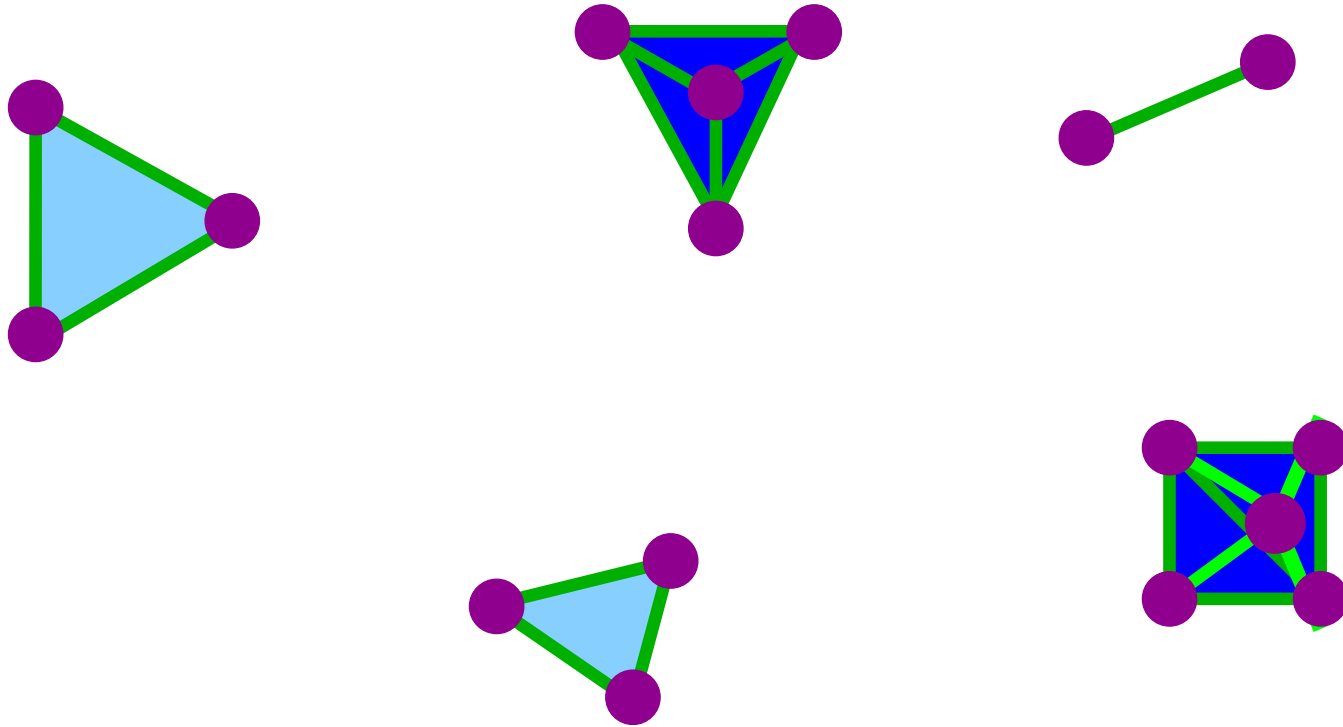
Creating the Vietoris Rips simplicial complex



2.) Add 2-dimensional triangles (2-simplices)

Add all possible 2-simplices.

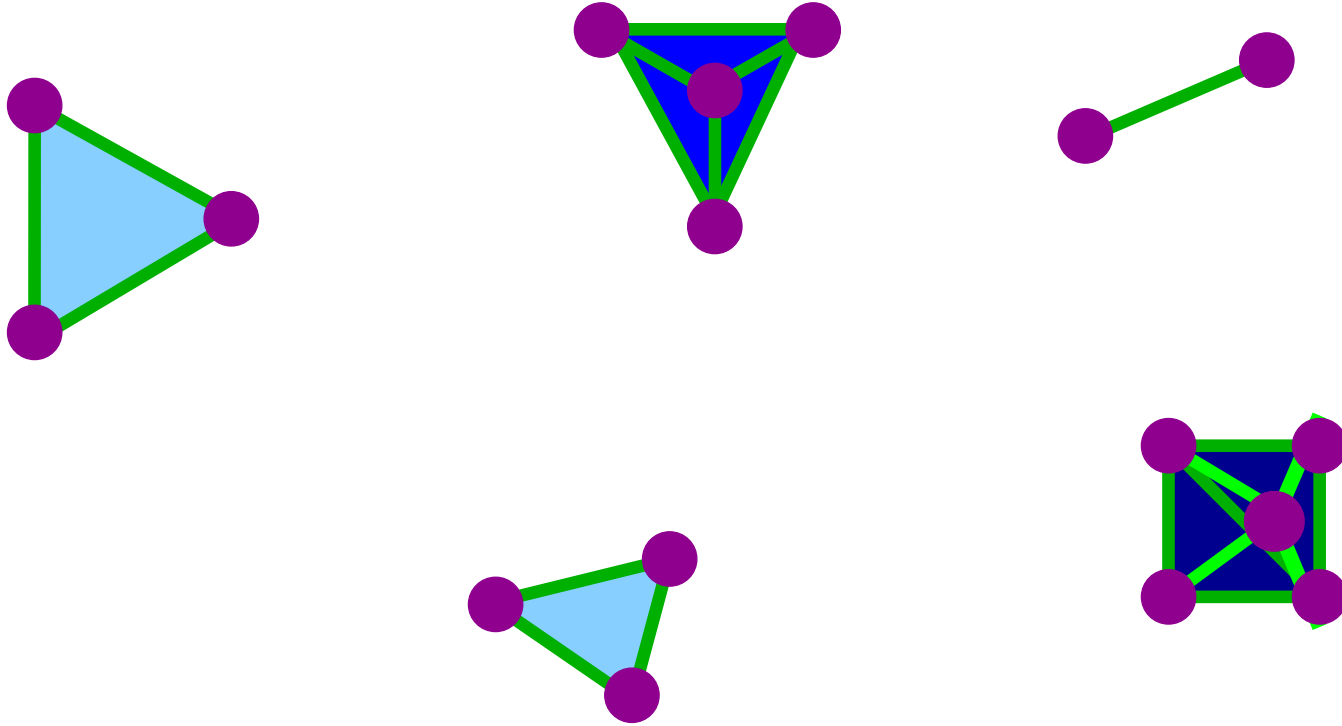
Creating the Vietoris Rips simplicial complex



3.) Add 3-dimensional tetrahedrons (3-simplices)

Add all possible 3-simplices.

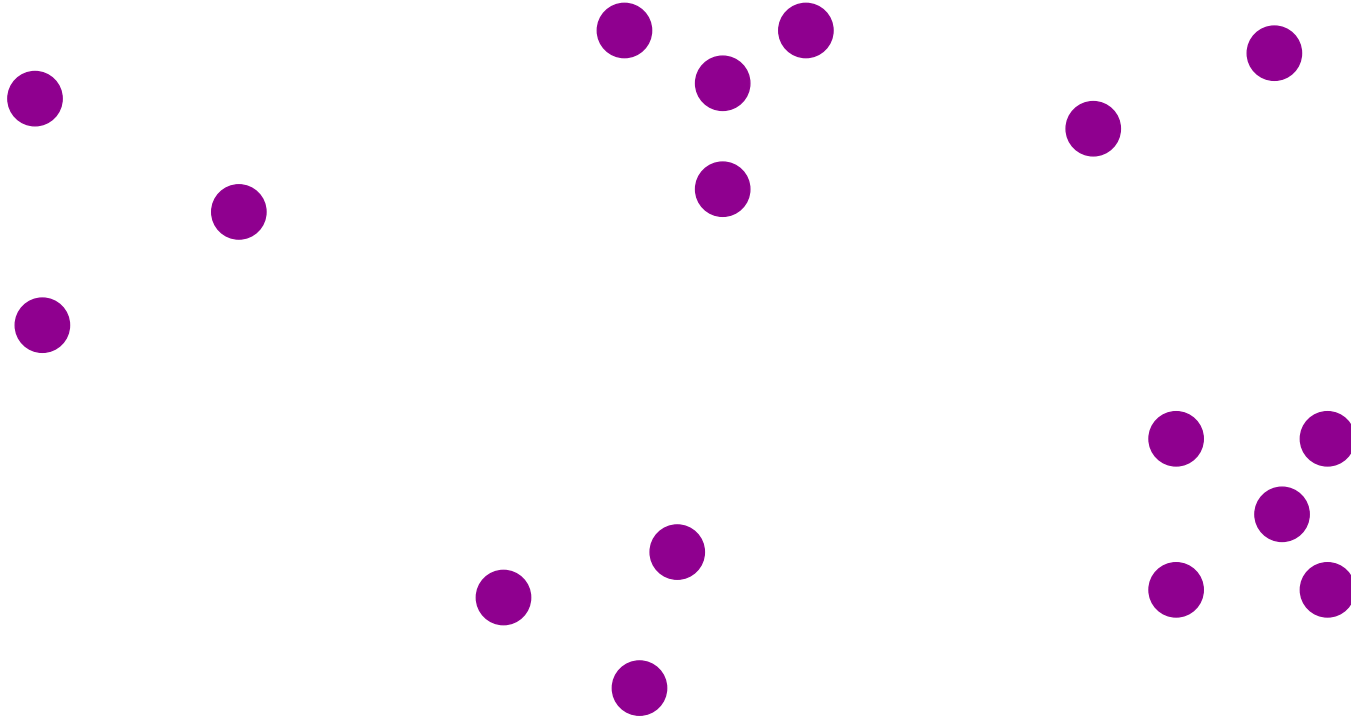
Creating the Vietoris Rips simplicial complex



4.) Add 4-simplices

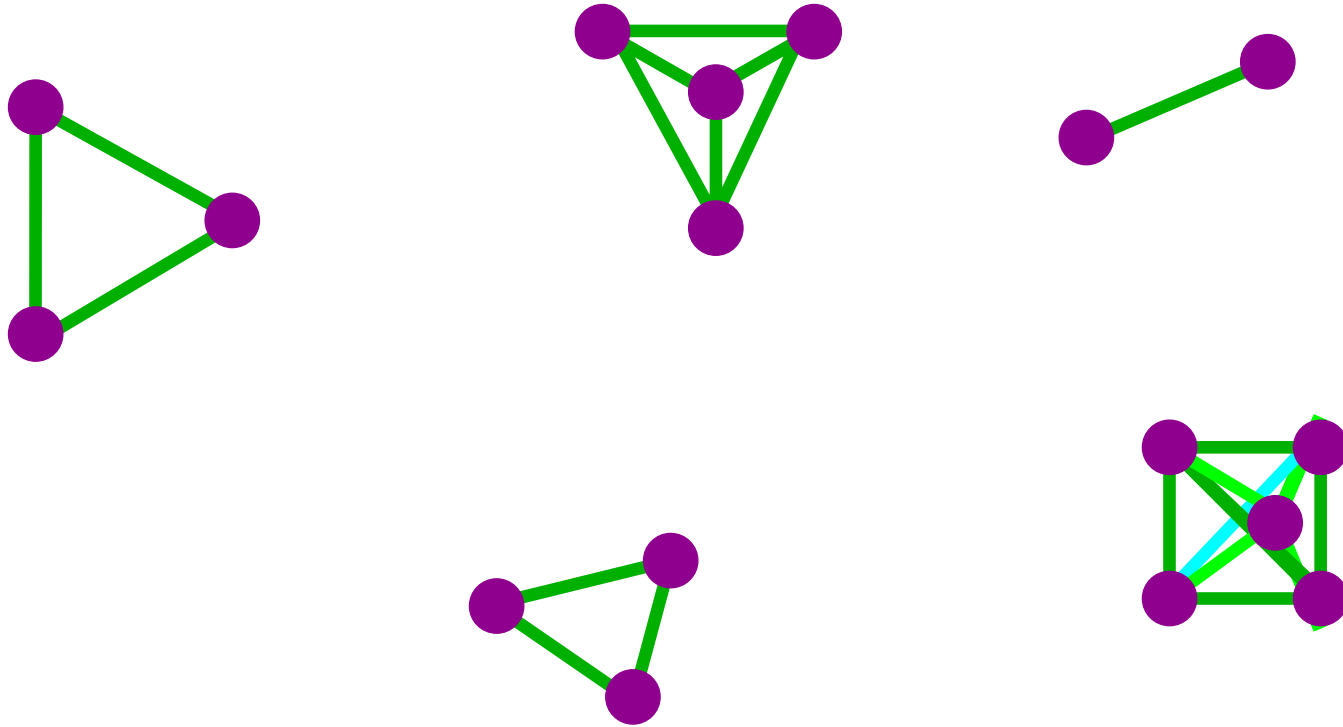
Add all possible 4-simplices.

Creating the Vietoris Rips simplicial complex



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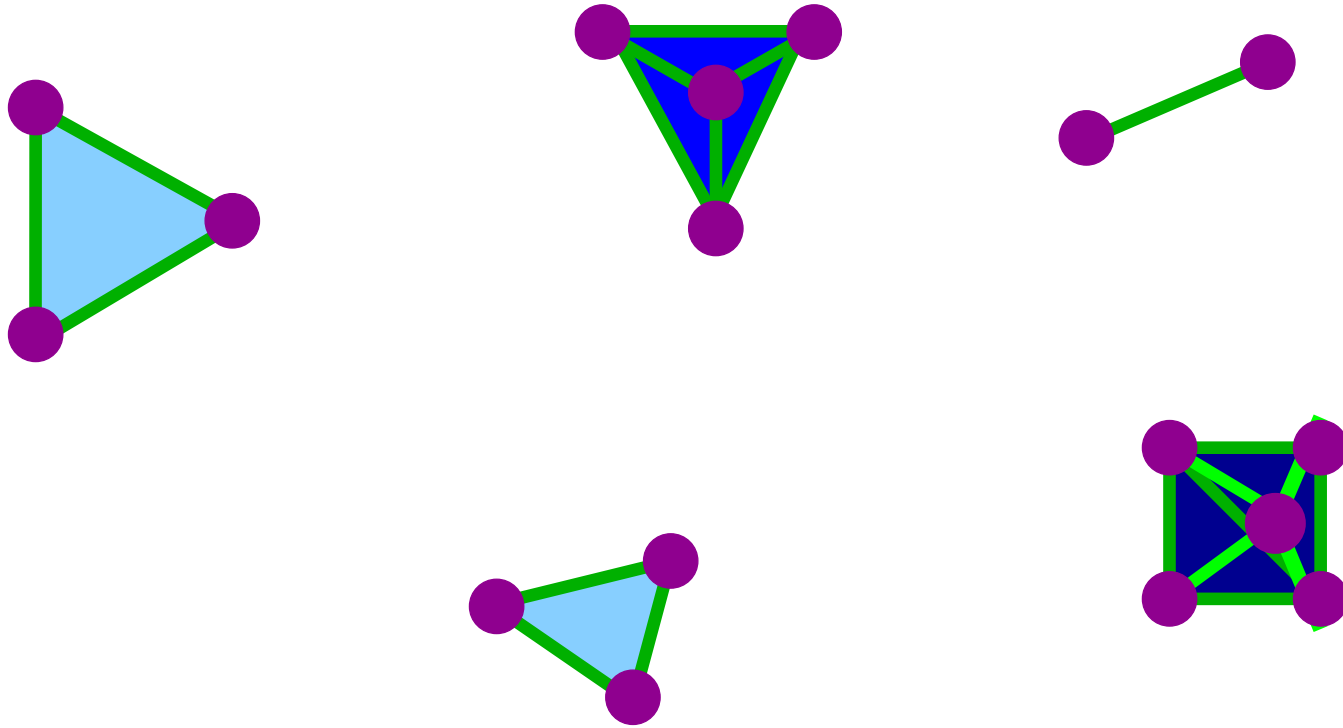
Creating the Vietoris Rips simplicial complex



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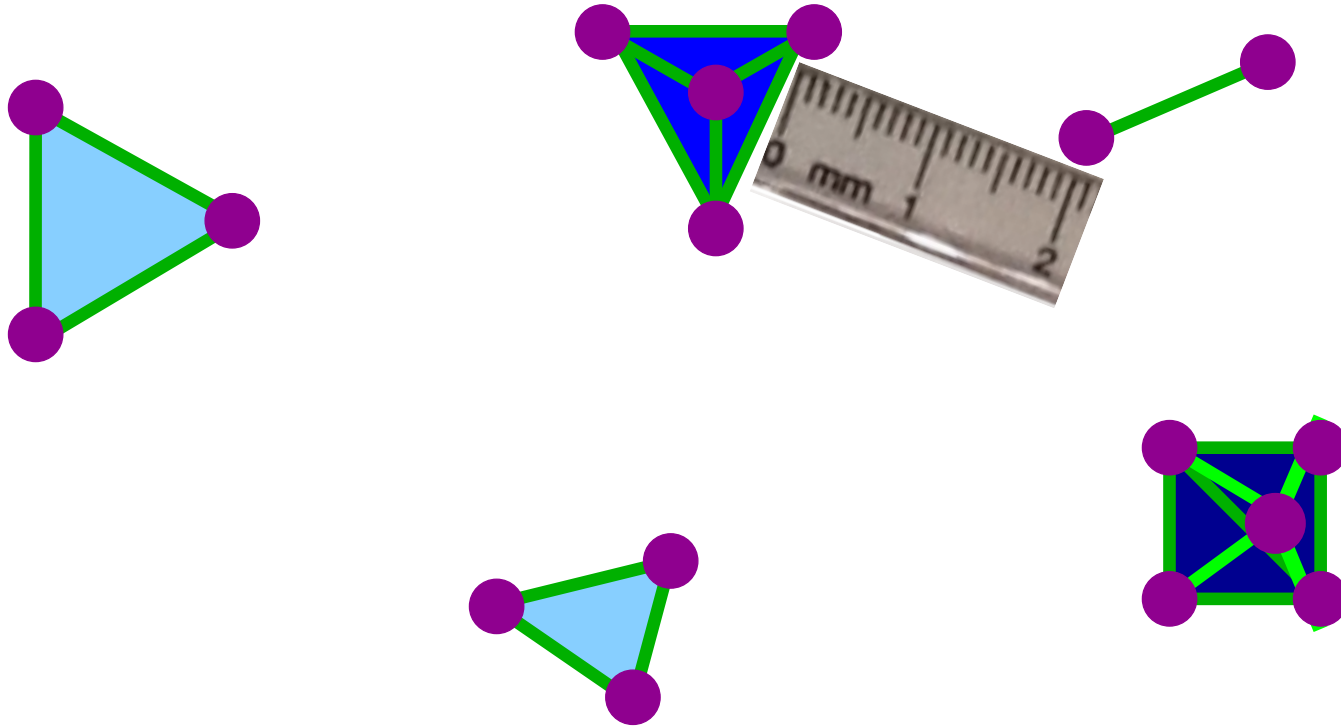
Add an edge between data points that are “close”

Creating the Vietoris Rips simplicial complex



2.) Add all possible simplices of dimensional > 1 .

Creating the Vietoris Rips simplicial complex

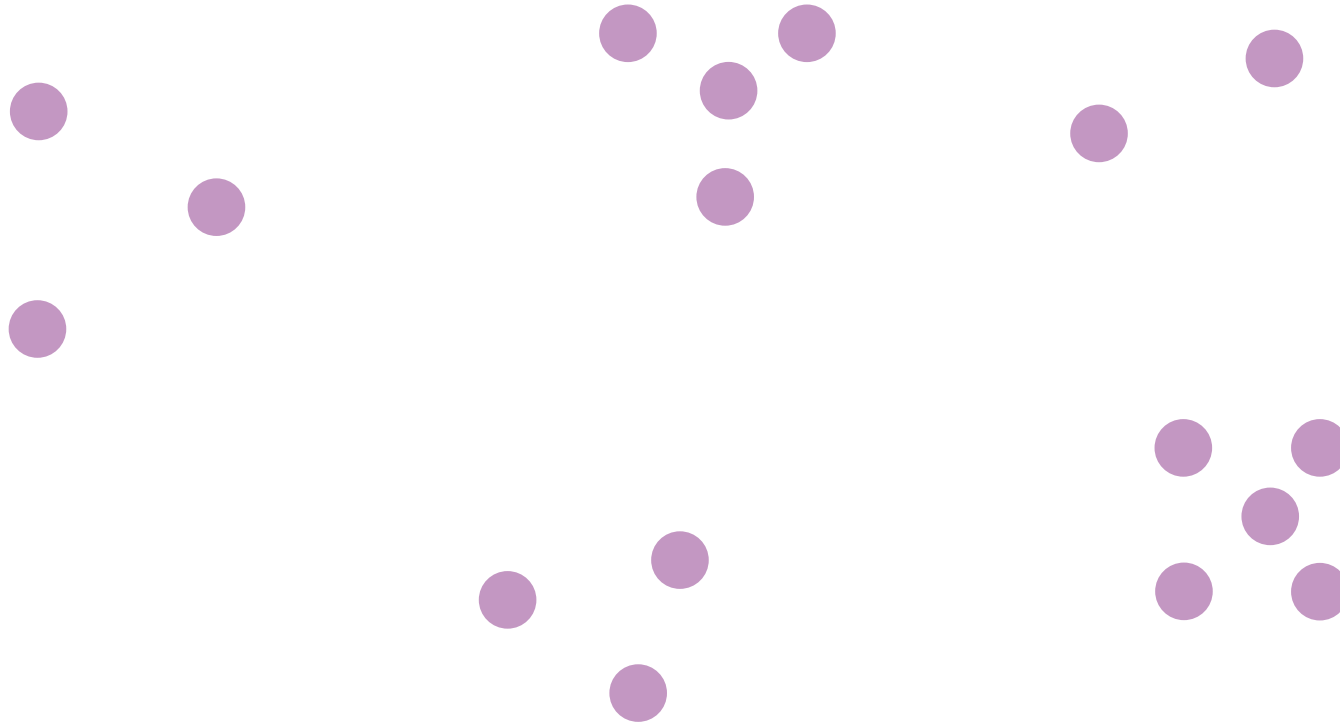


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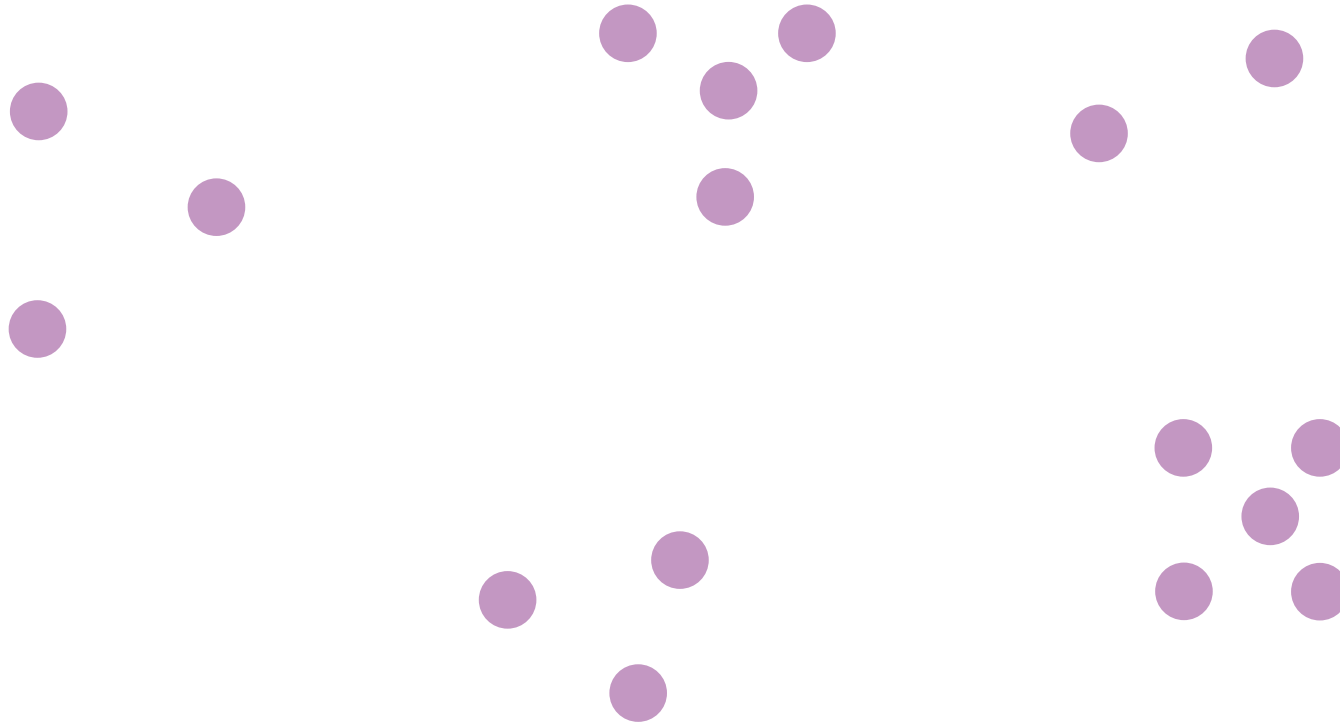
Creating the Vietoris Rips simplicial complex



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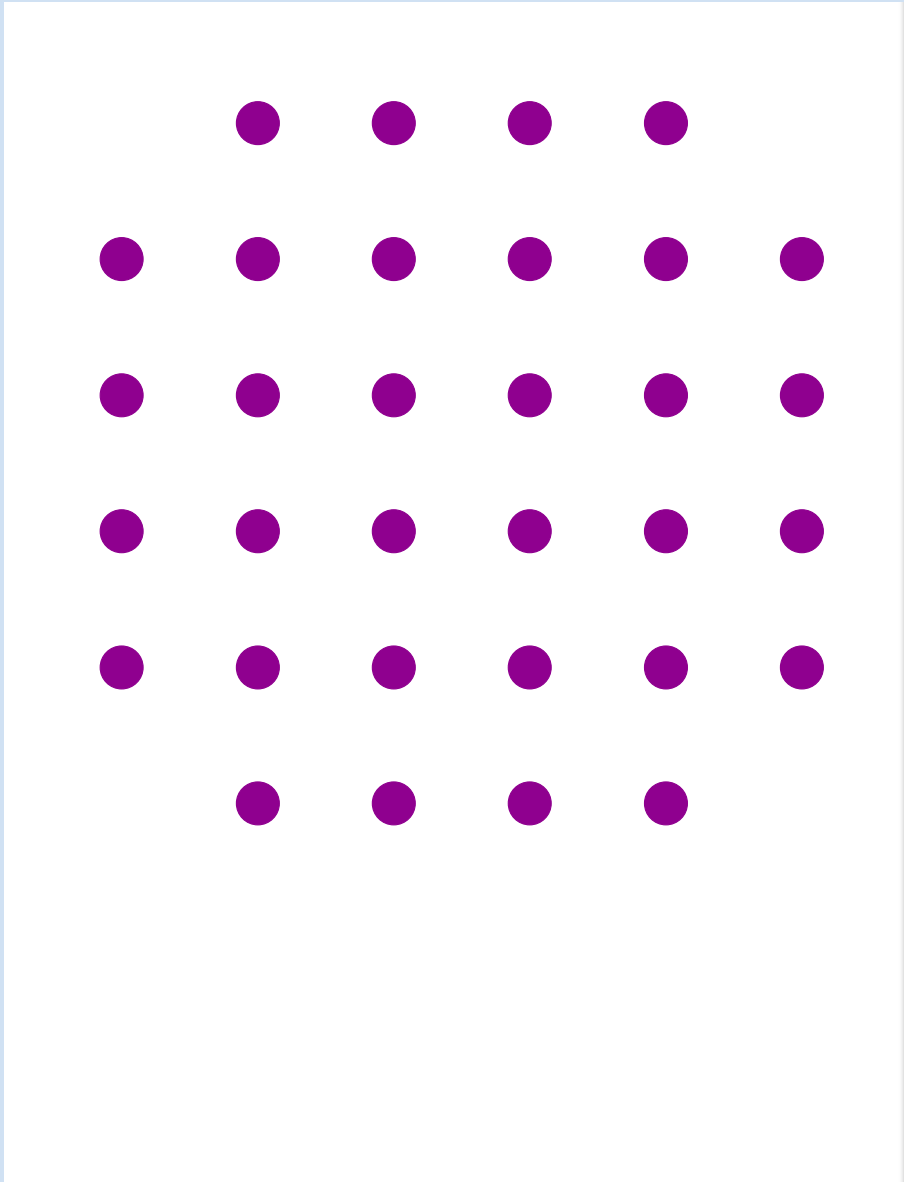
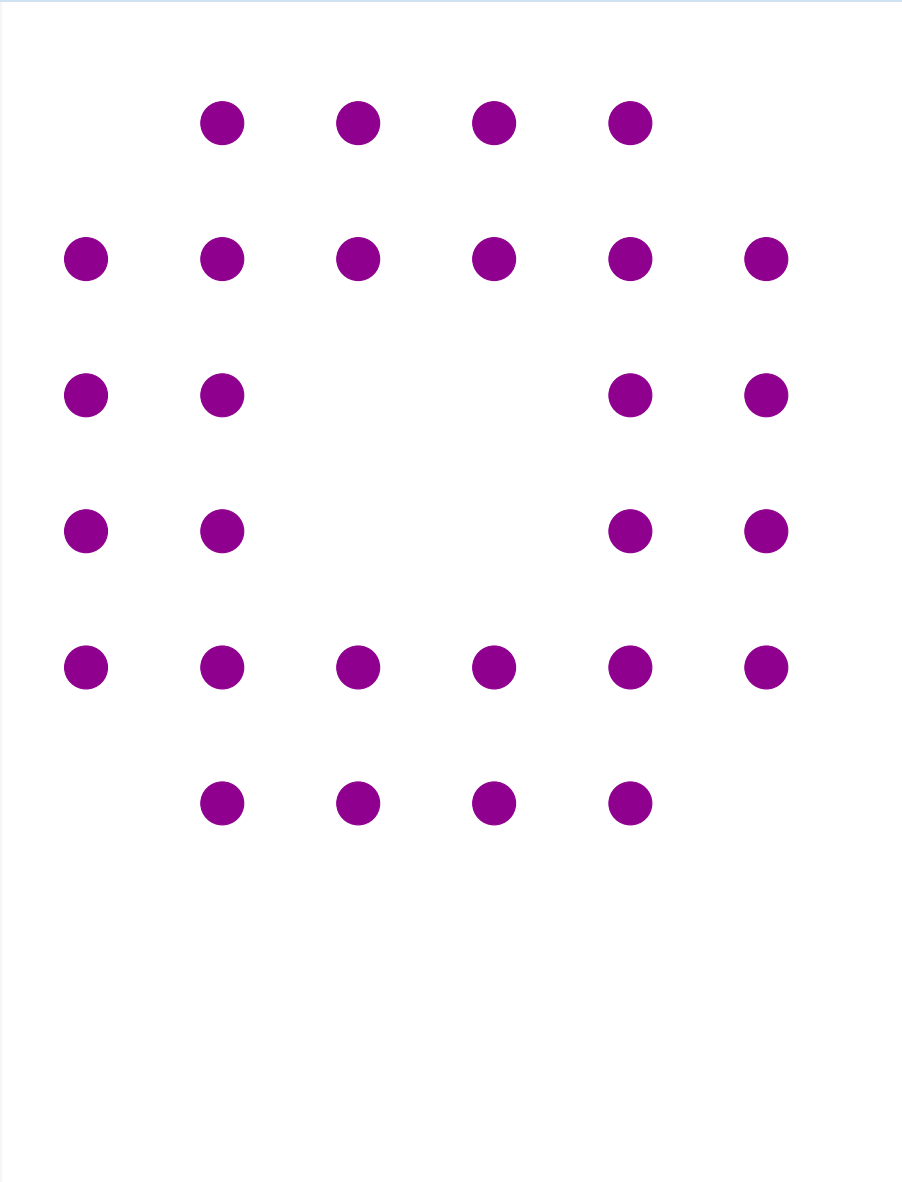
Creating the Vietoris Rips simplicial complex



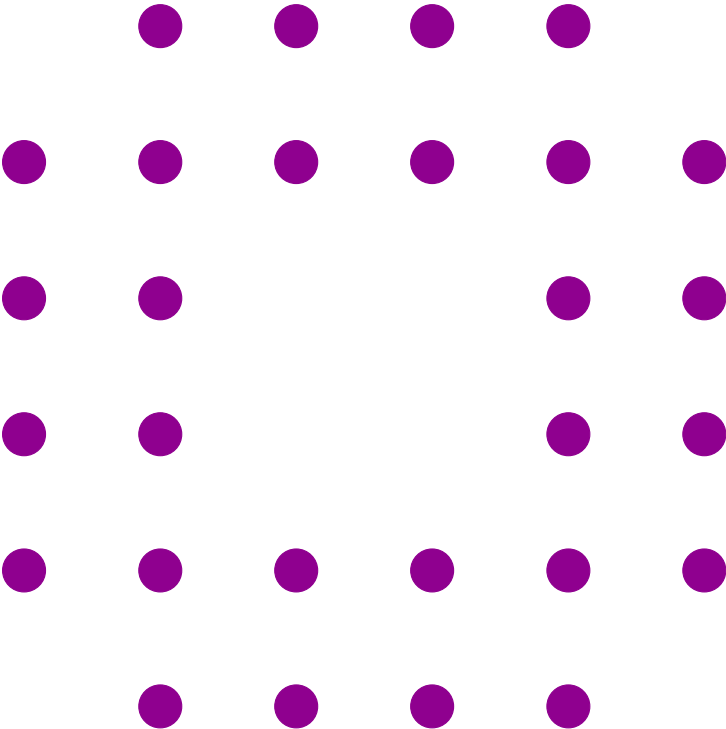
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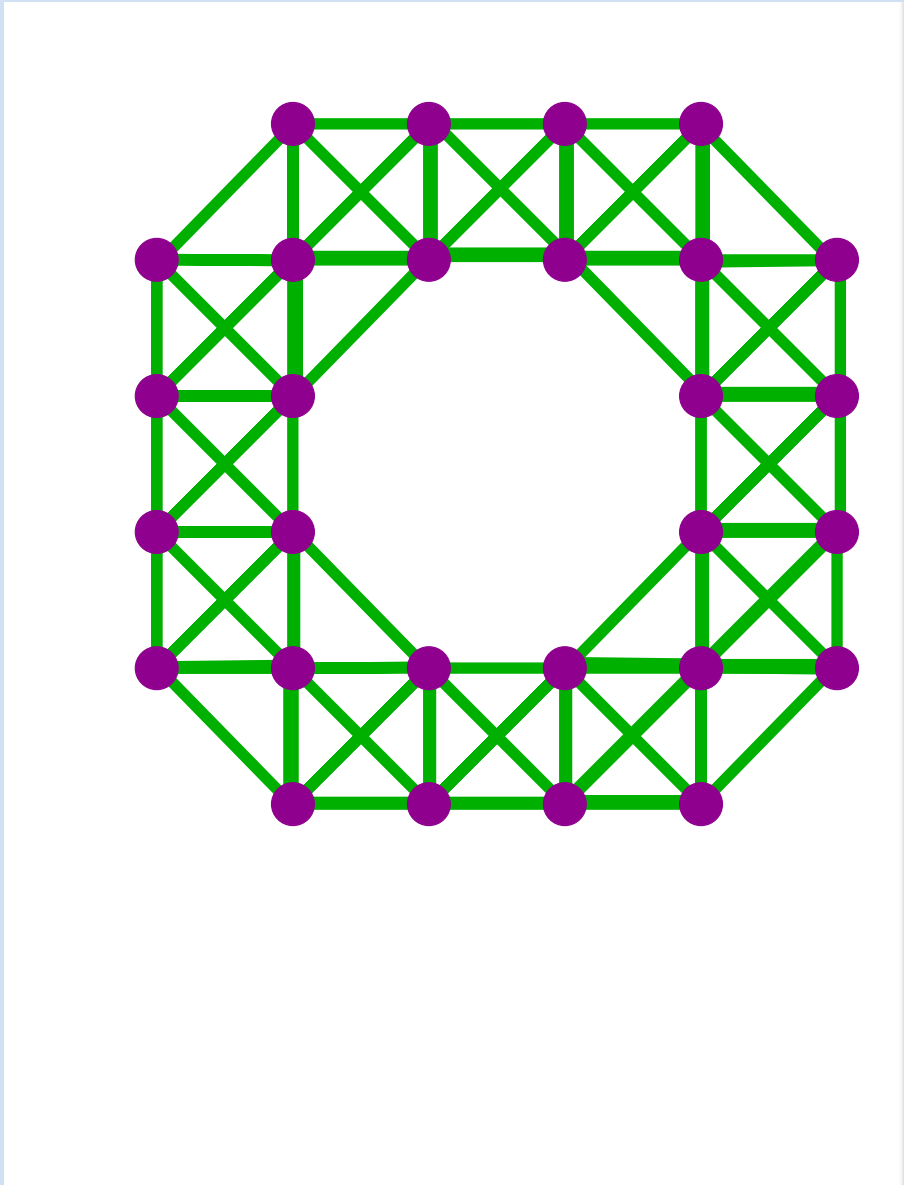
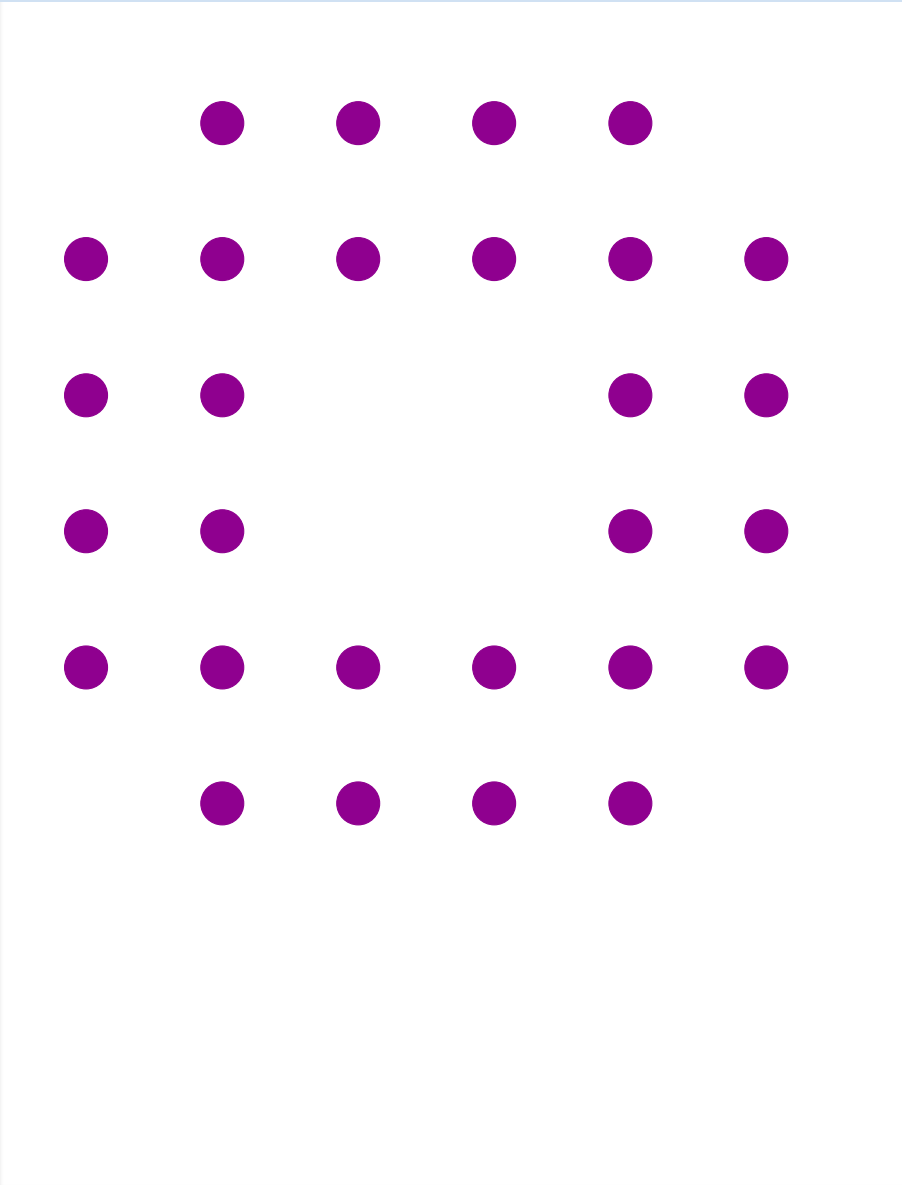
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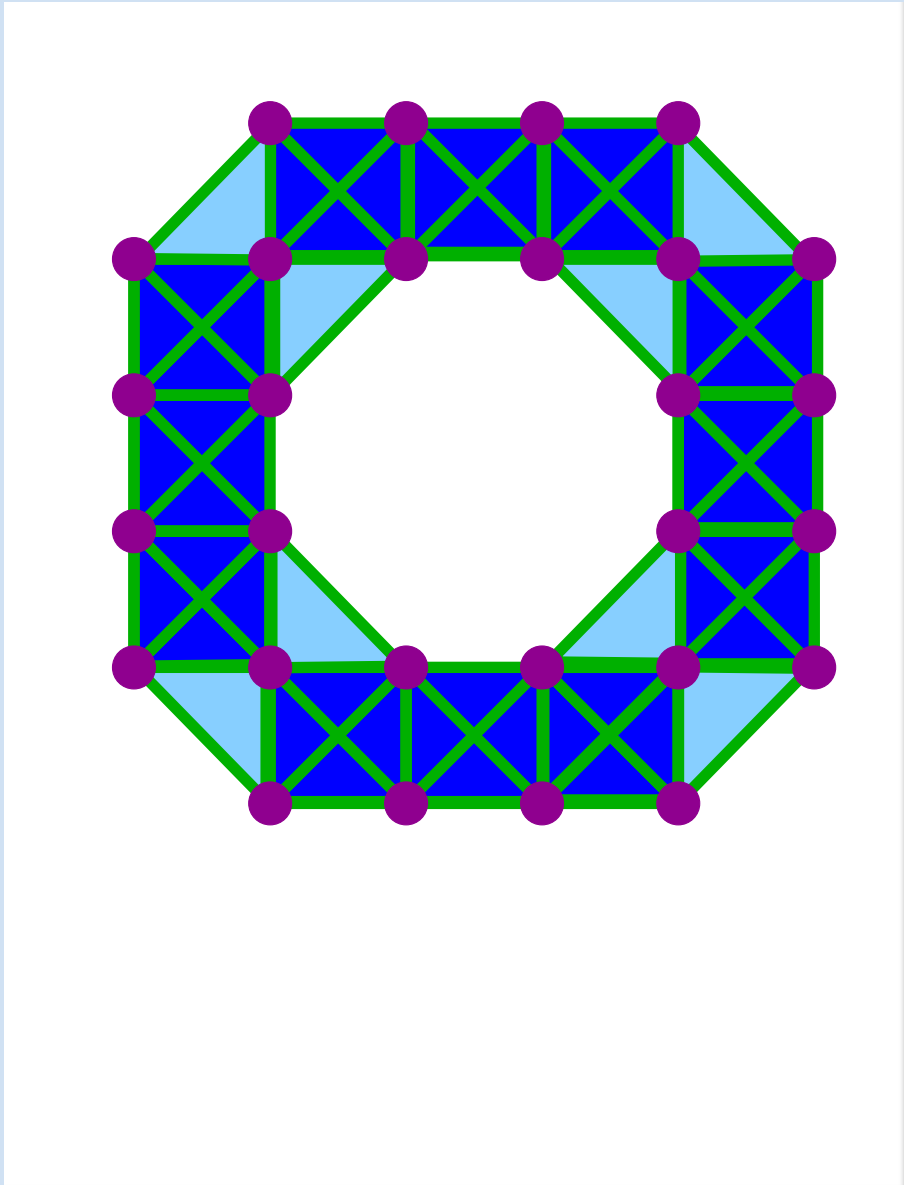
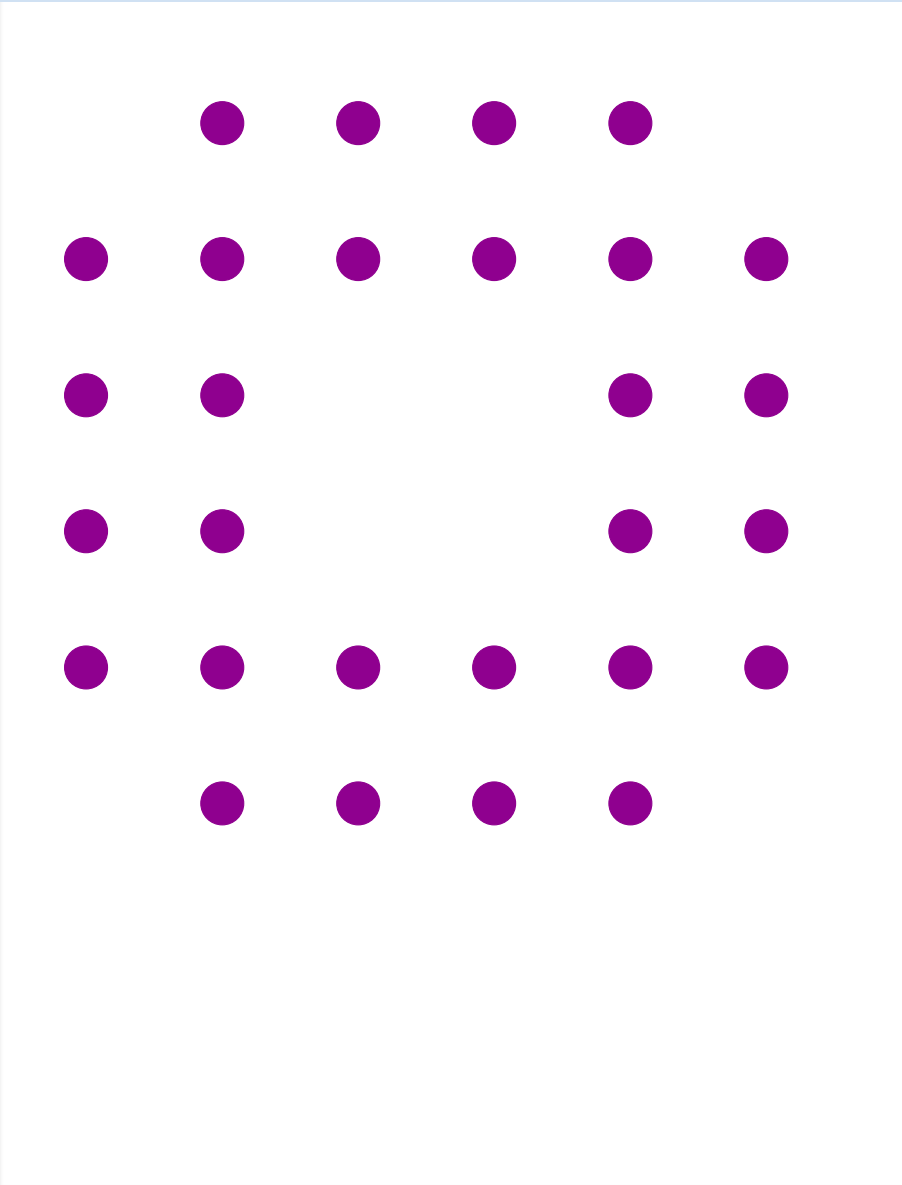
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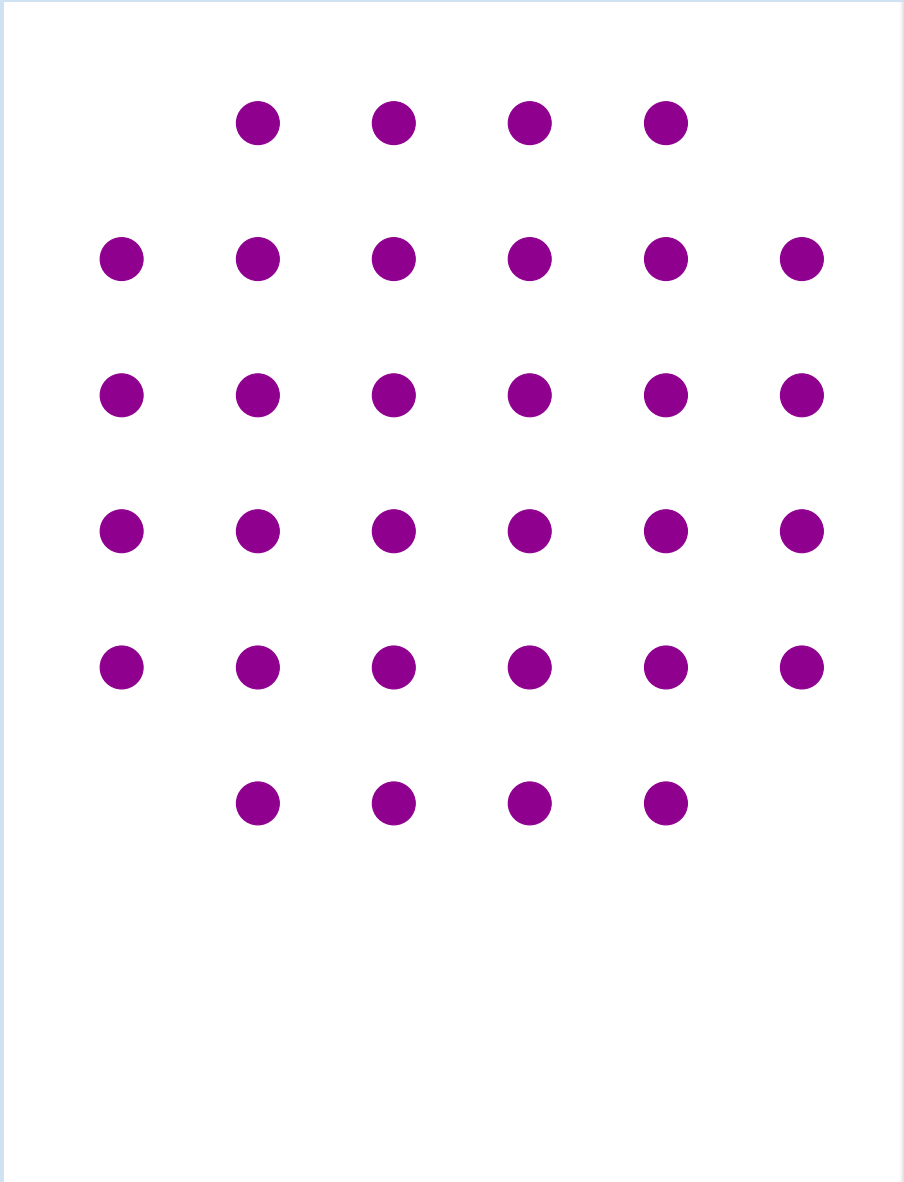
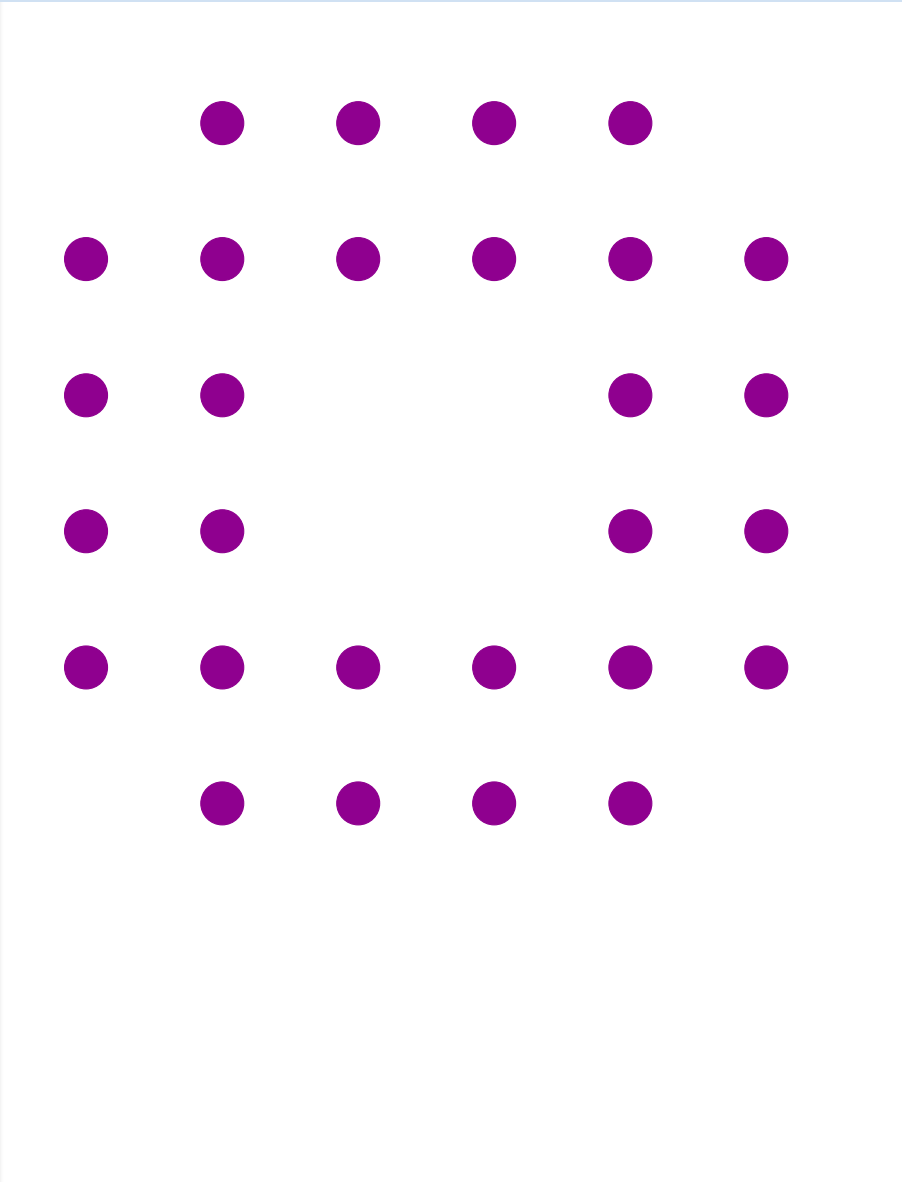
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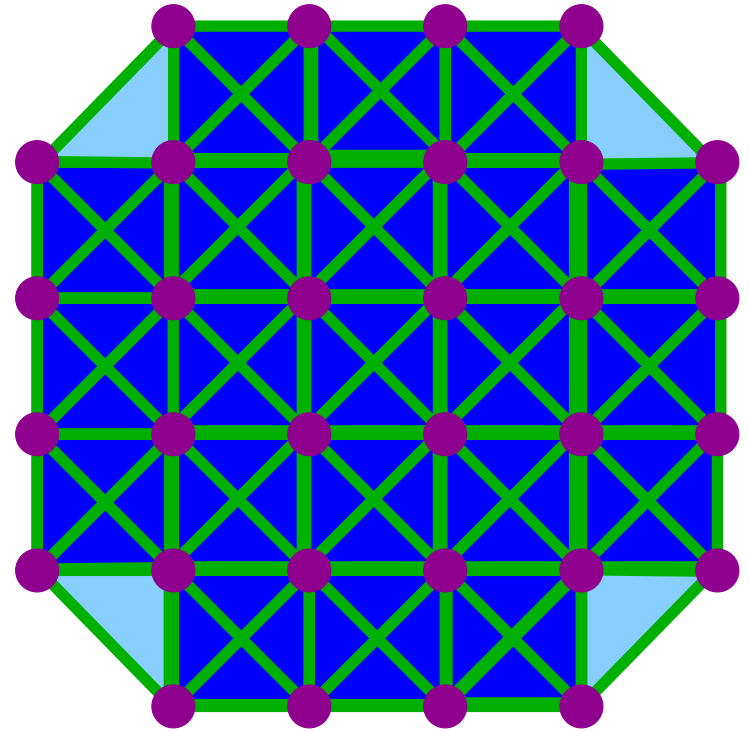
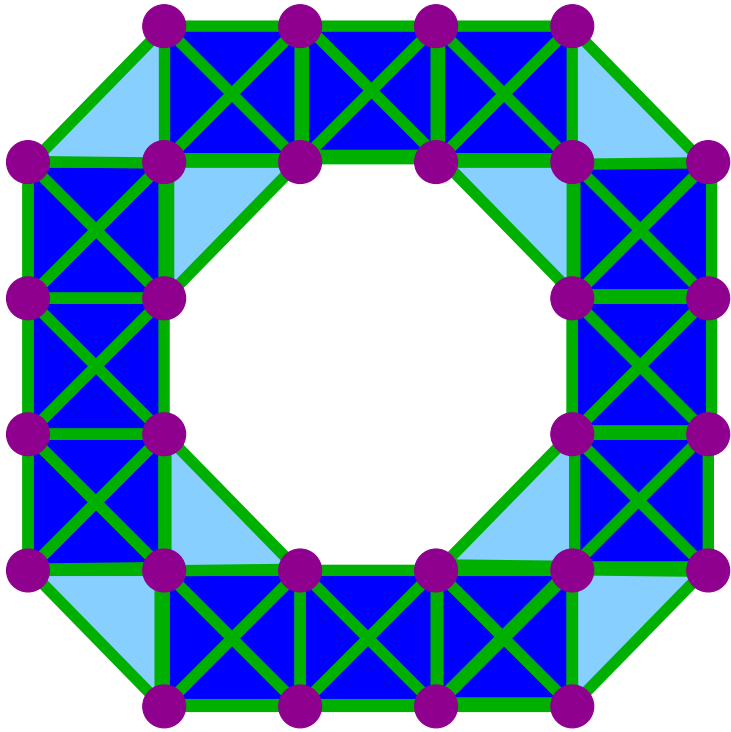
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