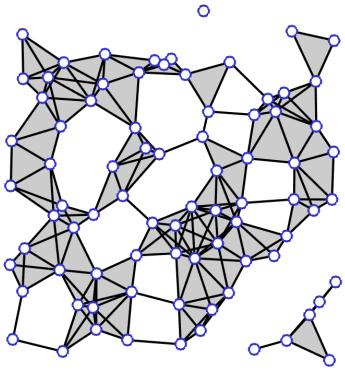
# A Generalized Random 2-Complex
# קומפלקס דו-ממדי אקראי מוכלל

A ***2-dimensional simplicial complex*** (or a 2-complex in short) $\mathrm{X} = (\mathrm{V},\mathrm{E},\mathrm{T})$ is an object that consists of a set of vertices ($\mathrm{V}$), a set of edges connecting the vertices ($\mathrm{E}$), and a set of triangles bounded by the edges ($\mathrm{T}$). This object is of a great mathematical interest, but also has interesting applications in network, shape, and data analysis.

In this project, we will consider two completely different models to generate such a simplicial complex at random: (1) In the ***Linial-Meshulam complex***, the vertices and edges are fixed, and we add triangles at random based on coin-tosses. (2) In the random ***Čech complex***, the vertices are generated as random points inside a box, and the edges and triangles are added based on the position of the points (see Figure). Both of these models have been studied extensively over the past decade. The main interest is in the ***homology*** of the random complex, which essentially describes "holes" or "cycles" that are formed. This study mainly combines methods and concepts from both probability theory and algebraic-topology.



A random Čech complex

Our goal in this project will be to study a new model that combines the two above together. In other words, we start by generating a random Čech complex, and then remove some of the triangles at random by tossing coins. We would like to understand how the homology of this generalized complex behave, and in particular the interaction between the two sources of randomness (the position of the points and the coin tosses).

We will start by briefly reviewing some of the existing theory that is relevant for this project. Then, we will look into the new generalized model and try to address different questions that could shed some light on its behavior. Part of the time could be dedicated to software simulations, to gain intuition or to verify theoretical statements, but this is optional.

**Prerequisites:** Basic knowledge in probability, calculus, and linear algebra.