Instancing

Instances are simply objects that share mesh data. There are several ways in Blender to create instances:

- The "proper" method using Duplivert (options found under Instancing on the Object Properties tab)
- Array Modifiers
- Particle Systems
- Linked Duplicates (Alt+D)
- Geometry Nodes' Point Instance node

The strength of instancing, aside from the convenience, is speed.

In rendering, something called Draw Calls are one of the biggest culprits for slowing things down. The fewer times the GPU needs to ask the CPU what to draw, the faster it can work. With instancing we can create dozens (or millions) of instances with a **single** draw call. Blender doesn't just "render" when we press F12. The 3D Viewport has to constantly render some kind of output for use to see.

Raster Engines like Eevee or the Workbench and solid view can't take as much advantage of instancing as Cycles can but they are still more performant.

Limitations:

Instances are instances. All instances will appear the same. In Geometry Nodes we can vary the scale and rotation but the mesh data itself will remain identical. When looking to create much more variation, instances must be converted to "real", unique geometry. At this point, the power of the instancing system is just for the initial object transforms. Once "real", any performance benefits of the previous instancing step is lost as all geometry needs to be individually calculated and called.

Making Real:

Instances can be made real in several different ways:

- If a node is added after the Point Instance node, the instances will be made real so that calculations can be carried out on the mesh.
- If a modifier is added after the Geometry Nodes modifier, the will be made real so that calculations can be carried out on the mesh.
- If the Geometry Nodes modifier is applied, the instances will be made real.

- Instances can be made **unique**, which means each instance will become its own object without sharing mesh data. This takes a couple of steps:
  1. **CTRL+A, Make Instances Real.** This creates different objects that share the mesh data.
  2. (With the instance objects still selected) **Object > Relations > Make Single User > Object & Data.** This will make each instance a unique, separate object for those edge cases when that's needed.