Verifying a Distributed System with Combinatorial Topology

CodeMesh 2018

Verónica López
Sr. Software Engineer
@maria_fibonacci

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- Personal preference: Elixir (BEAM)
- Before: Big Latin American systems: many constraints
- Technology as a means of social progress

Agenda

- Distributed Systems
- Graph Theory
- Topology

Topology: the math term, not the (pretentious) engineer term for any systems design diagram

All these concepts have connectivity in common

Distributed Systems

Famous -and overused- quote about distsys…

“A distributed system is one in which the failure of a computer you didn’t even know existed can render your own computer* unusable”

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- Highly available
- Recoverable
- Consistent

- Scalable
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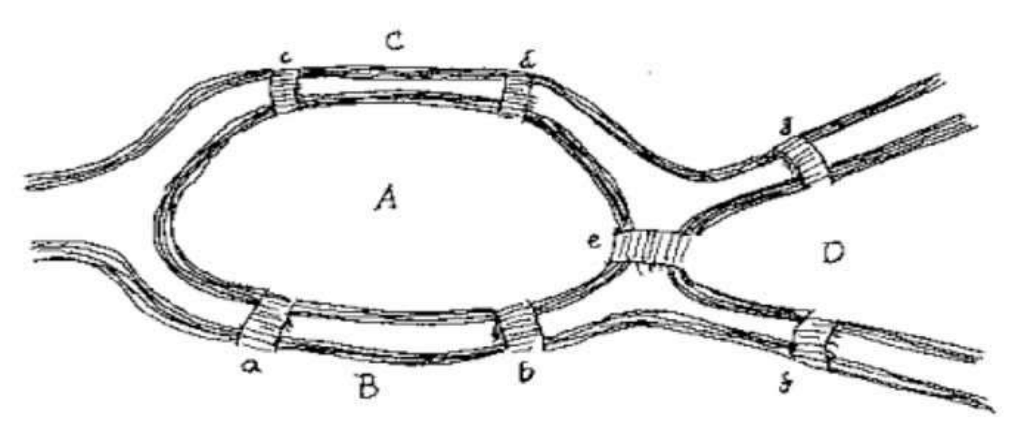

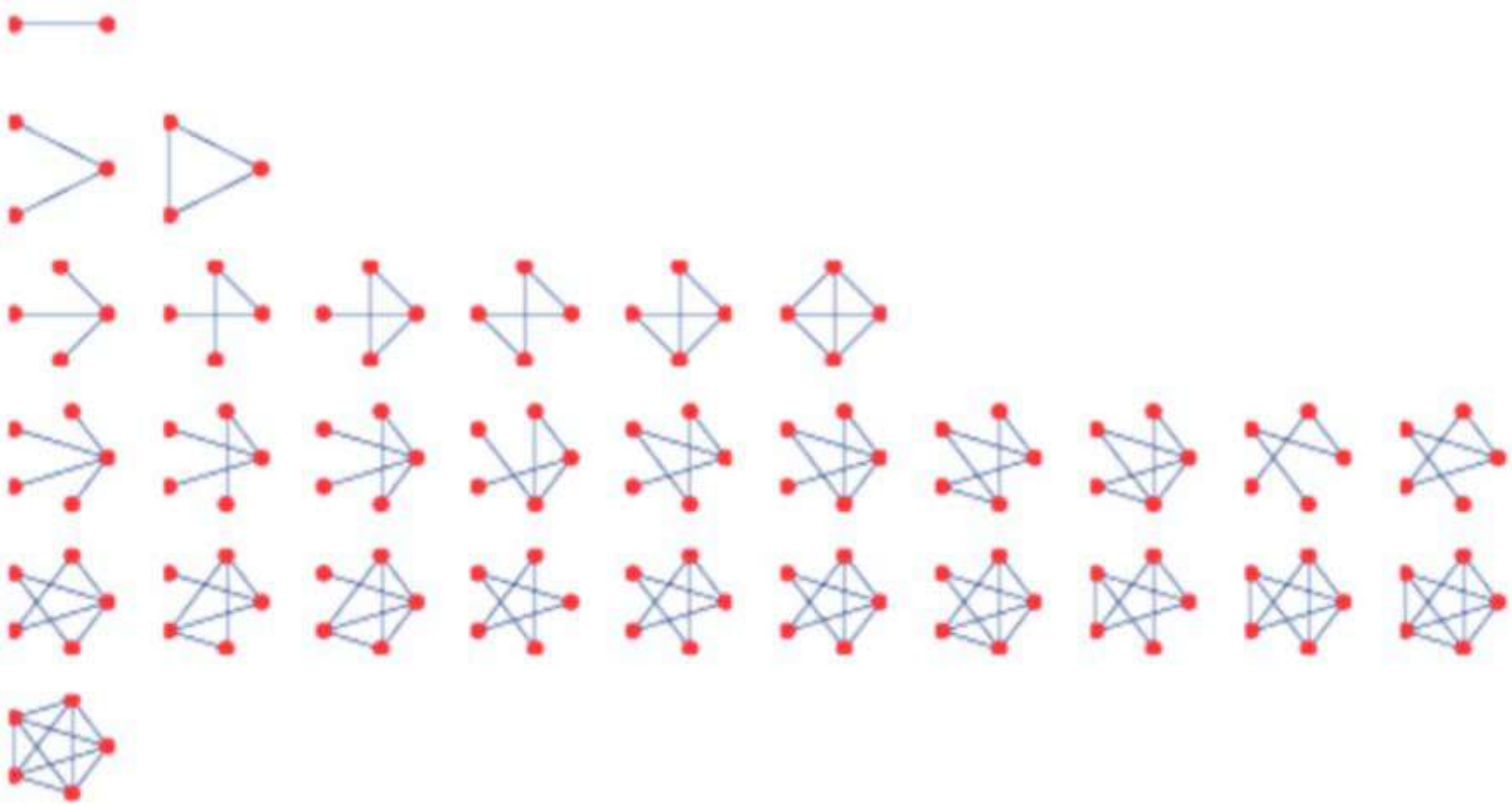

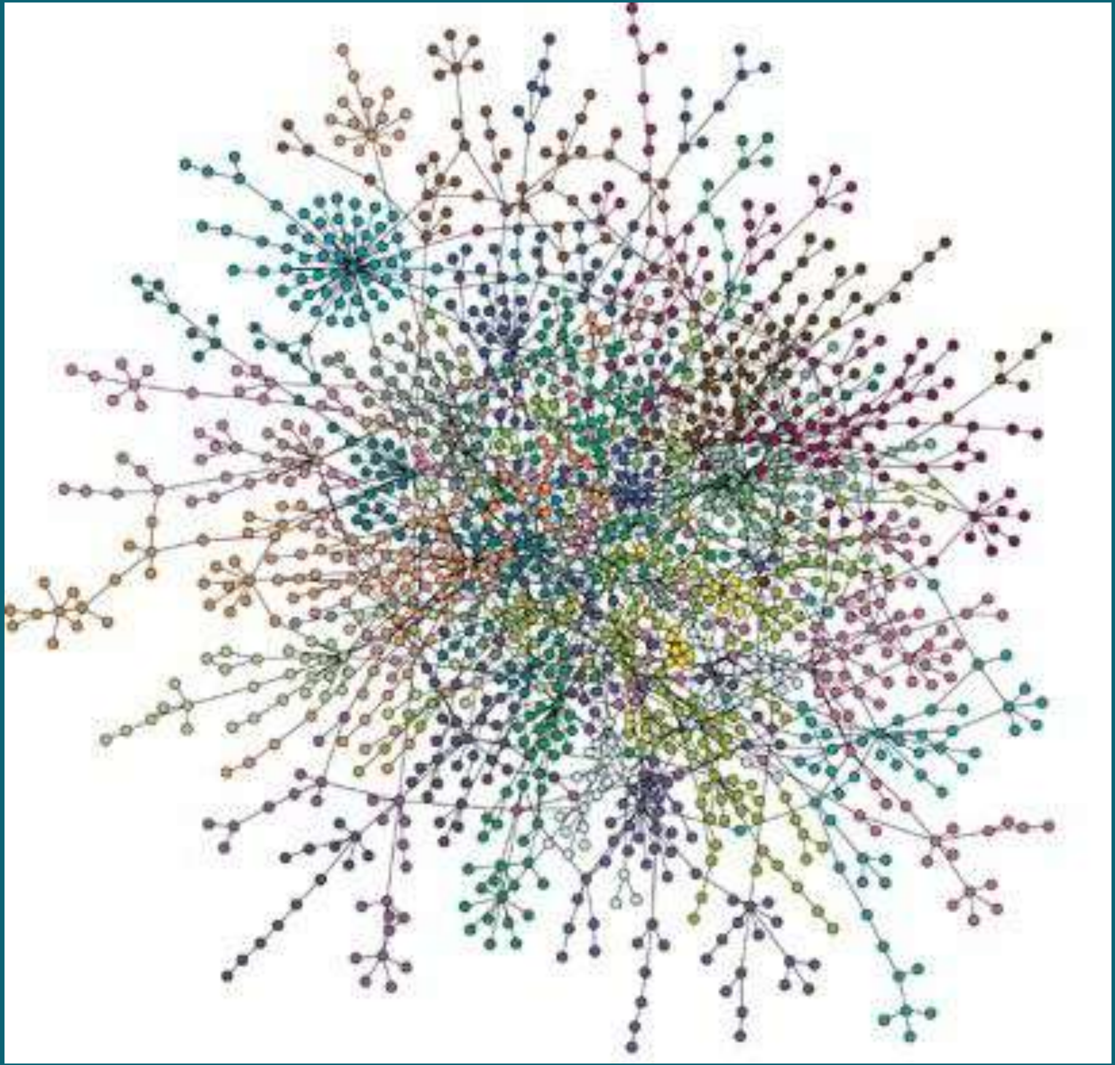

Describing the adjacencies (interactions) of distributed systems gets messier with graphs

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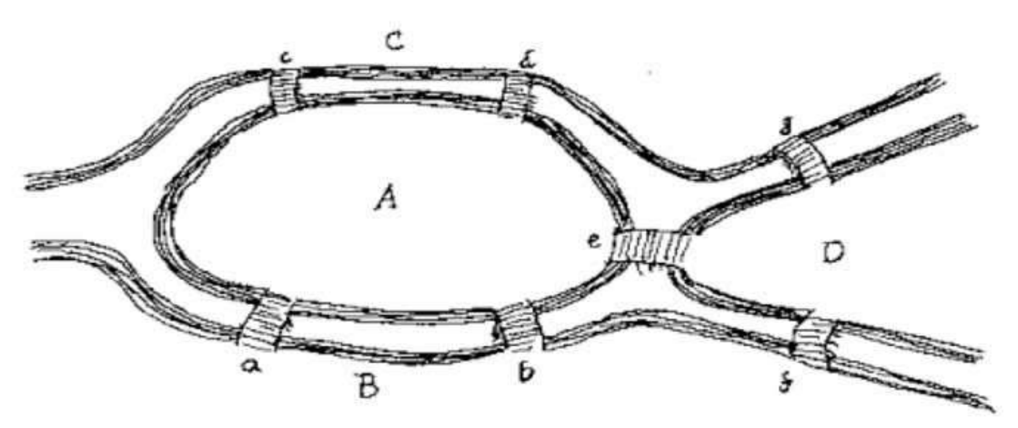

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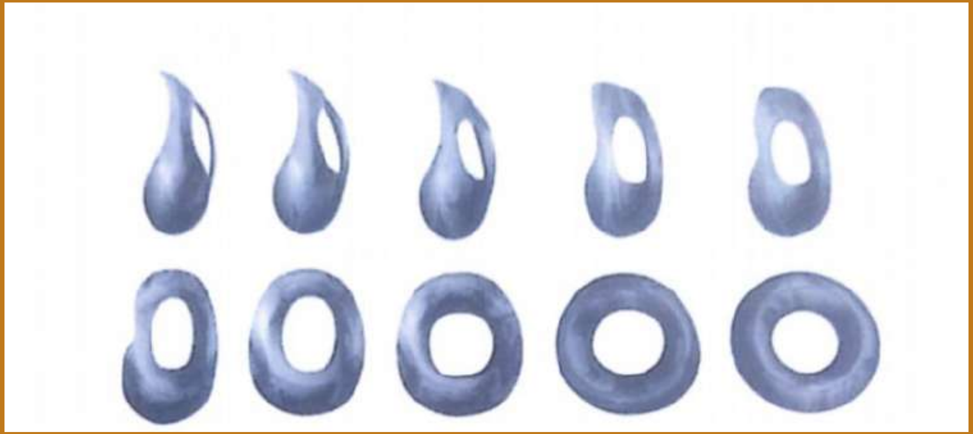

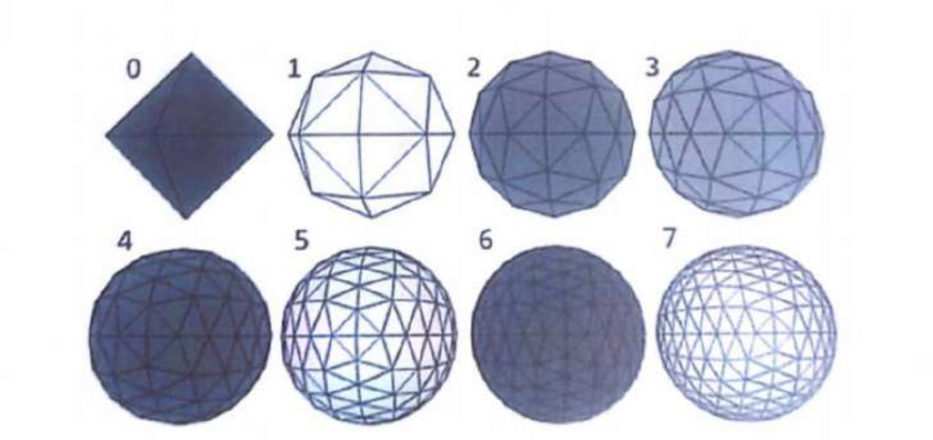

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Combinatorial (Algebraic) Topology

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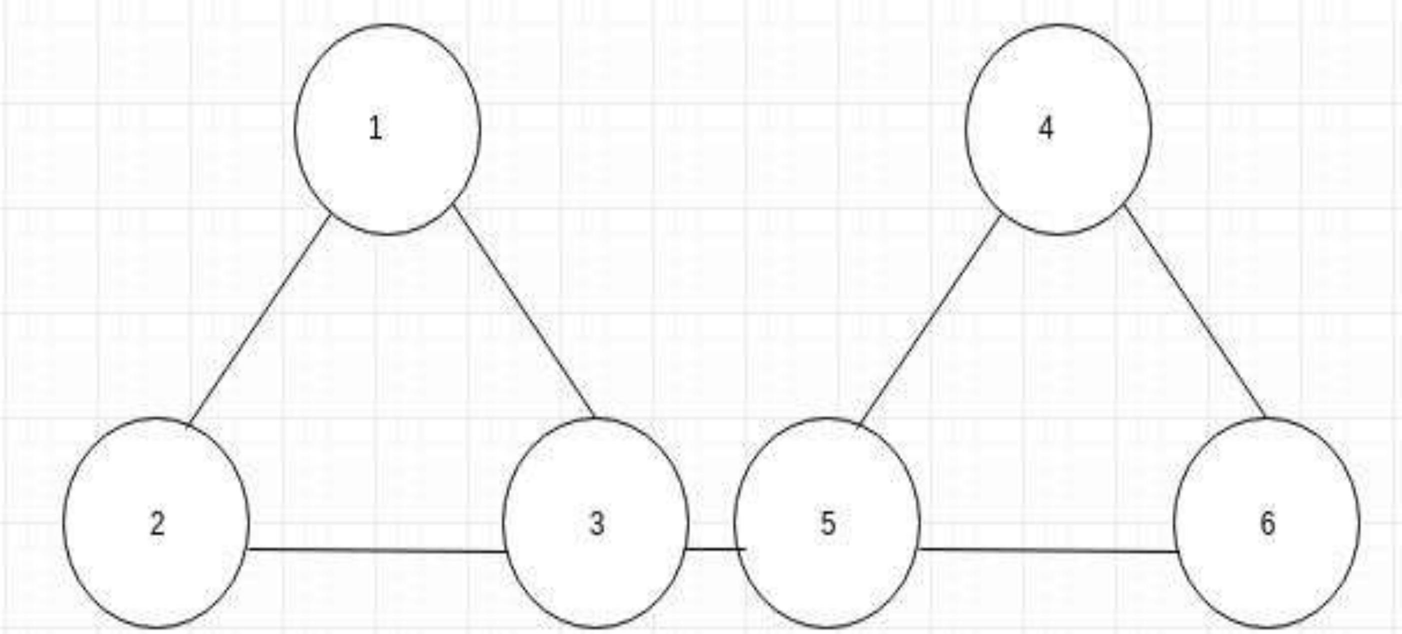
Views can be later put together to describe the system.



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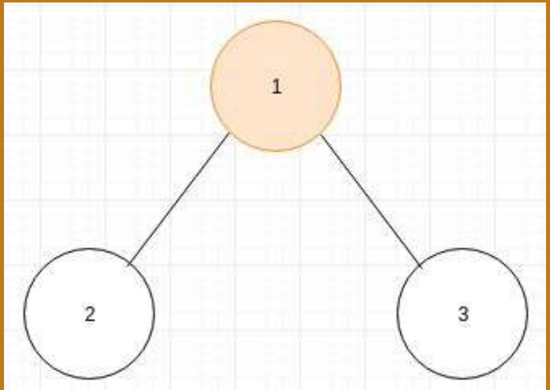

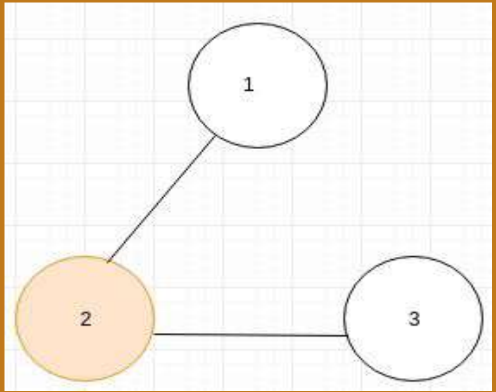

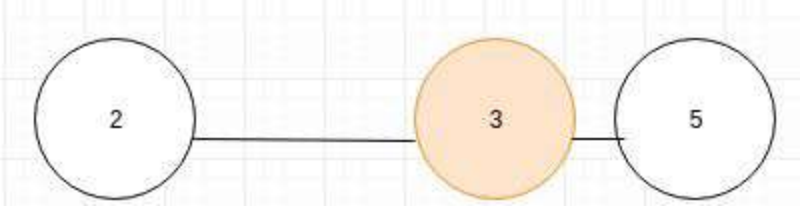

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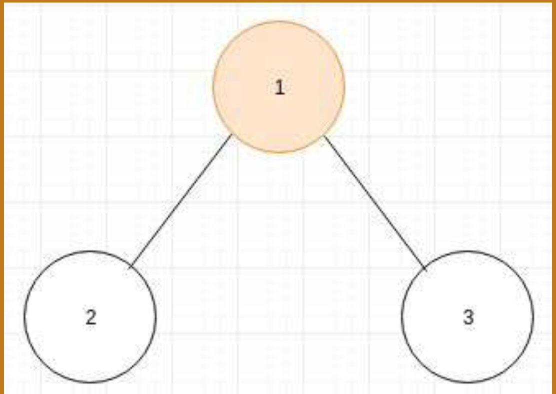

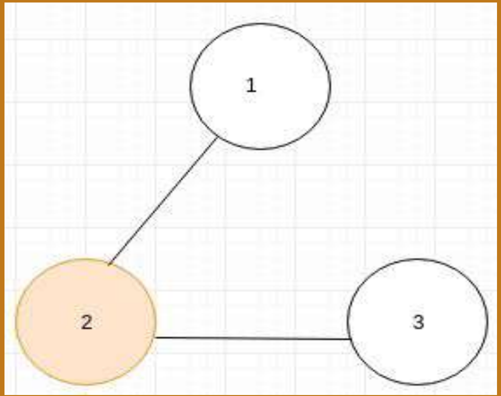

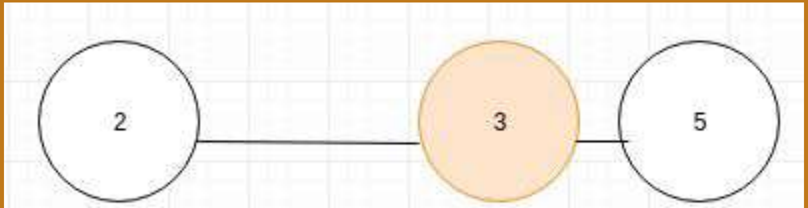

Perspective	Node	Connected to
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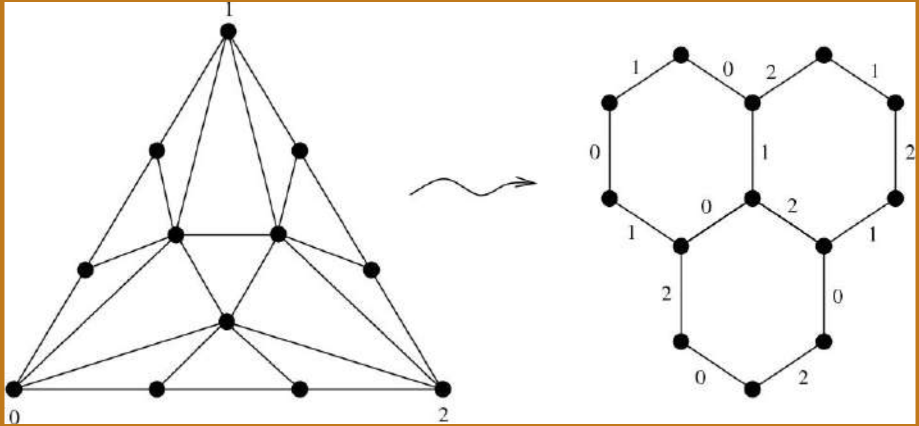

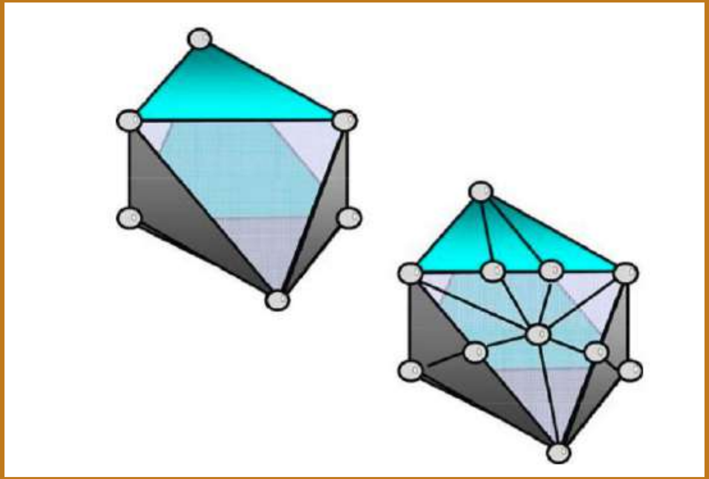

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Not every continuous map A->B has a simplicial approximation.

Verifying a Distributed System with Combinatorial Topology

Thesis

Distributed systems can be formally verified by treating them as (a set of) topological entities that are subject to (valid) subdivisions, analysis of the persistence and consistency of their interconnections (paths), offering a comprehensive set of states of the world

Step 1

If your system can be described as a graph, it can also be described as a topological object (if the connections are preserved)

Theorem:

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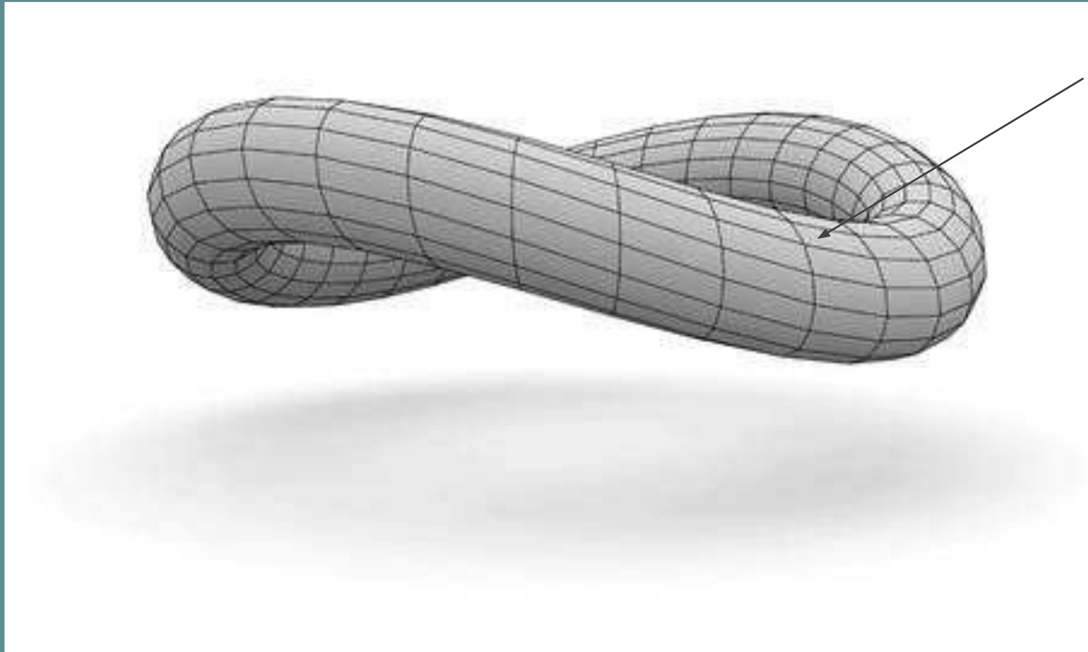
Describe our systems as a topological object:



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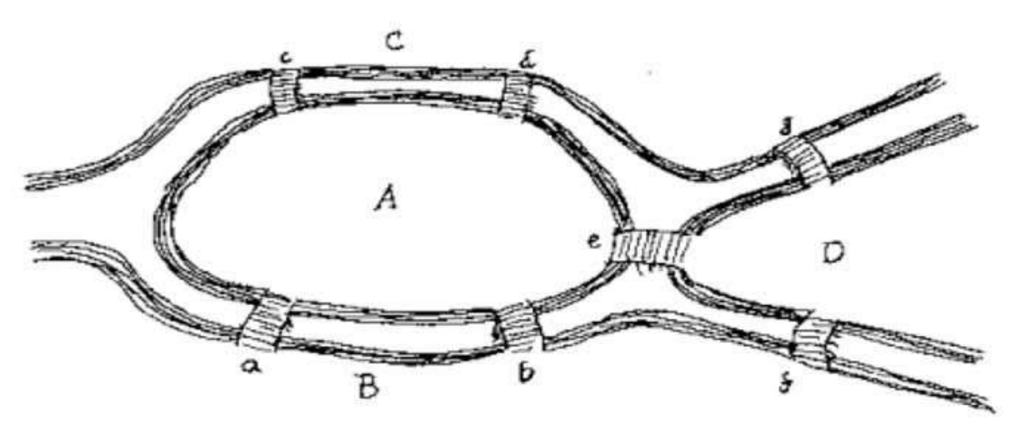

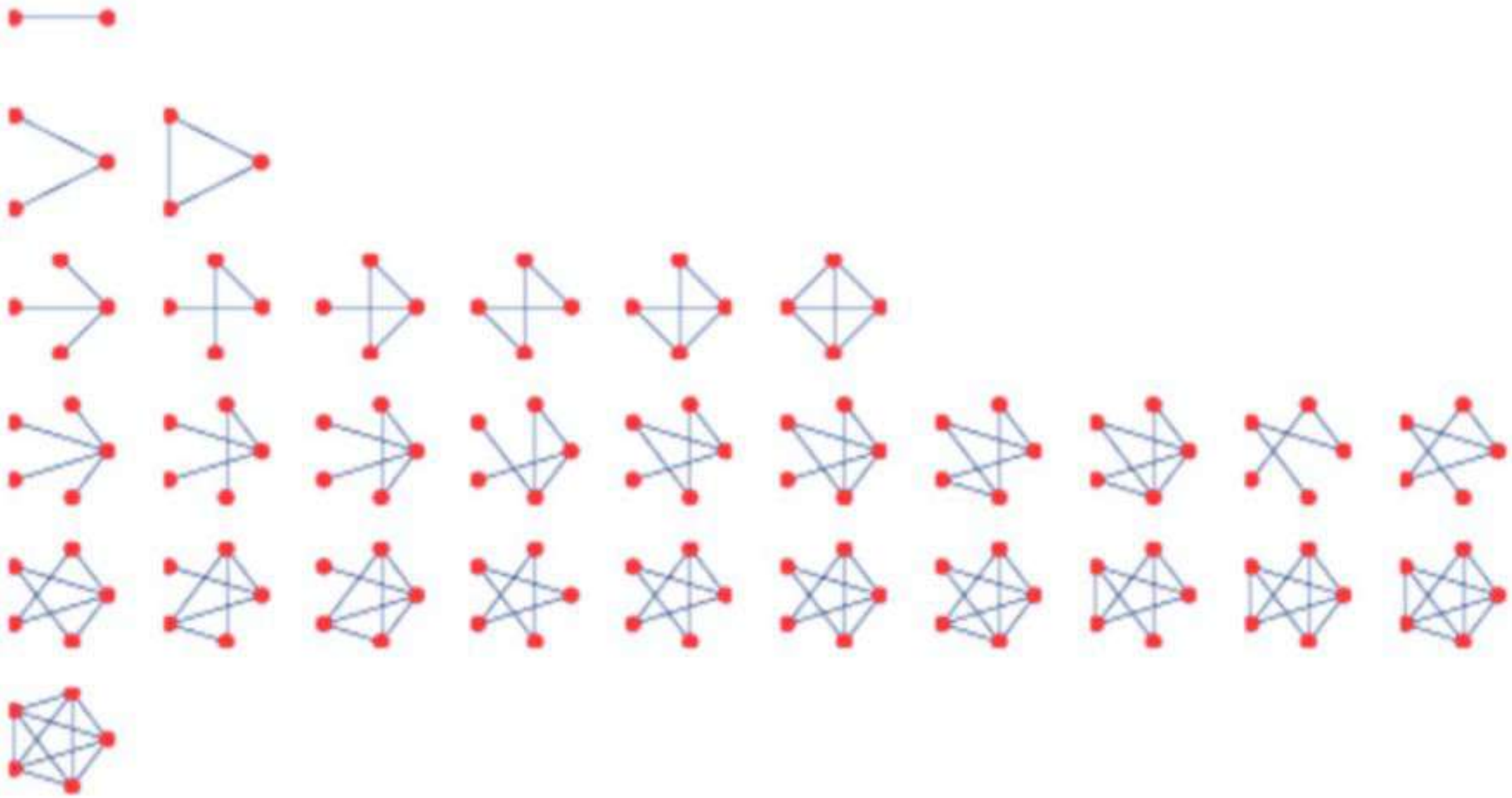

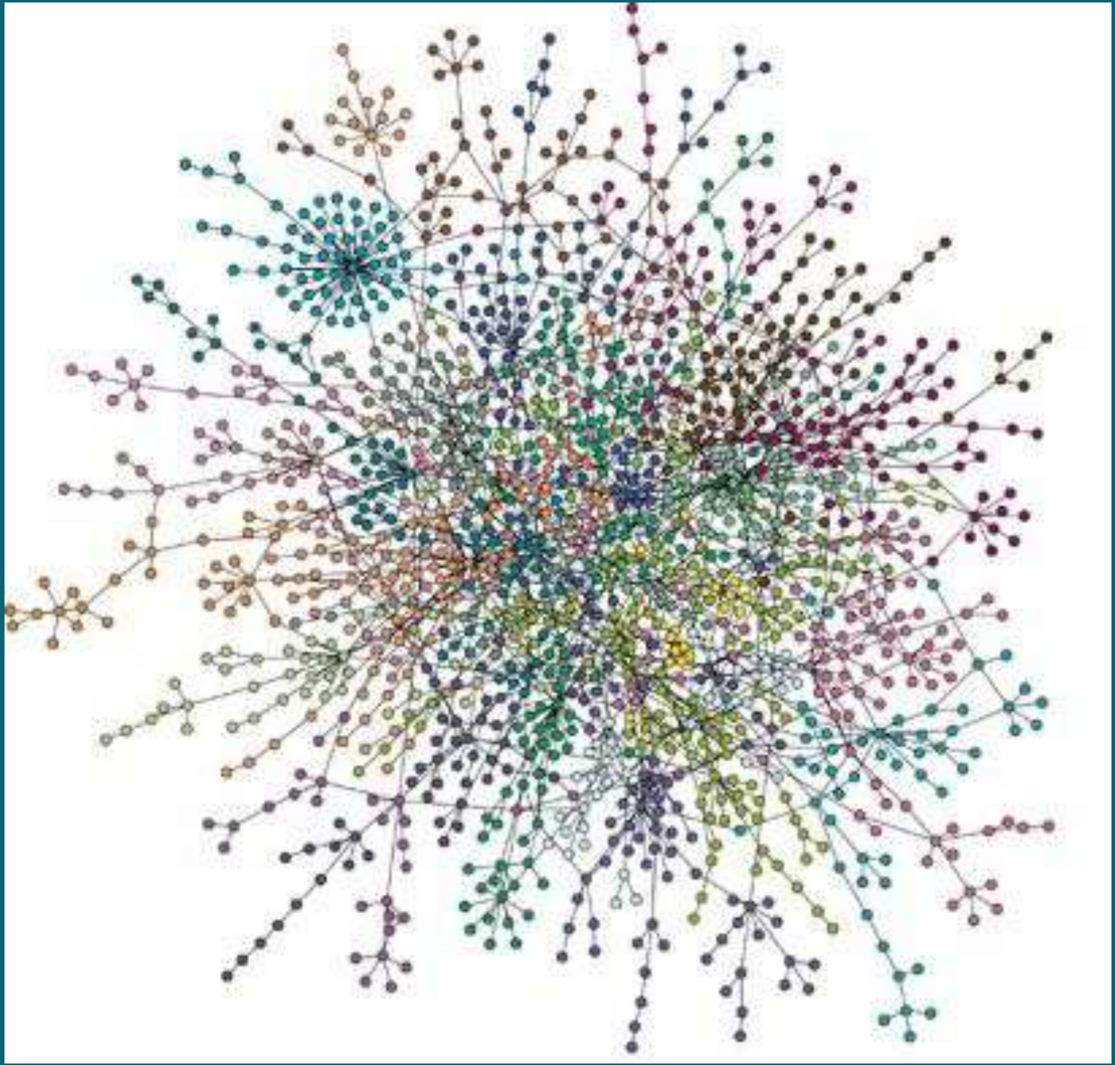

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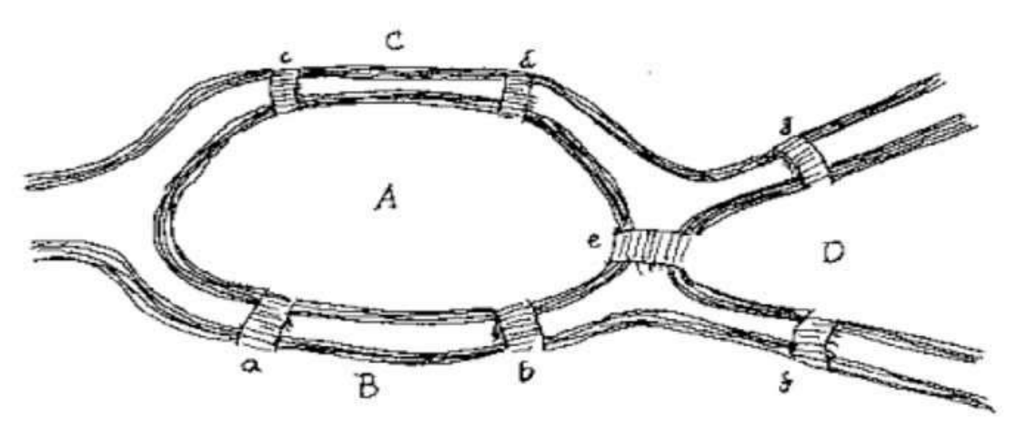

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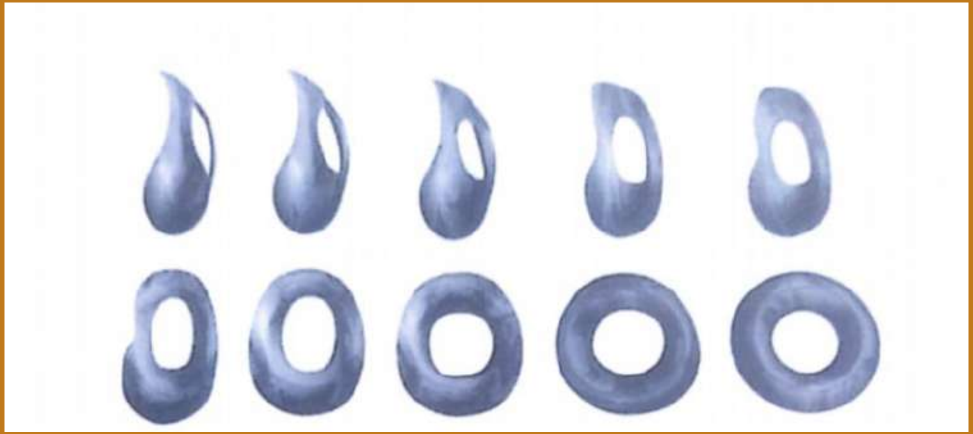

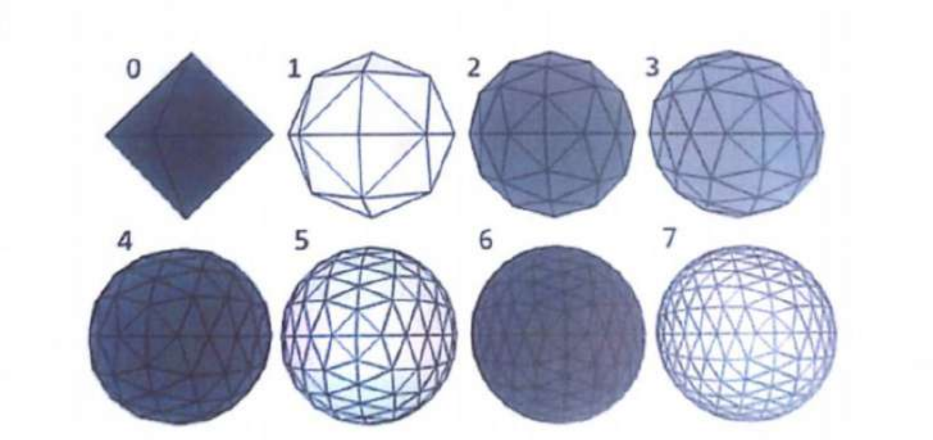

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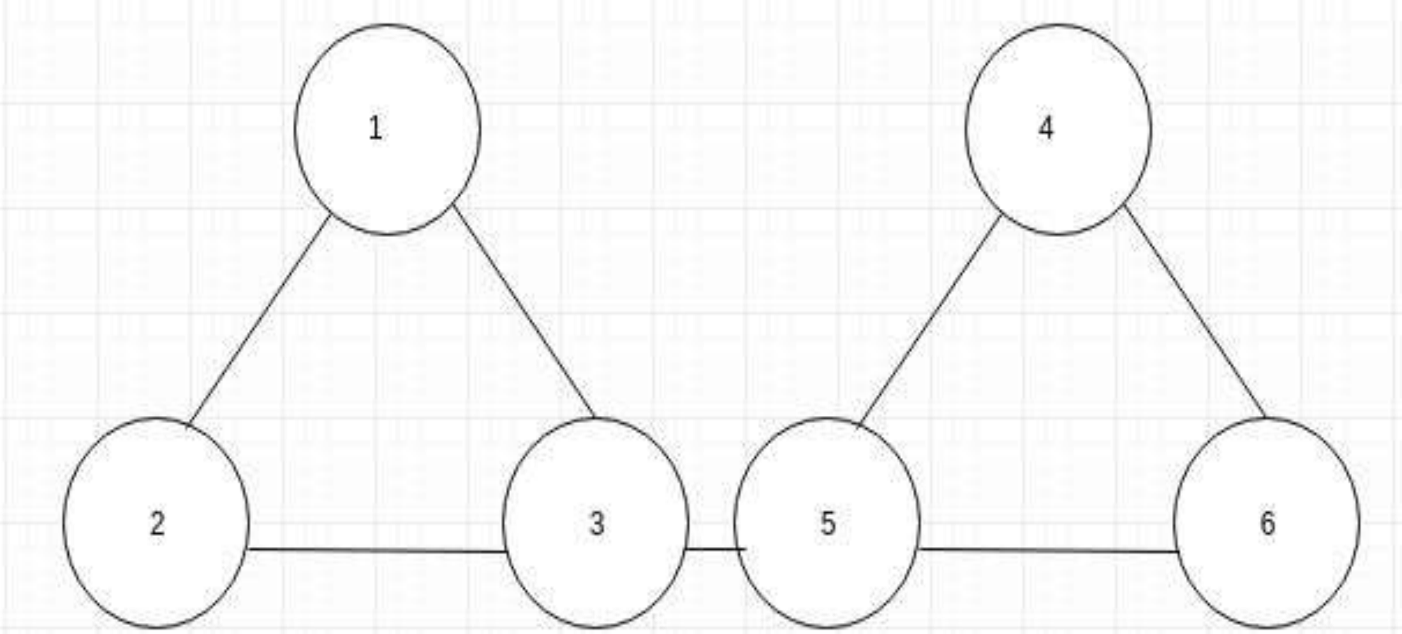

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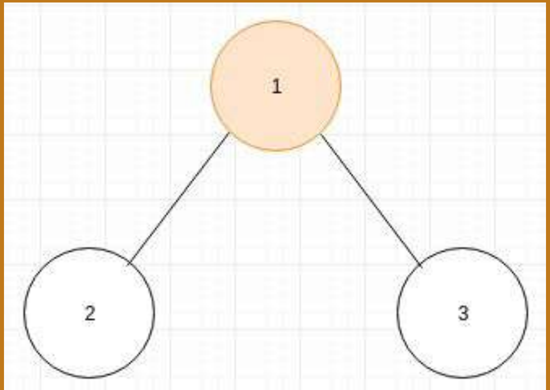

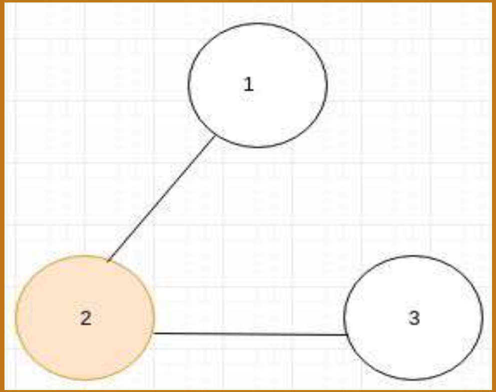

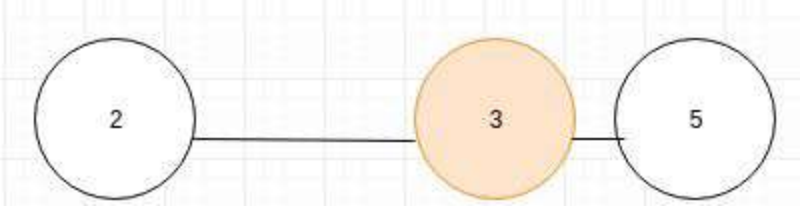

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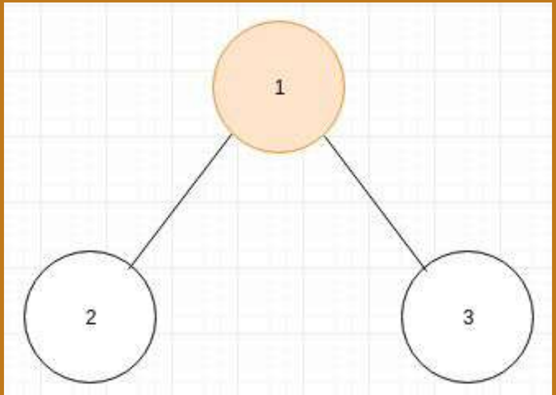

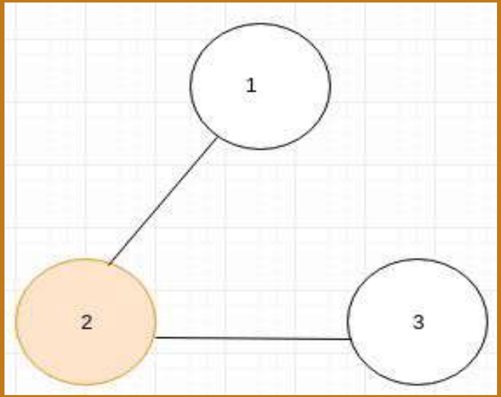

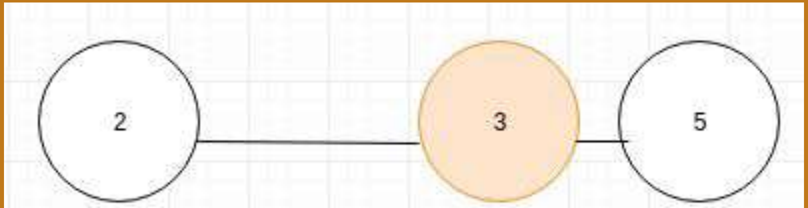

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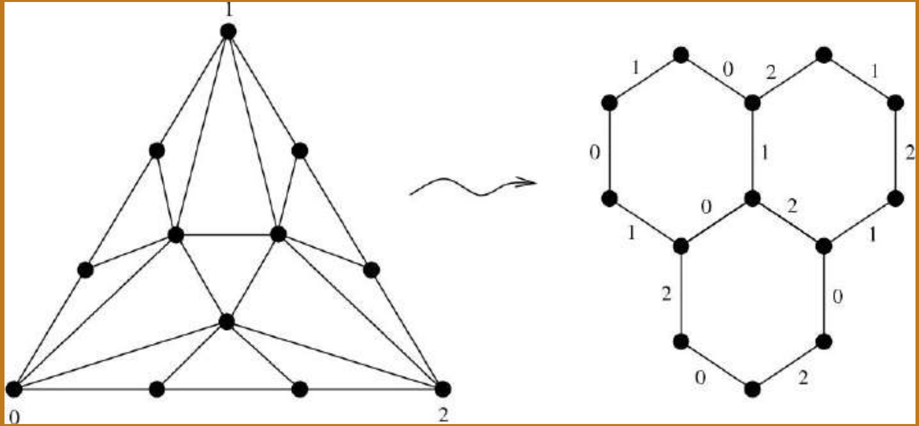

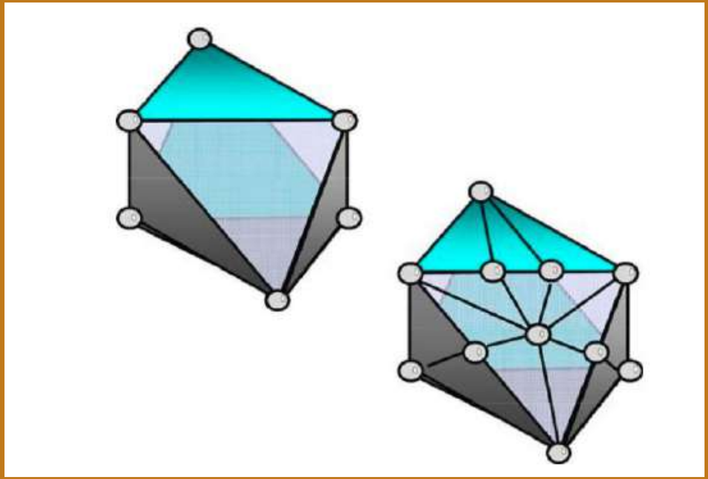

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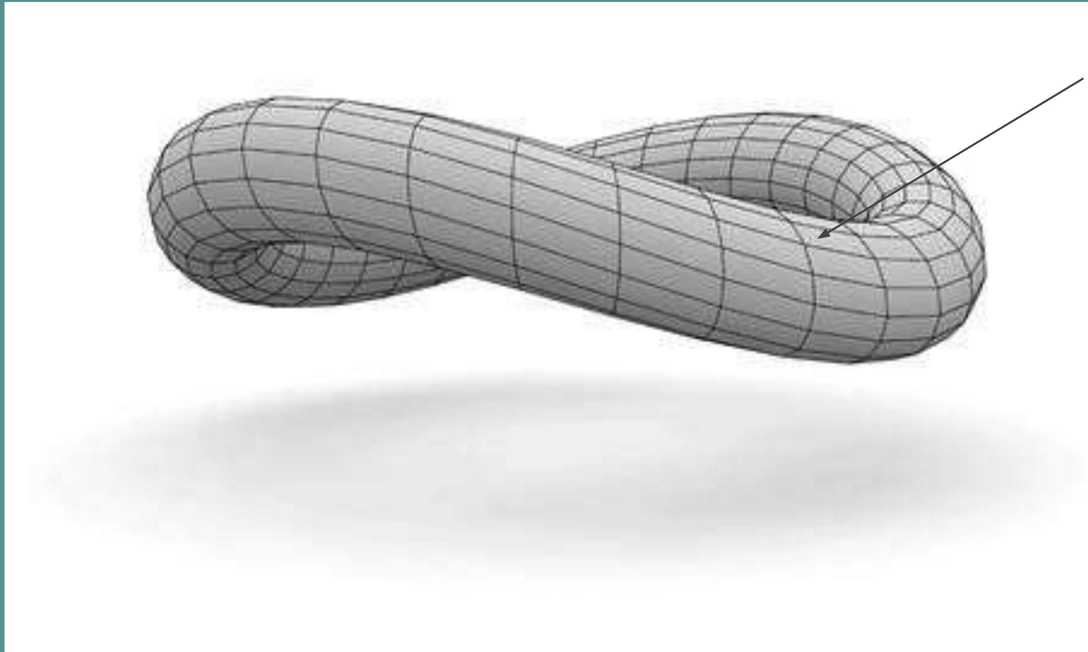

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