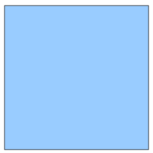
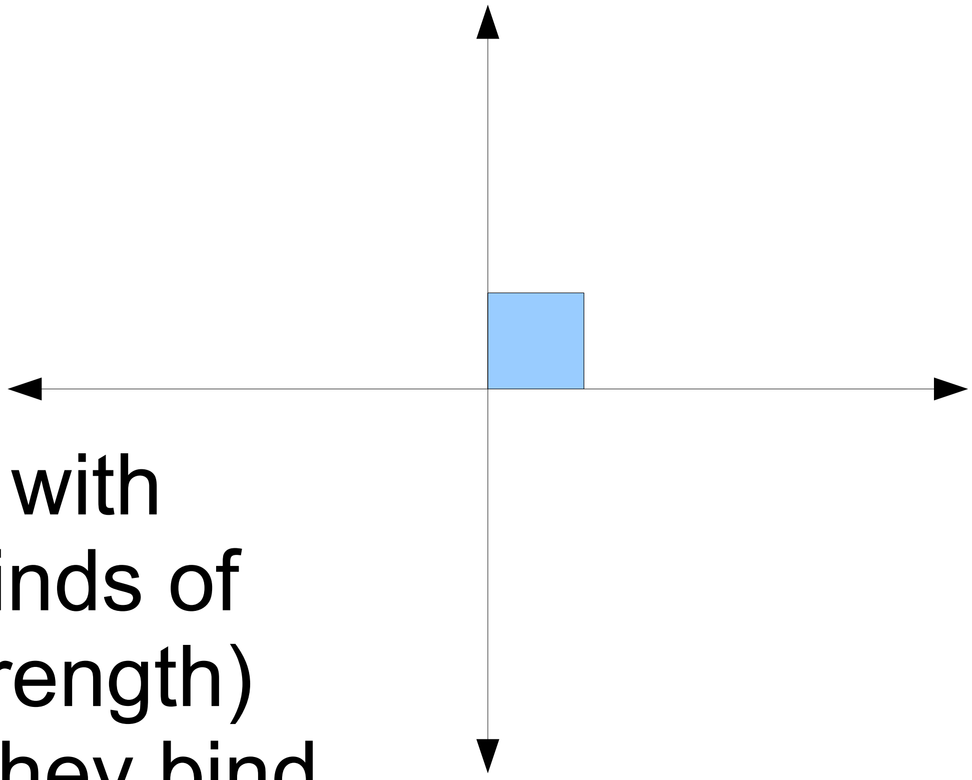
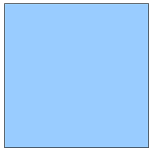
Self-Assembly at Temperature 1
Tiling the Plane

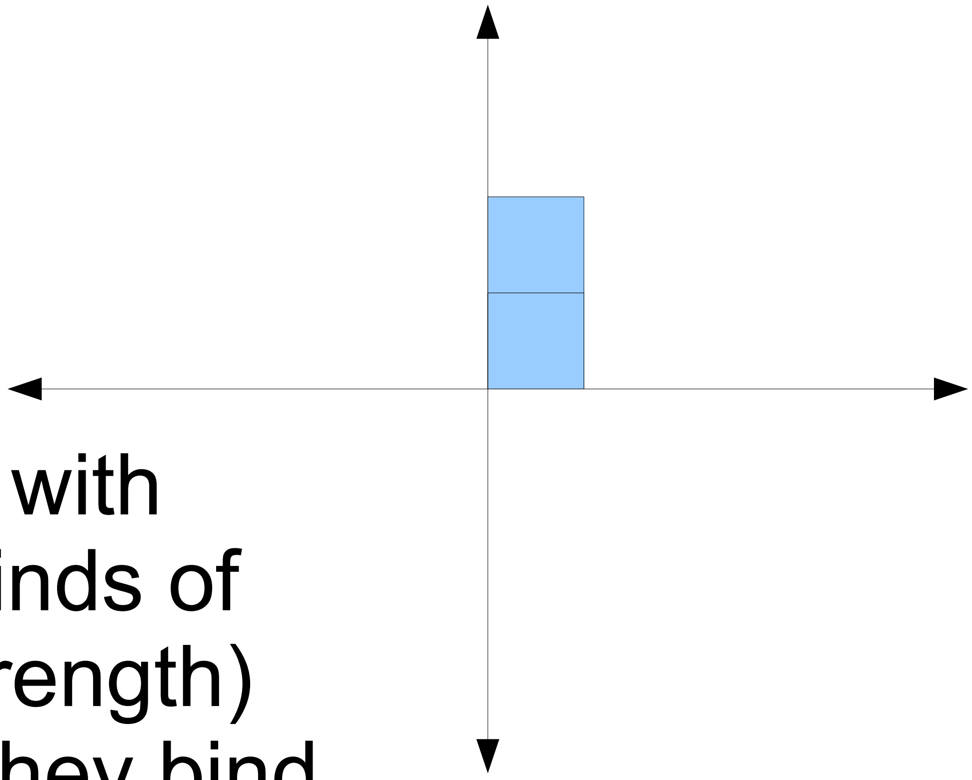
Tile set: 



If tiles abut with matching kinds of (positive strength) glue, then they bind.

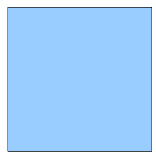
Self-Assembly at Temperature 1
Tiling the Plane

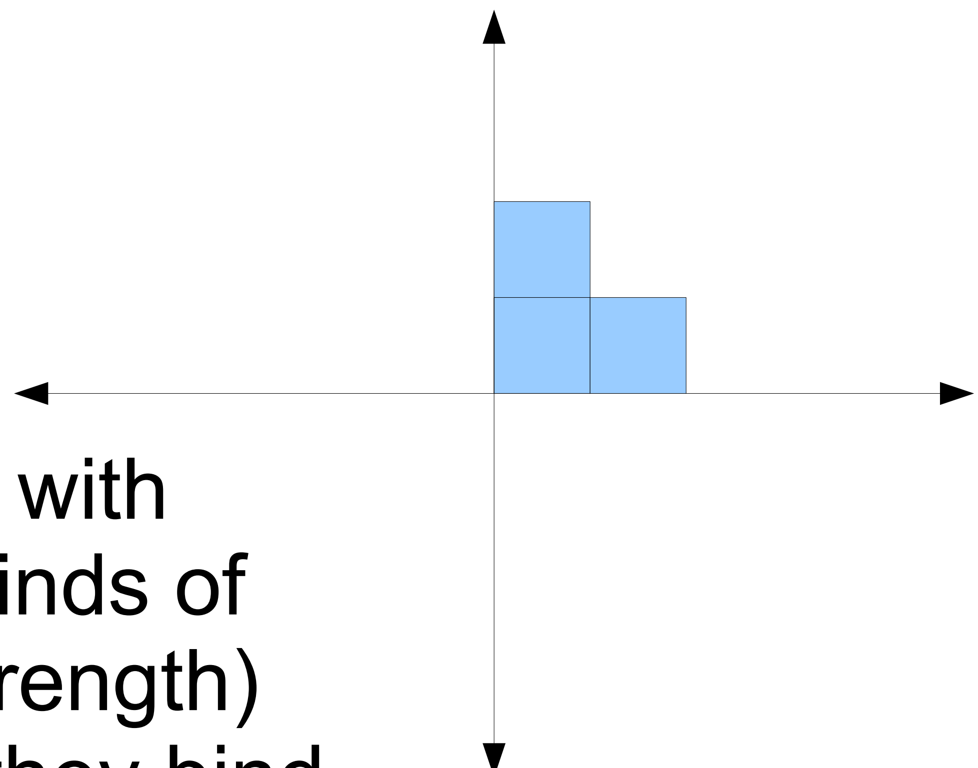
Tile set: 



If tiles abut with matching kinds of (positive strength) glue, then they bind.

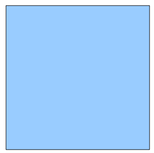
Self-Assembly at Temperature 1
Tiling the Plane

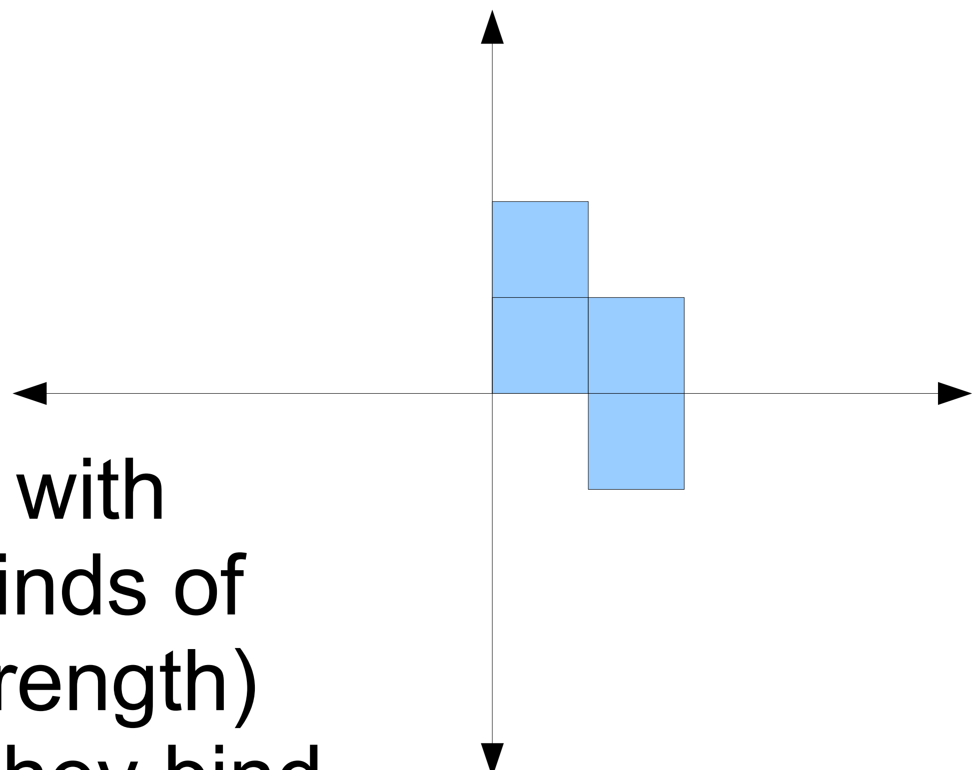
Tile set: 



If tiles abut with matching kinds of (positive strength) glue, then they bind.

Self-Assembly at Temperature 1
Tiling the Plane

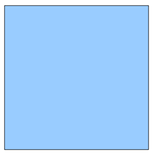
Tile set: 

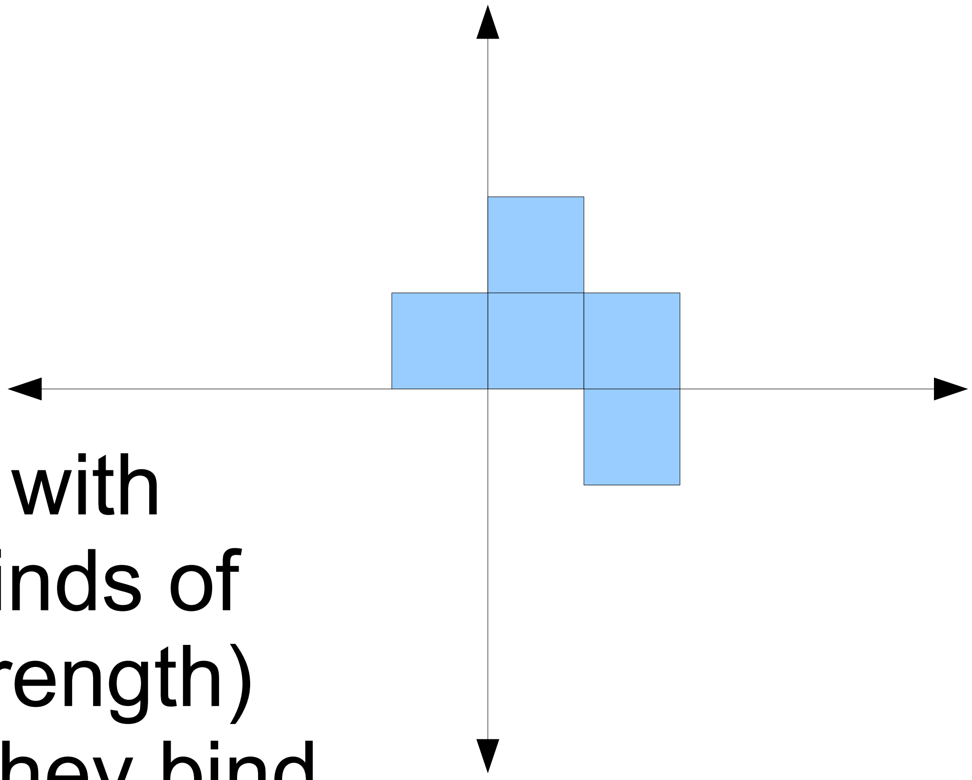


If tiles abut with matching kinds of (positive strength) glue, then they bind.

Self-Assembly at Temperature 1
Tiling the Plane

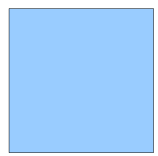
Tile set:

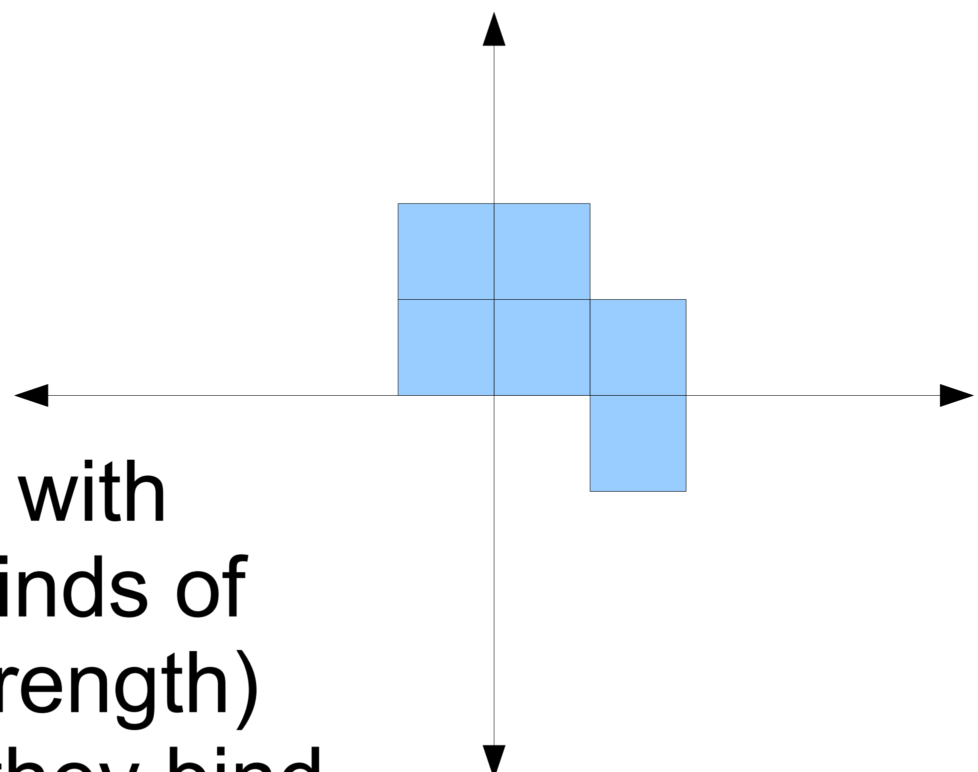




If tiles abut with matching kinds of (positive strength) glue, then they bind.

Self-Assembly at Temperature 1
Tiling the Plane

Tile set: 

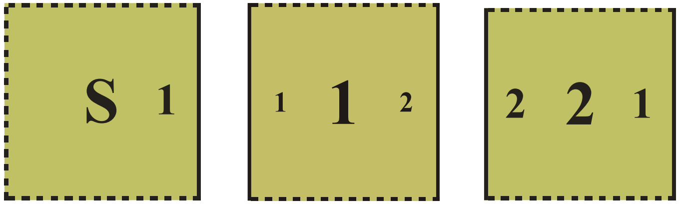


If tiles abut with matching kinds of (positive strength) glue, then they bind.

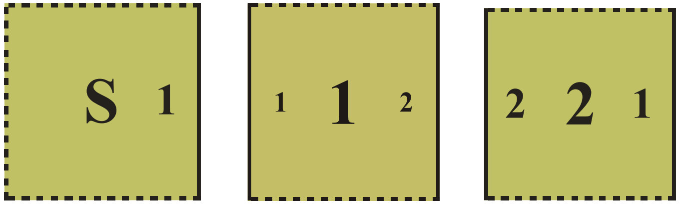
Self-Assembly at Temperature 1
Tiling the Plane

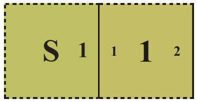
Self-Assembly at Temperature 1
Building a Periodic Line

Tile set:



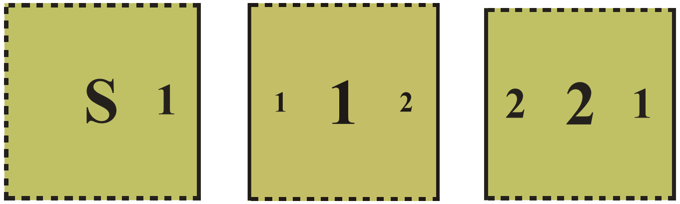
Self-Assembly at Temperature 1
Building a Periodic Line

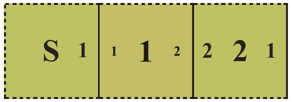
Tile set: 



Self-Assembly at Temperature 1
Building a Periodic Line

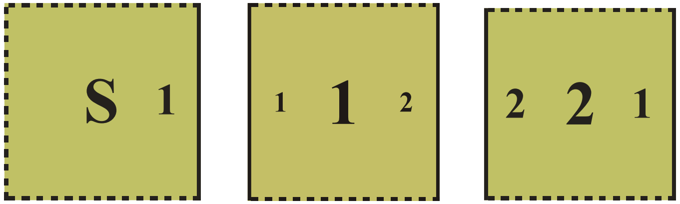
Tile set:

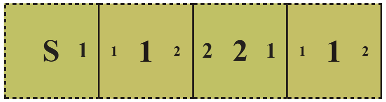




Self-Assembly at Temperature 1
Building a Periodic Line

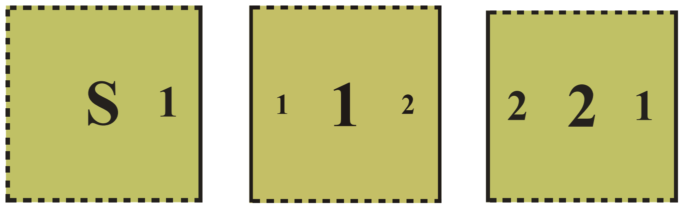
Tile set:

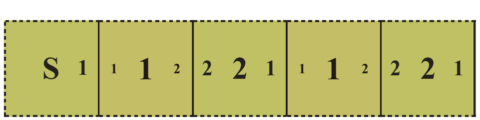




Self-Assembly at Temperature 1
Building a Periodic Line

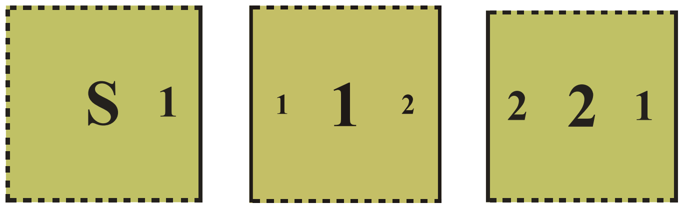
Tile set:

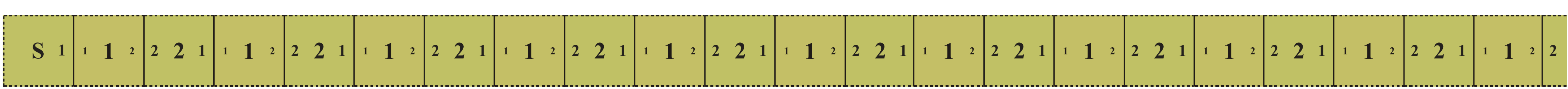




Self-Assembly at Temperature 1
Building a Periodic Line

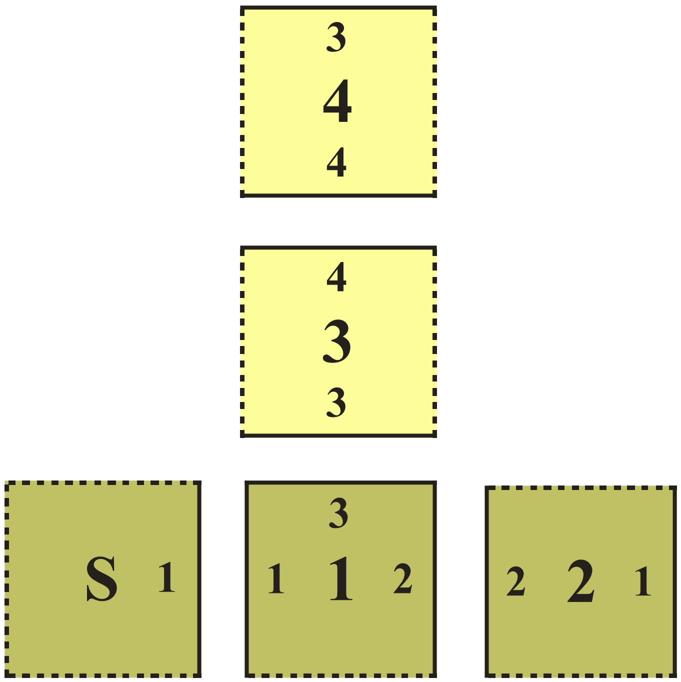
Tile set:





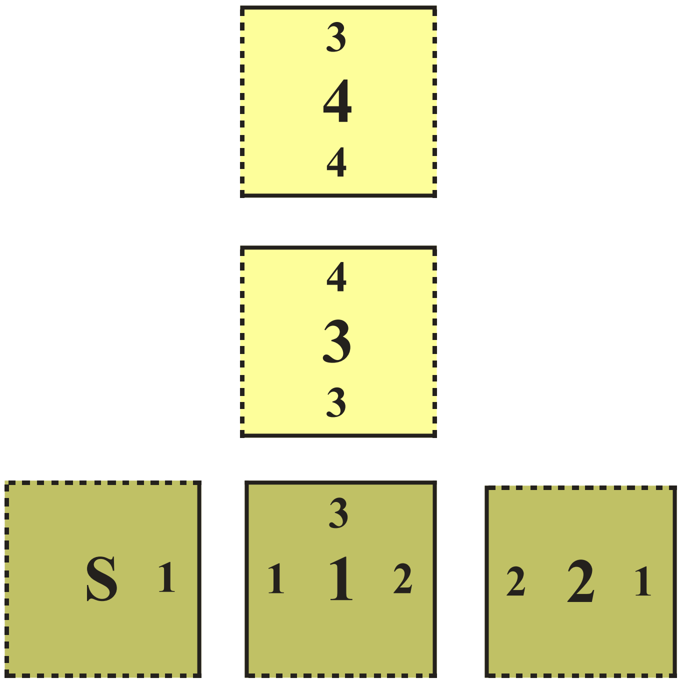
Self-Assembly at Temperature 1
Building a "Comb"

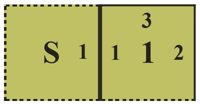
Tile set:



Self-Assembly at Temperature 1
Building a "Comb"

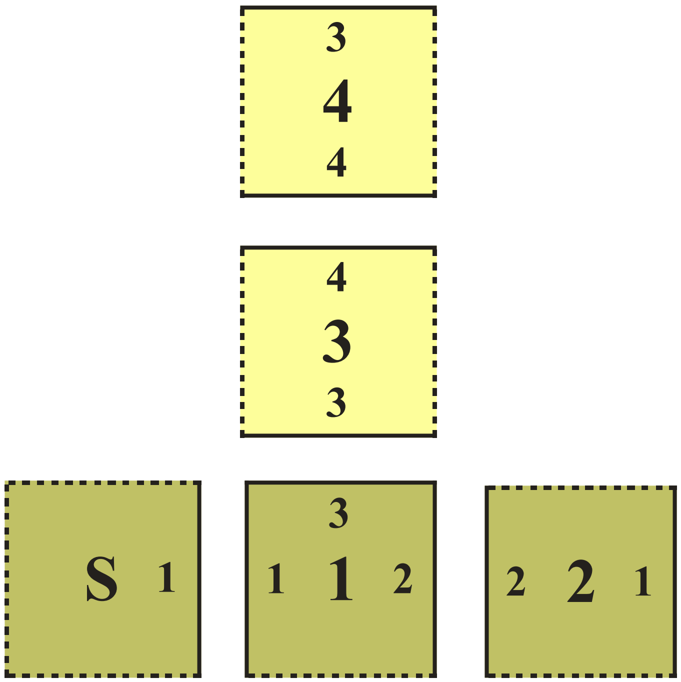
Tile set:

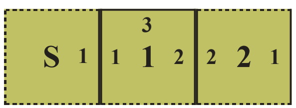




Self-Assembly at Temperature 1
Building a "Comb"

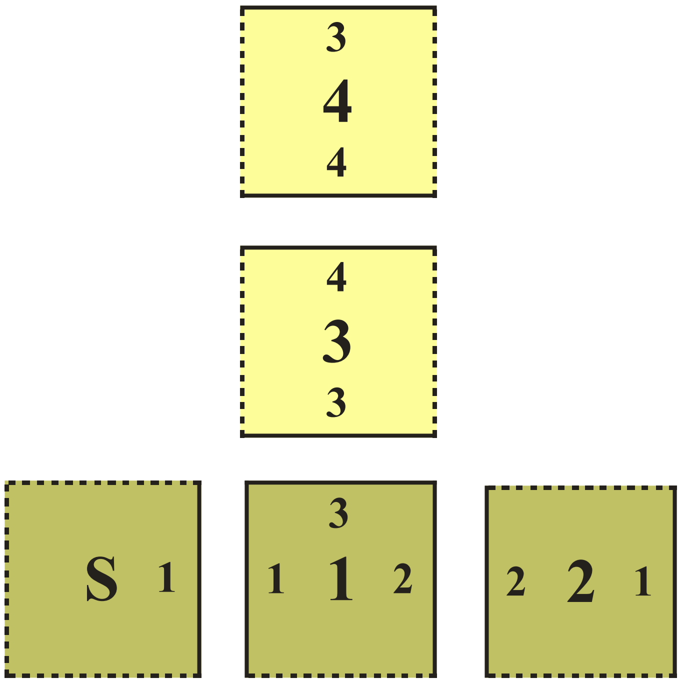
Tile set:

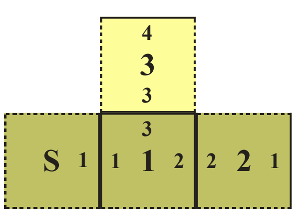




Self-Assembly at Temperature 1 Building a “Comb”

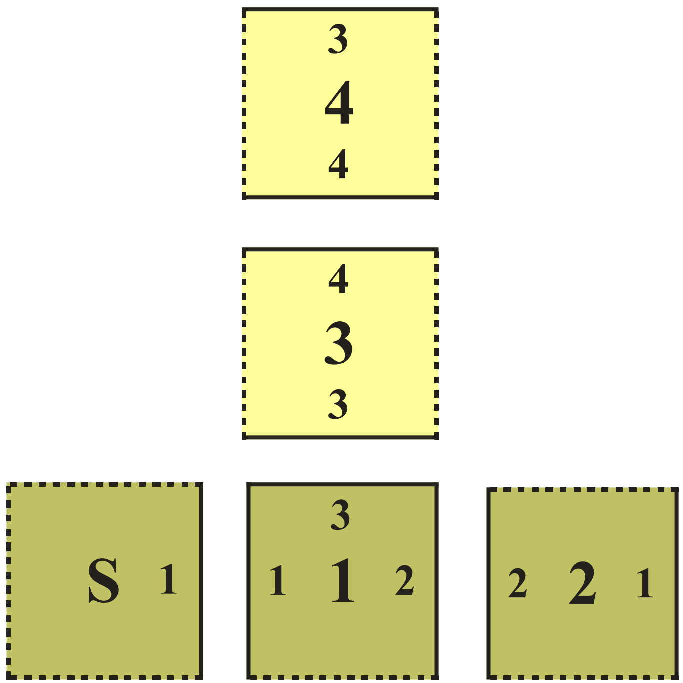
Tile set:

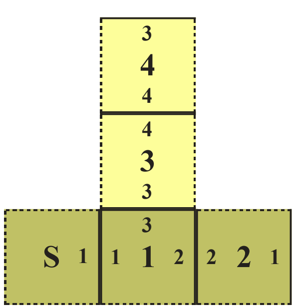




Self-Assembly at Temperature 1
Building a "Comb"

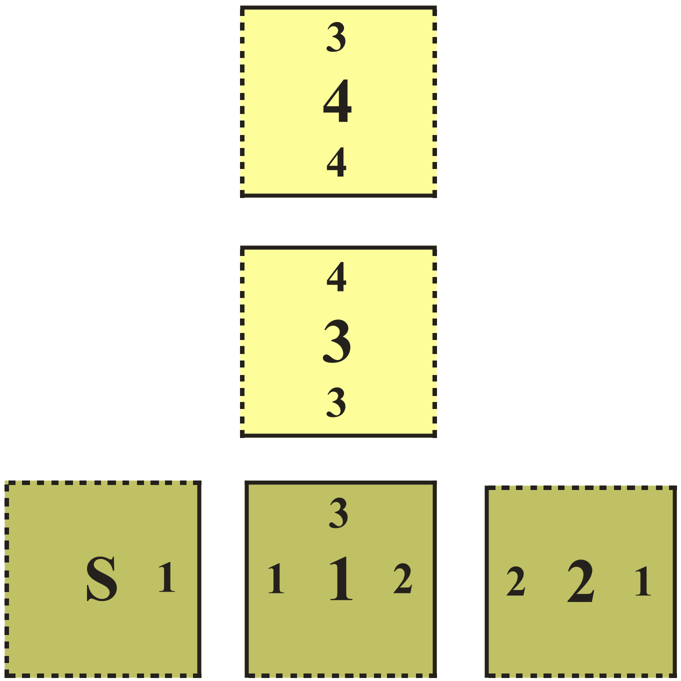
Tile set:

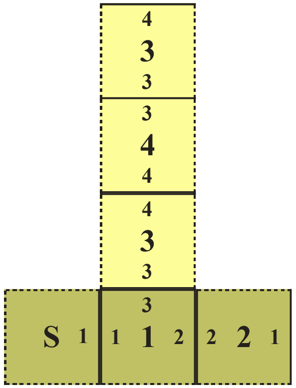




Self-Assembly at Temperature 1
Building a "Comb"

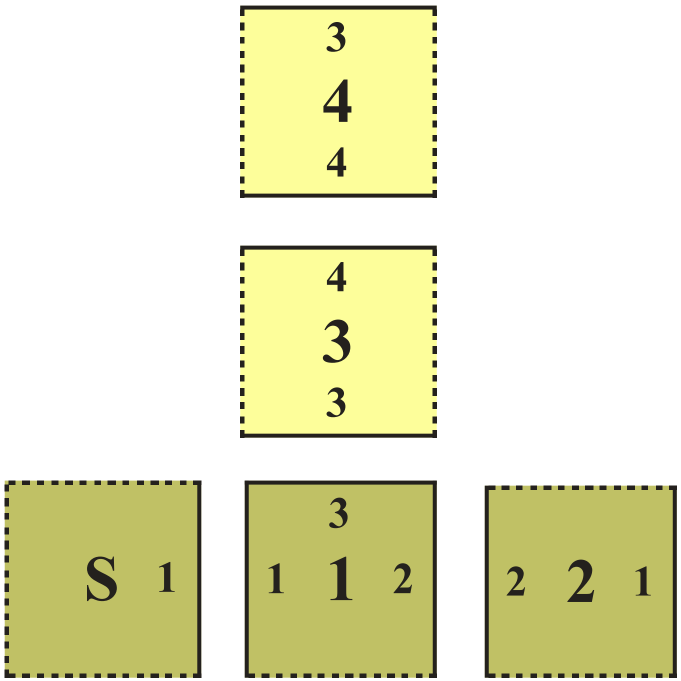
Tile set:

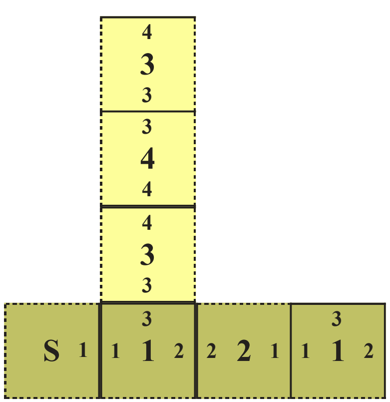




Self-Assembly at Temperature 1
Building a "Comb"

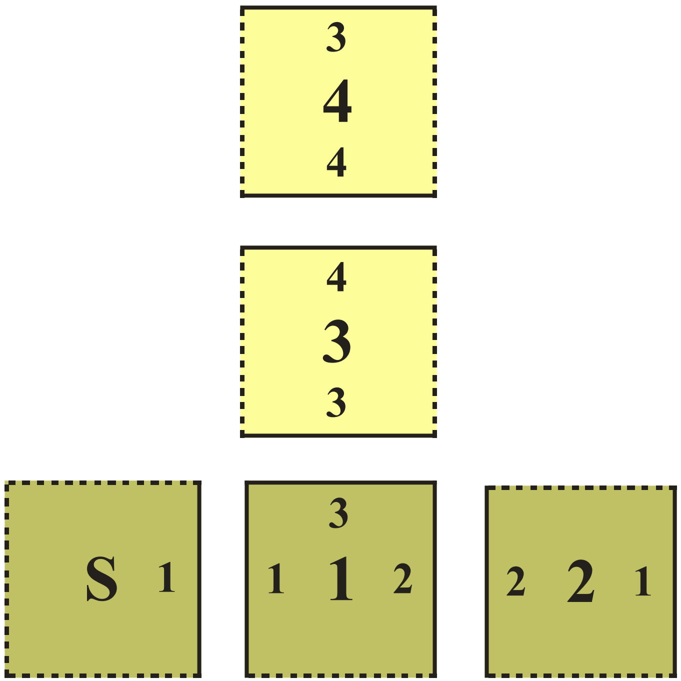
Tile set:

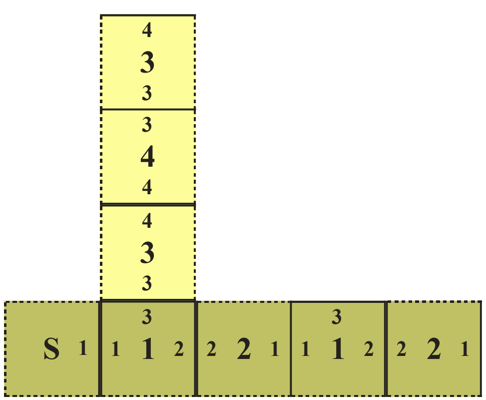




Self-Assembly at Temperature 1
Building a "Comb"

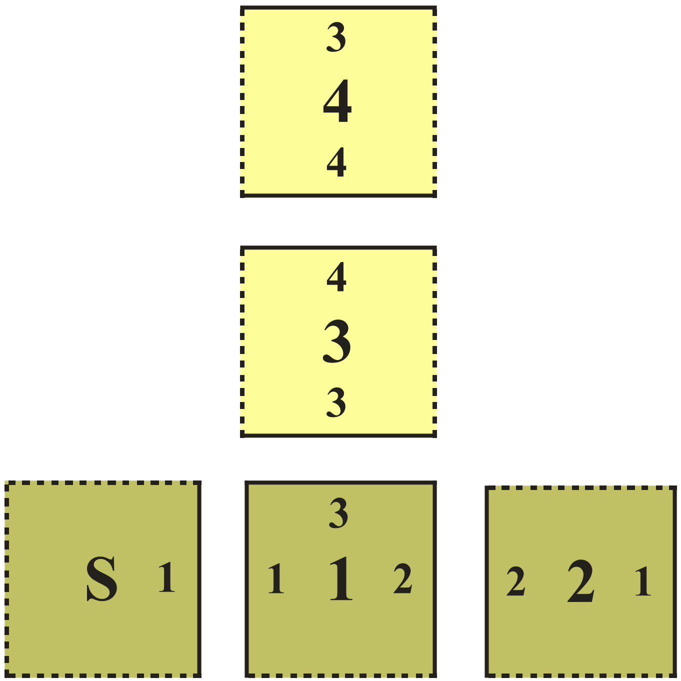
Tile set:

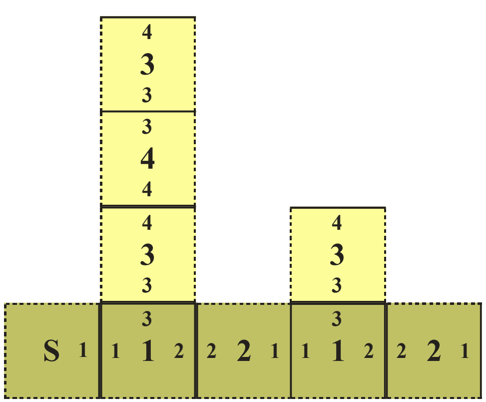




Self-Assembly at Temperature 1
Building a “Comb”

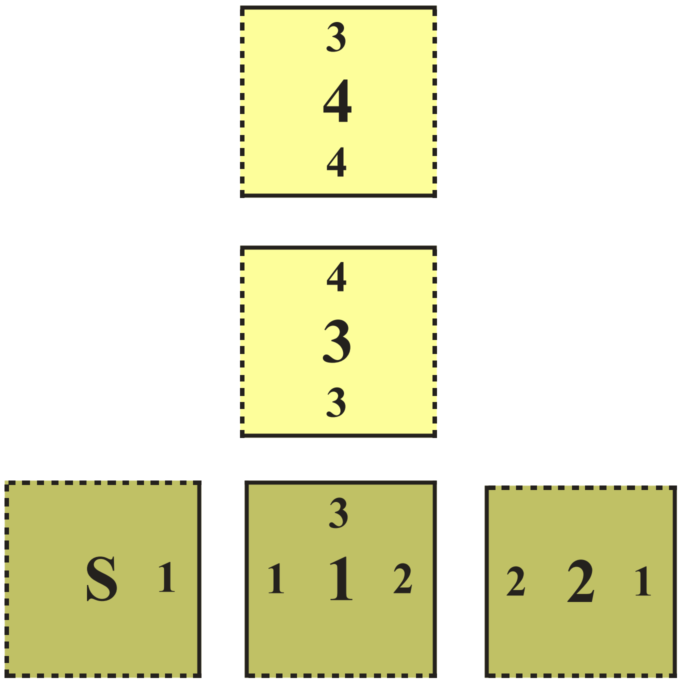
Tile set:

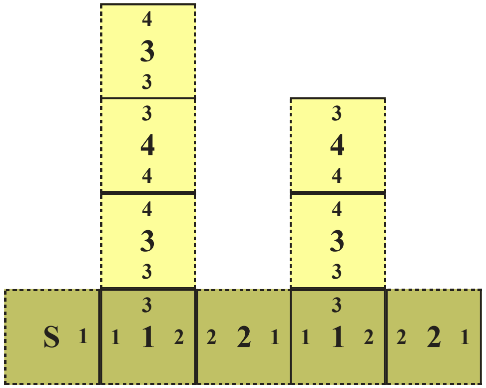




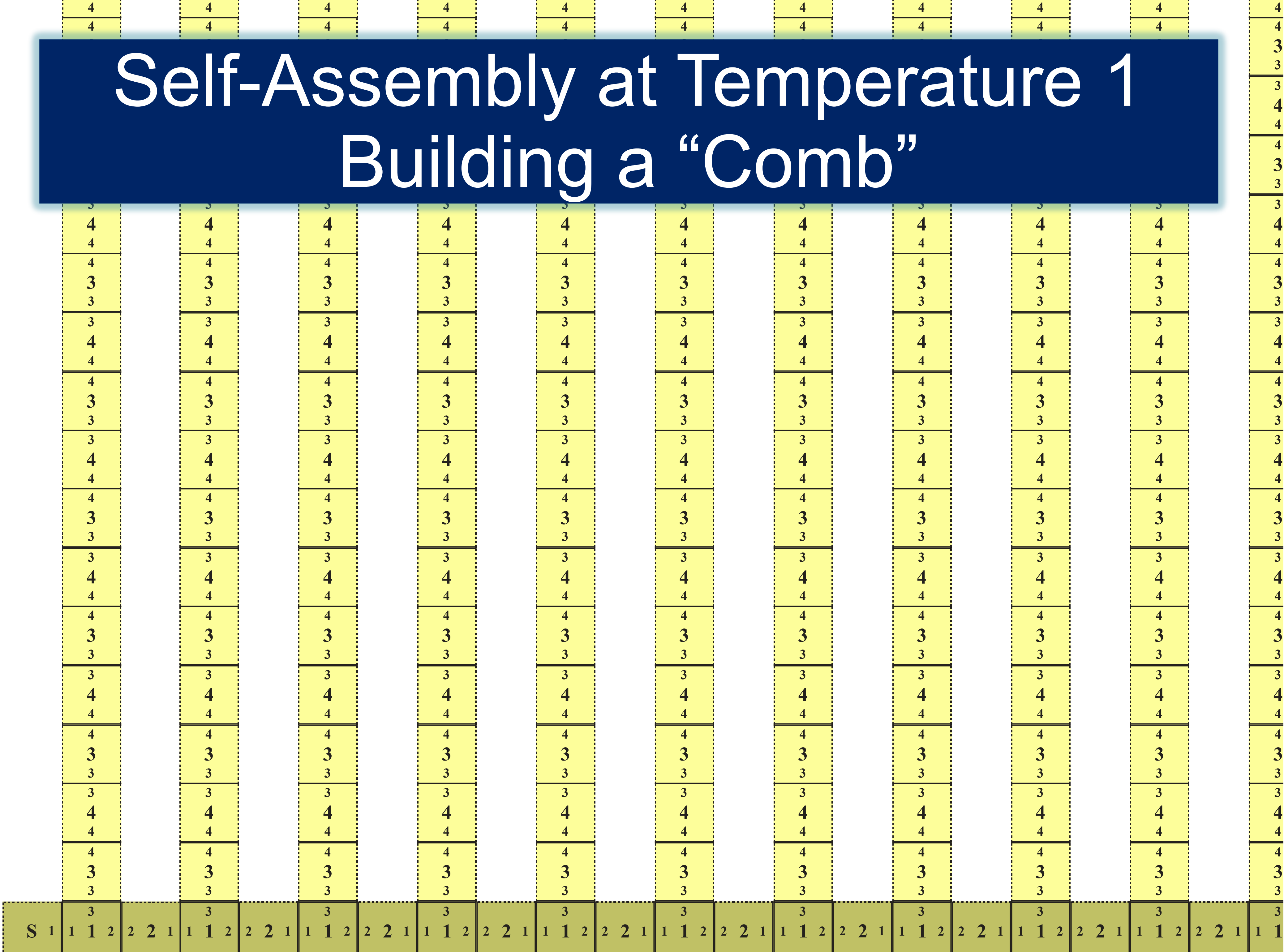
Self-Assembly at Temperature 1
Building a "Comb"

Tile set:



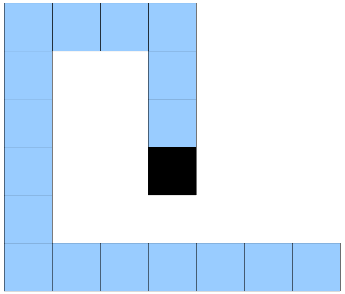


Self-Assembly at Temperature 1
Building a “Comb”

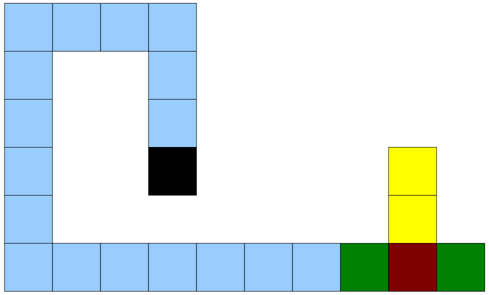


Self-Assembly at Temperature 1
Building an “Eventual Comb”

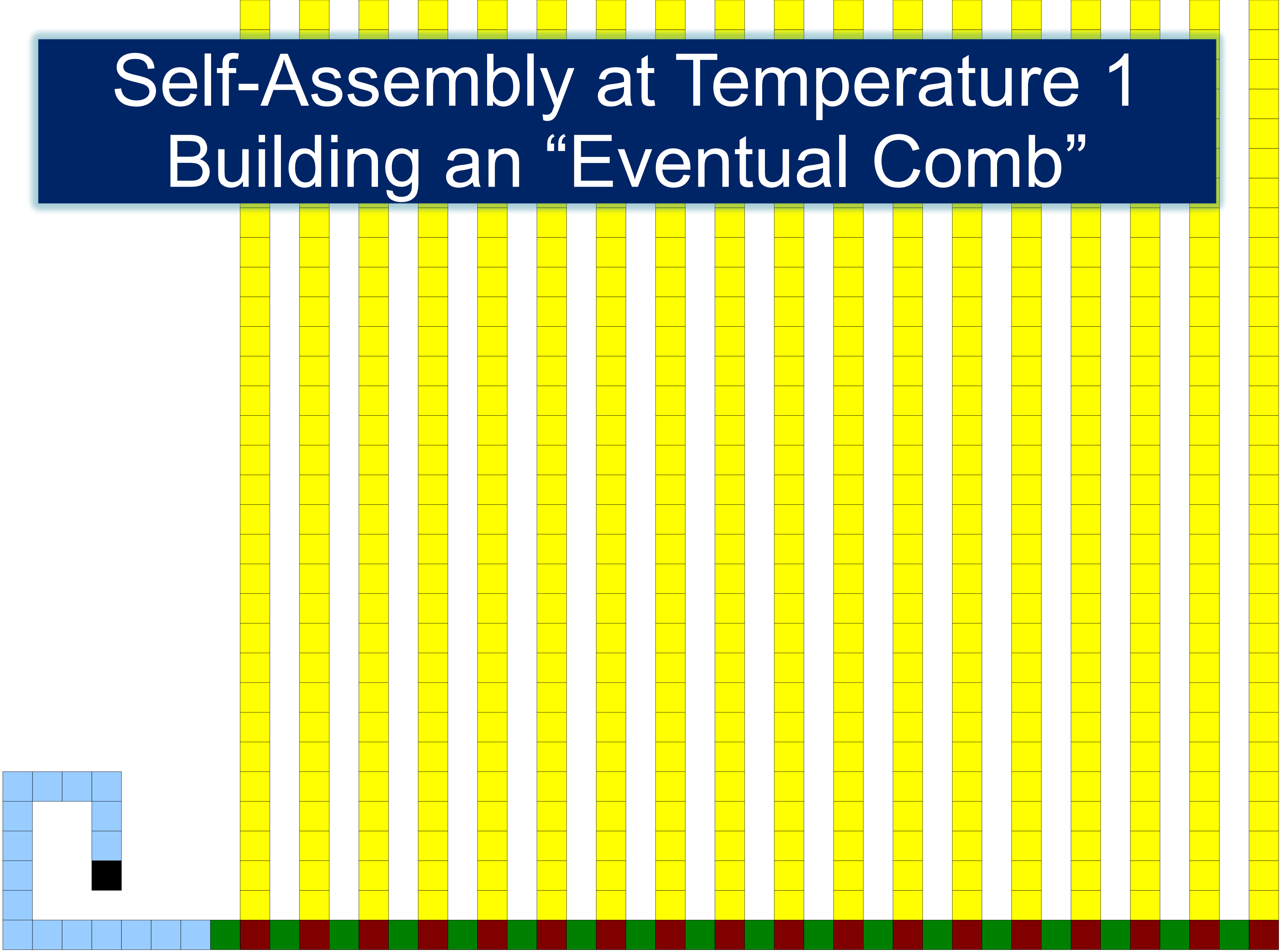
Self-Assembly at Temperature 1 Building an "Eventual Comb"



Self-Assembly at Temperature 1
Building an “Eventual Comb”

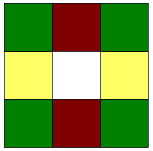


Self-Assembly at Temperature 1
Building an "Eventual Comb"

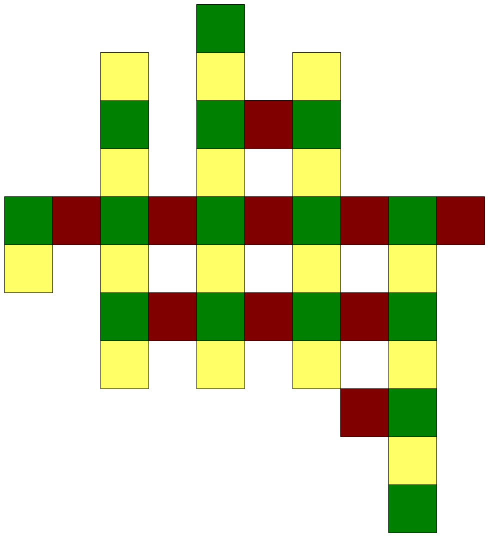


Self-Assembly at Temperature 1
Building a Plane-Filling Grid

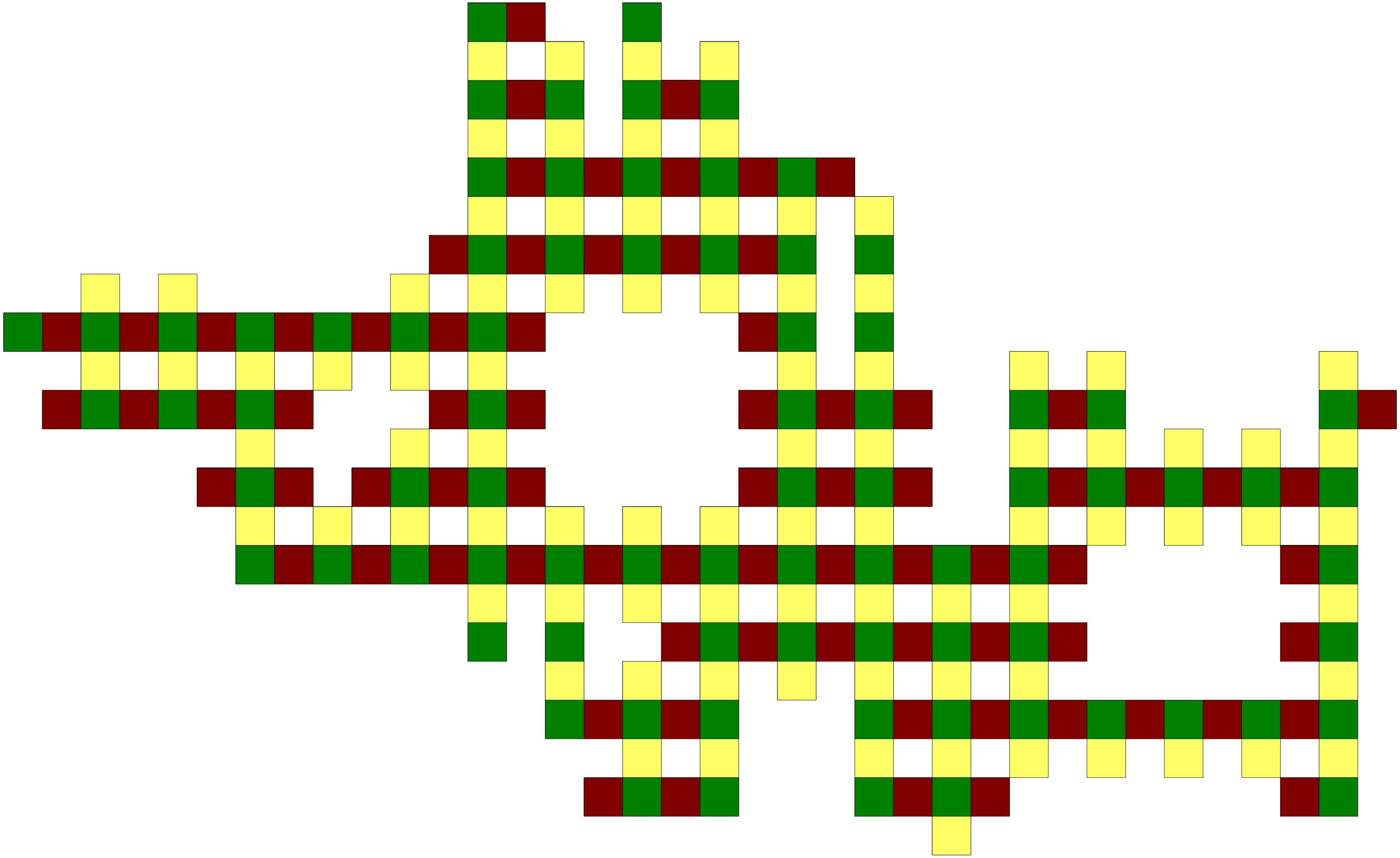
Self-Assembly at Temperature 1
Building a Plane-Filling Grid



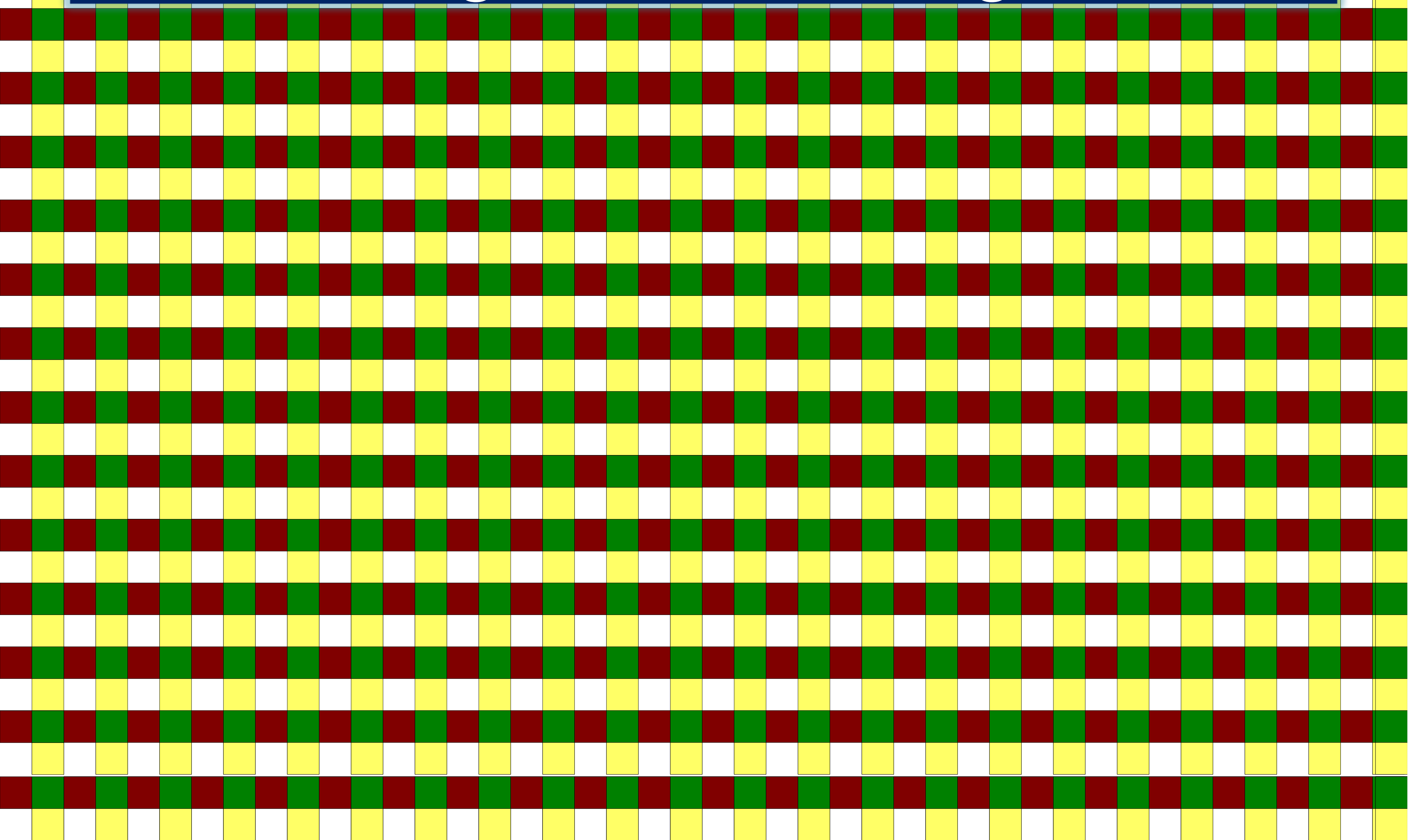
Self-Assembly at Temperature 1
Building a Plane-Filling Grid



Self-Assembly at Temperature 1
Building a Plane-Filling Grid



Self-Assembly at Temperature 1
Building a Plane-Filling Grid



Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches

Power of Cooperative Binding

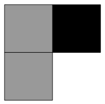
- “Temperature 1” self-assembly: any tile may bind if even one glue matches

Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches

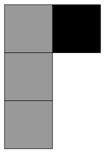
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



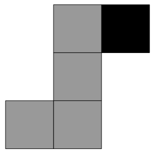
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



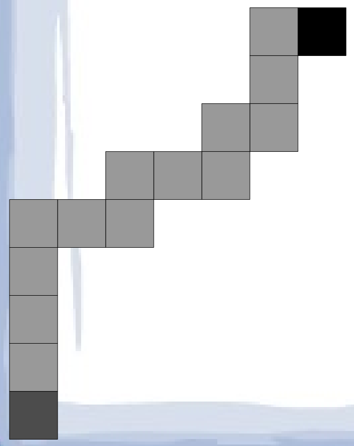
Power of Cooperative Binding

- "Temperature 1" self-assembly: any tile may bind if even one glue matches



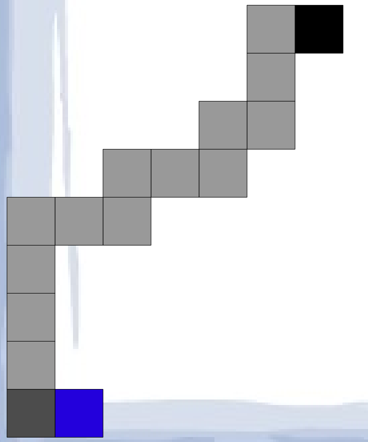
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



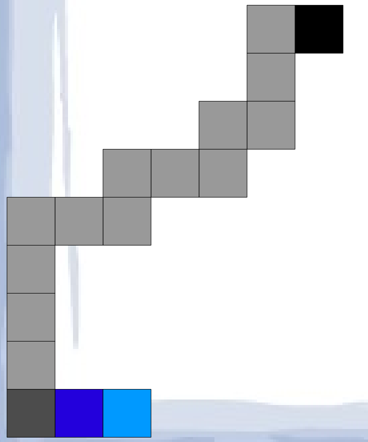
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



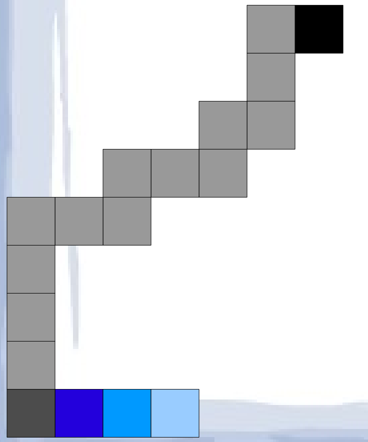
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



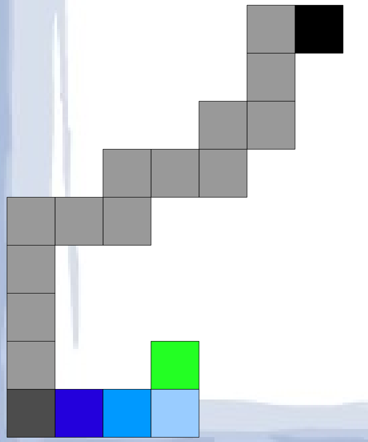
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



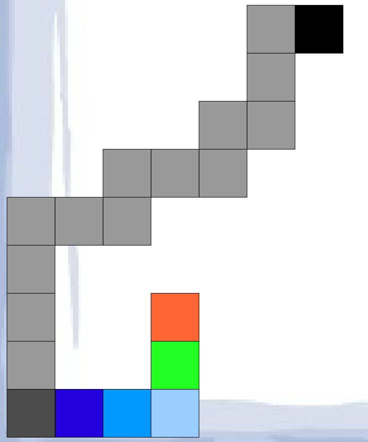
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



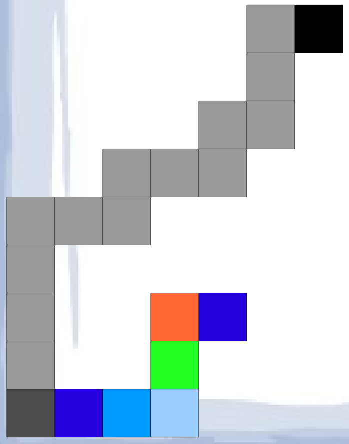
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



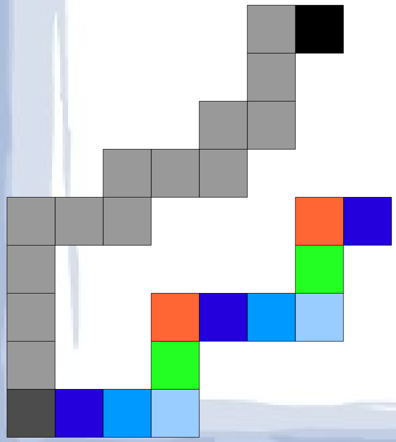
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



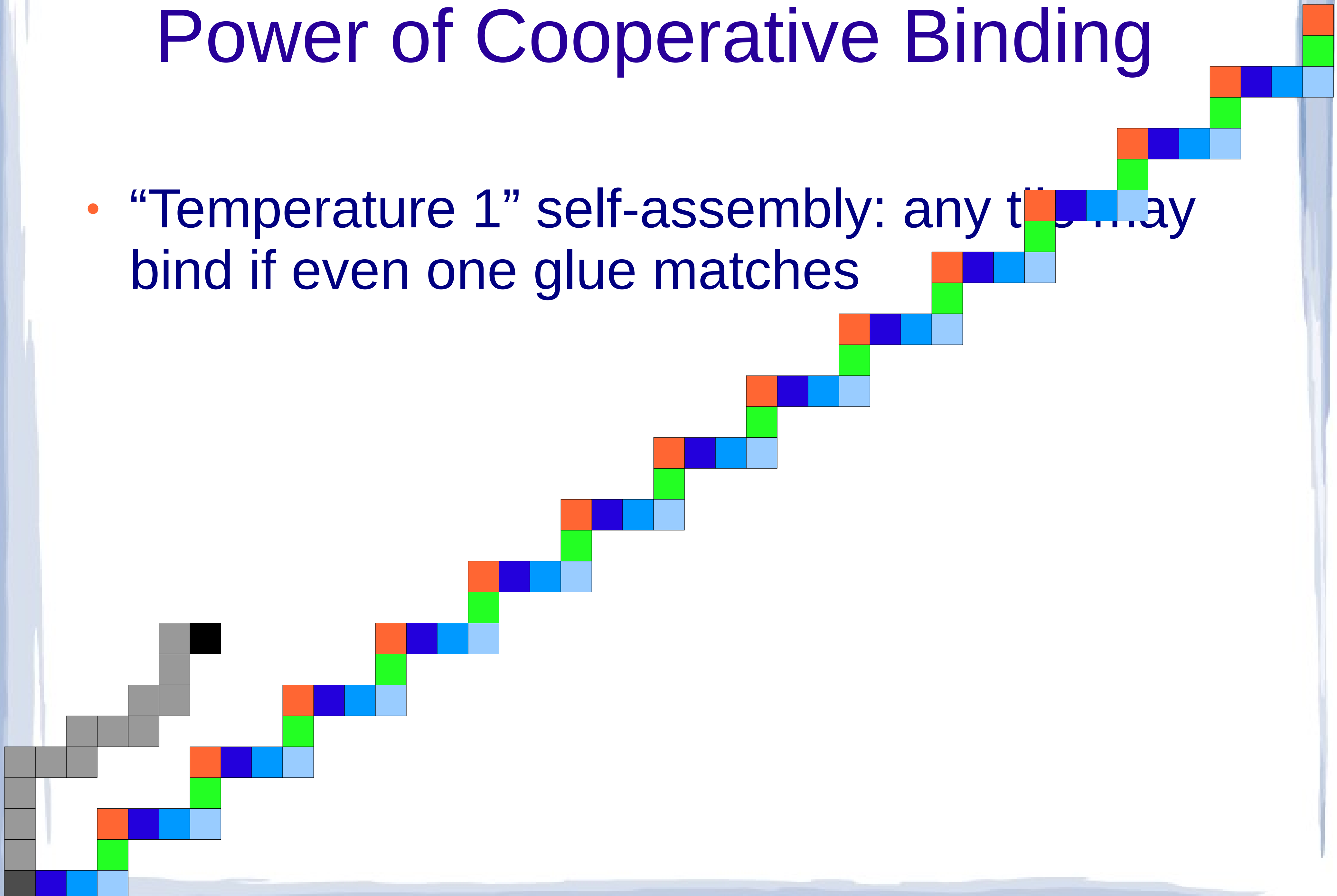
Power of Cooperative Binding

- "Temperature 1" self-assembly: any tile may bind if even one glue matches



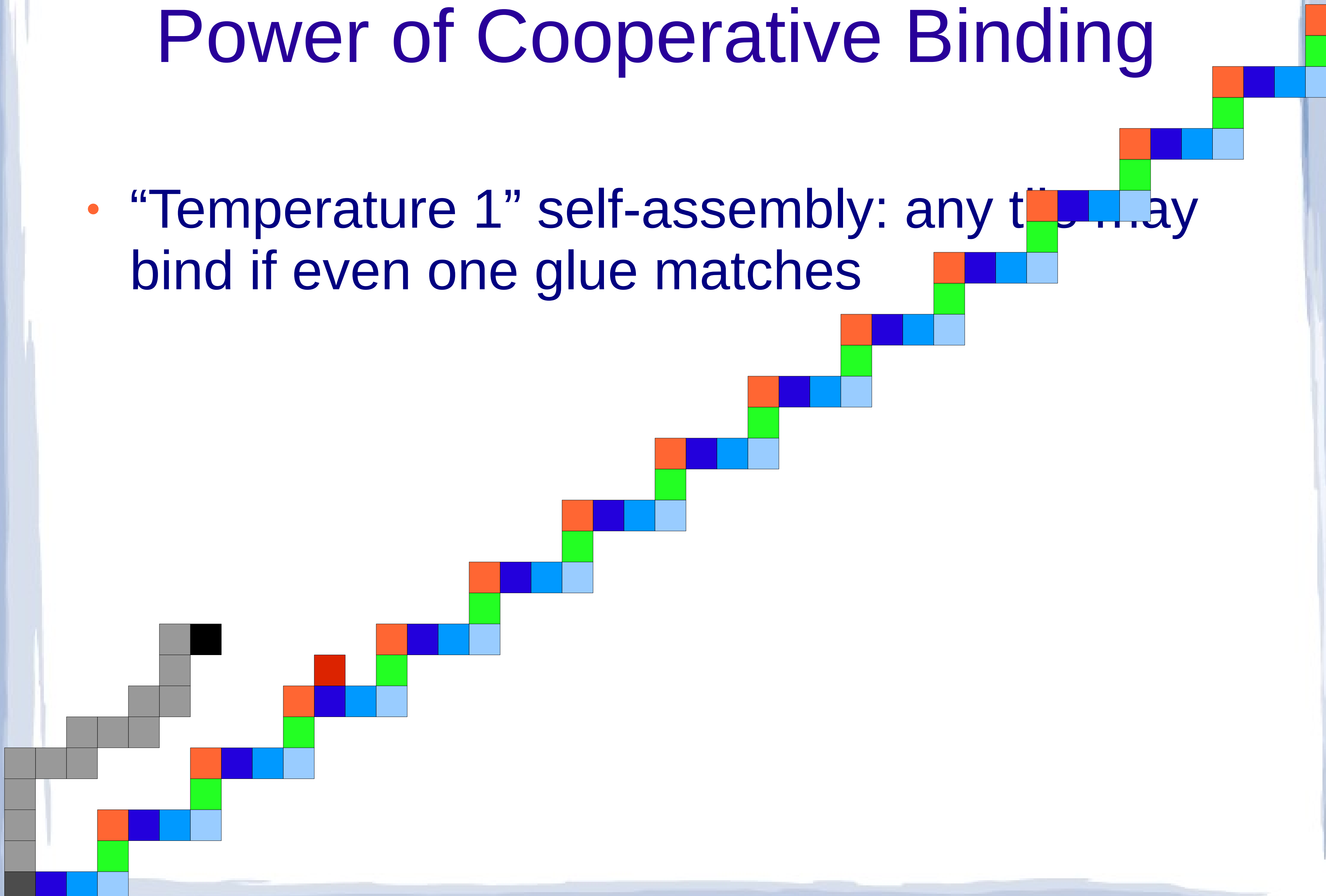
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



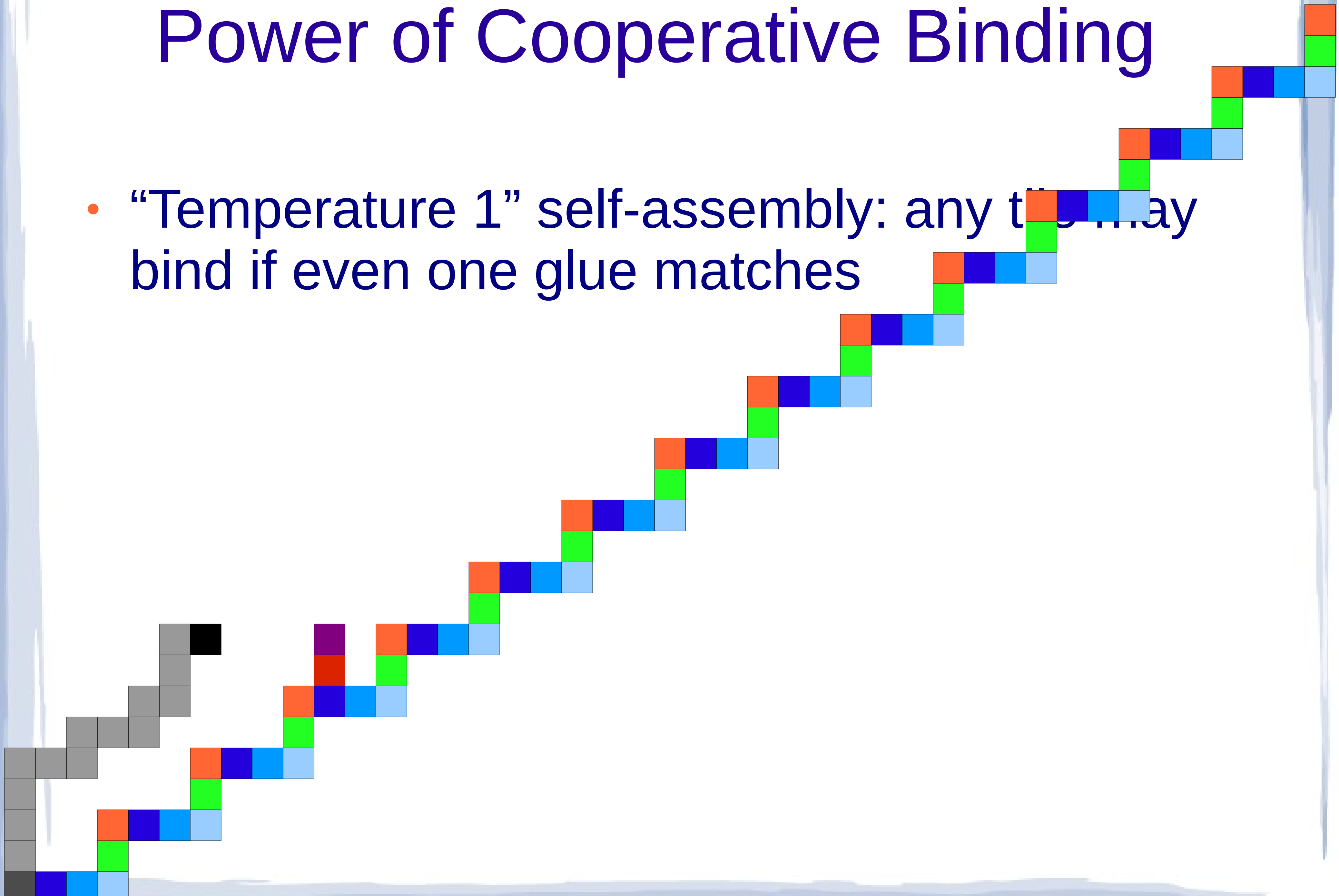
Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches



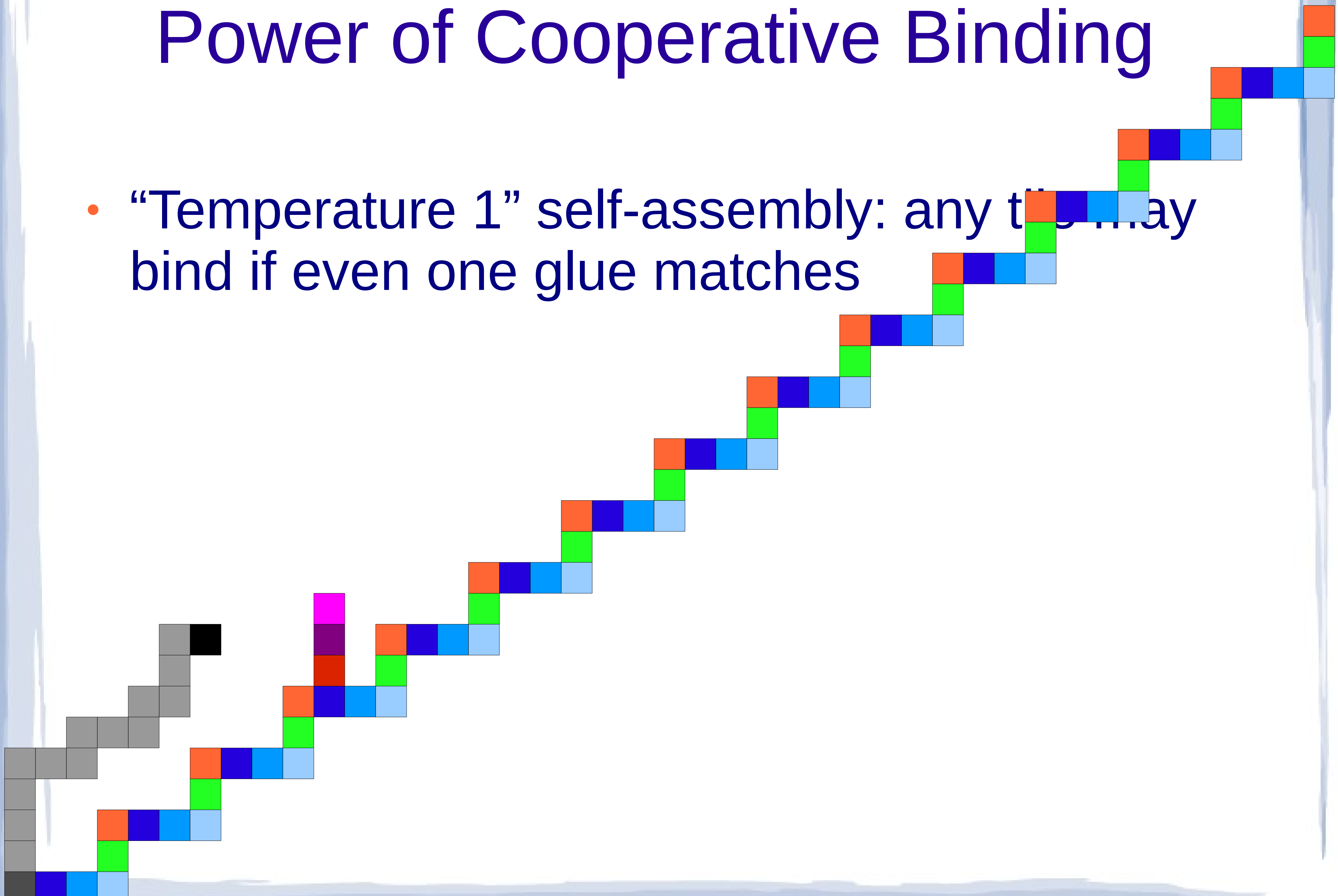
Power of Cooperative Binding

- "Temperature 1" self-assembly: any tile may bind if even one glue matches



Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches

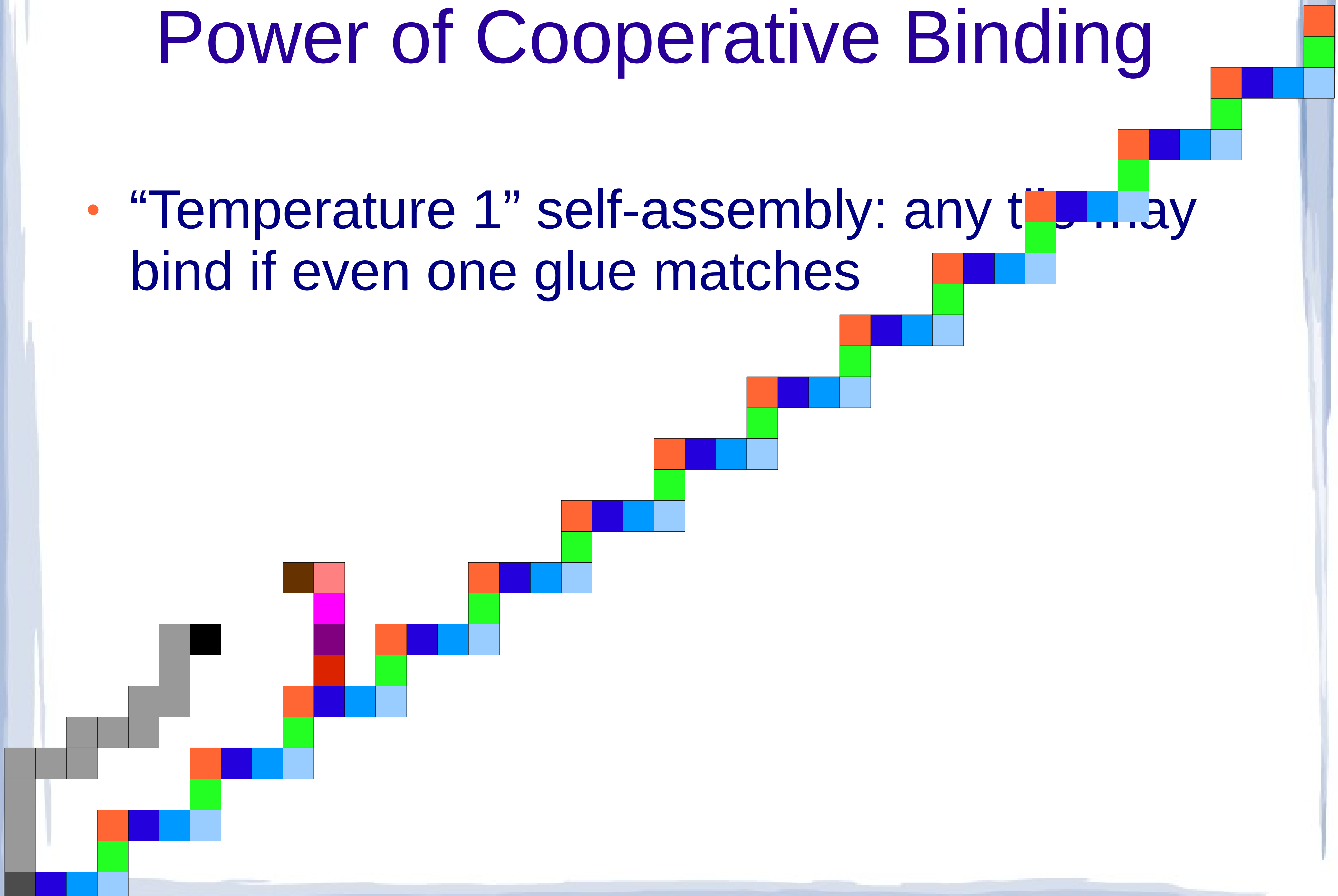


Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches

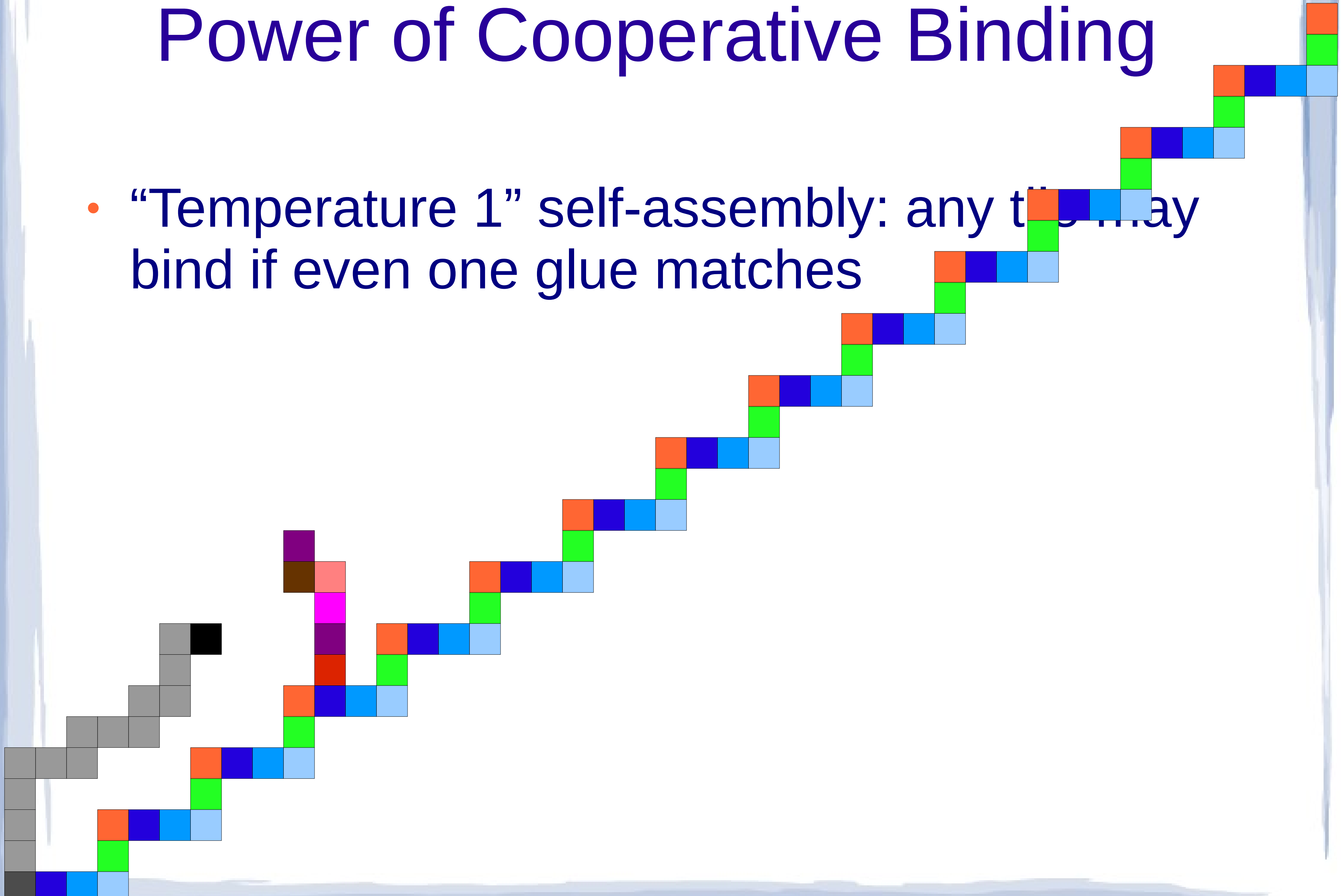
Power of Cooperative Binding

- "Temperature 1" self-assembly: any tile may bind if even one glue matches



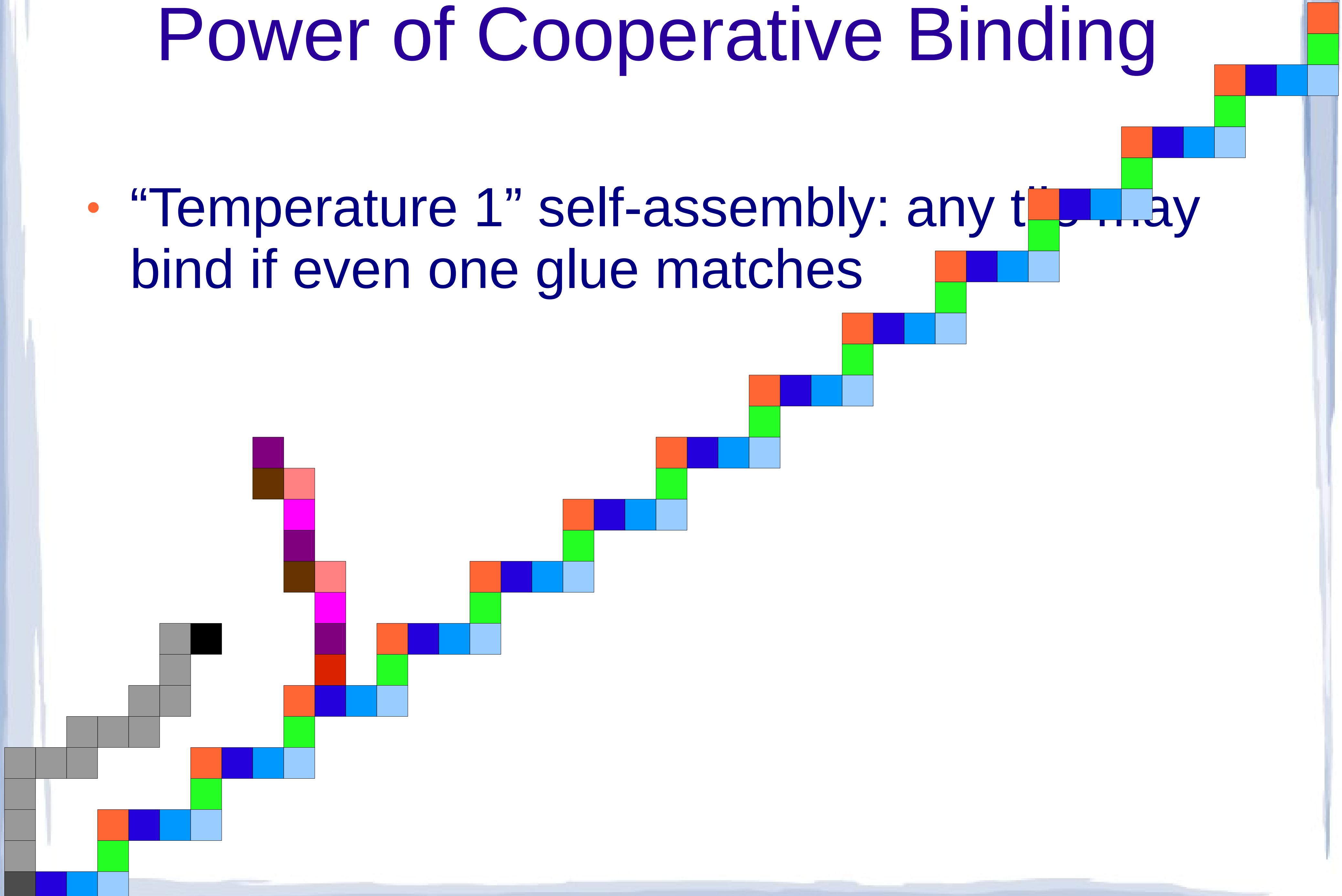
Power of Cooperative Binding

- "Temperature 1" self-assembly: any tile may bind if even one glue matches



Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches

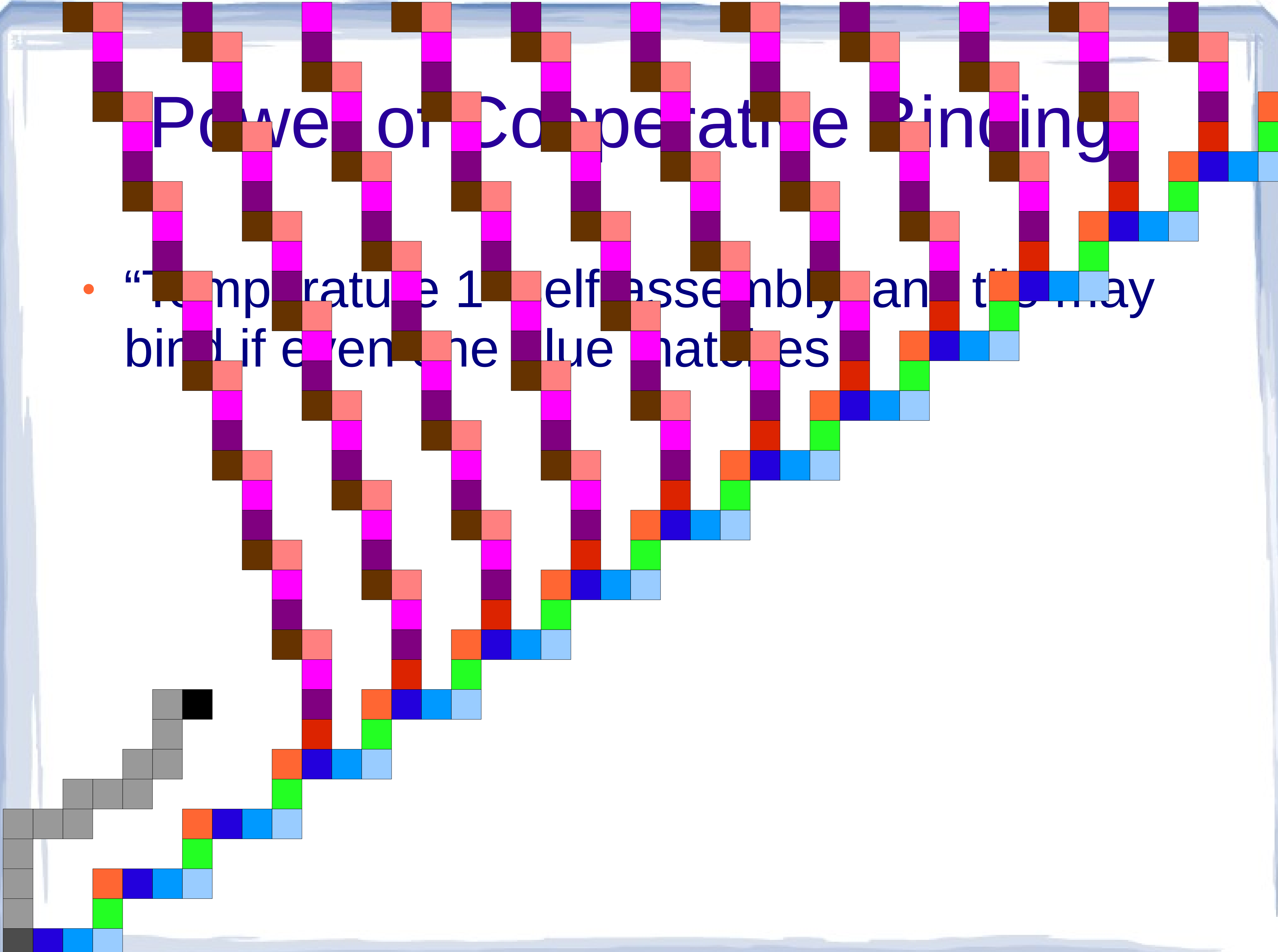


Power of Cooperative Binding

- “Temperature 1” self-assembly: any tile may bind if even one glue matches

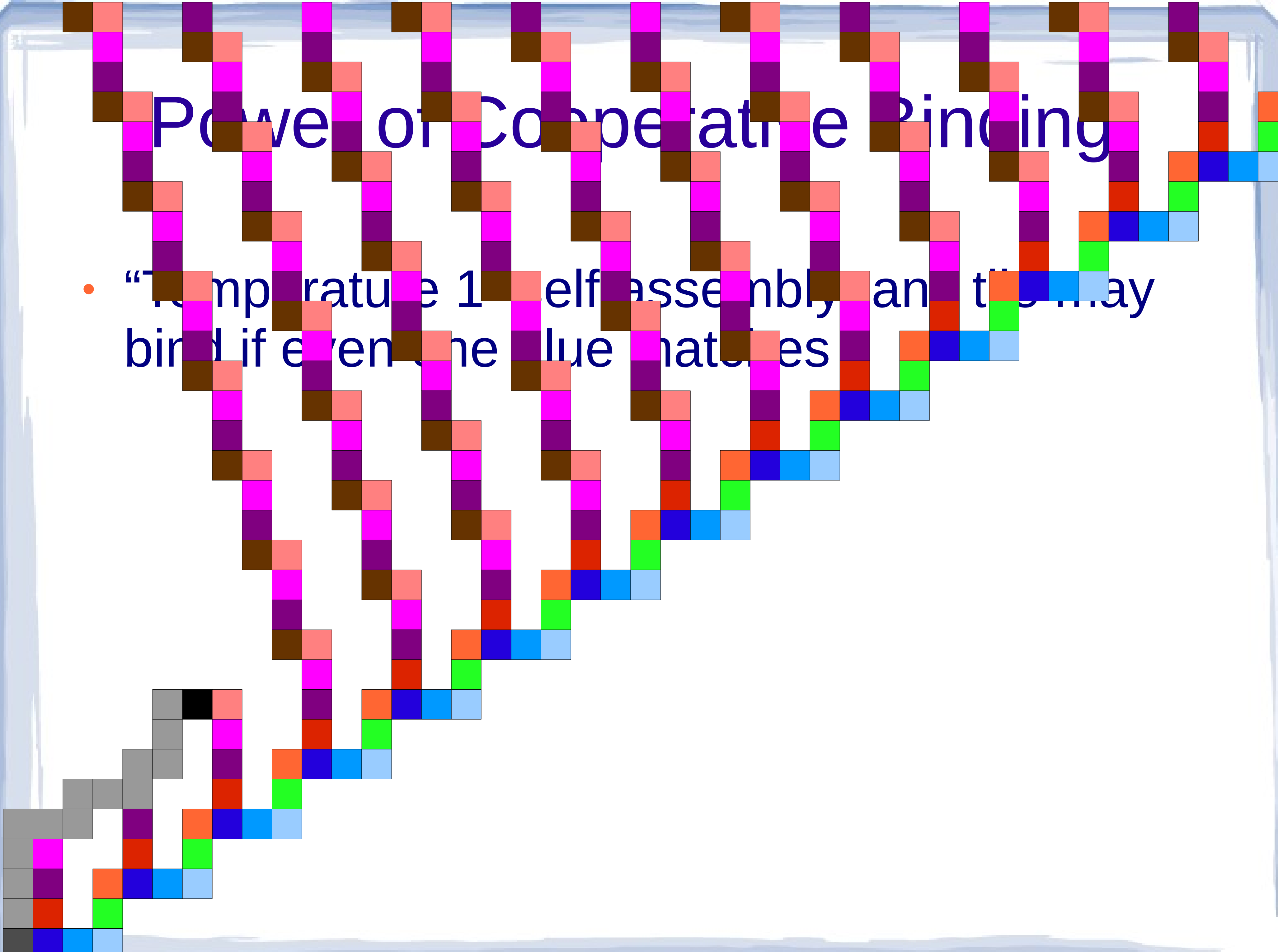
Power of Cooperative Binding

- “Temperature 1” self-assembly and tile may bind if even one glue matches



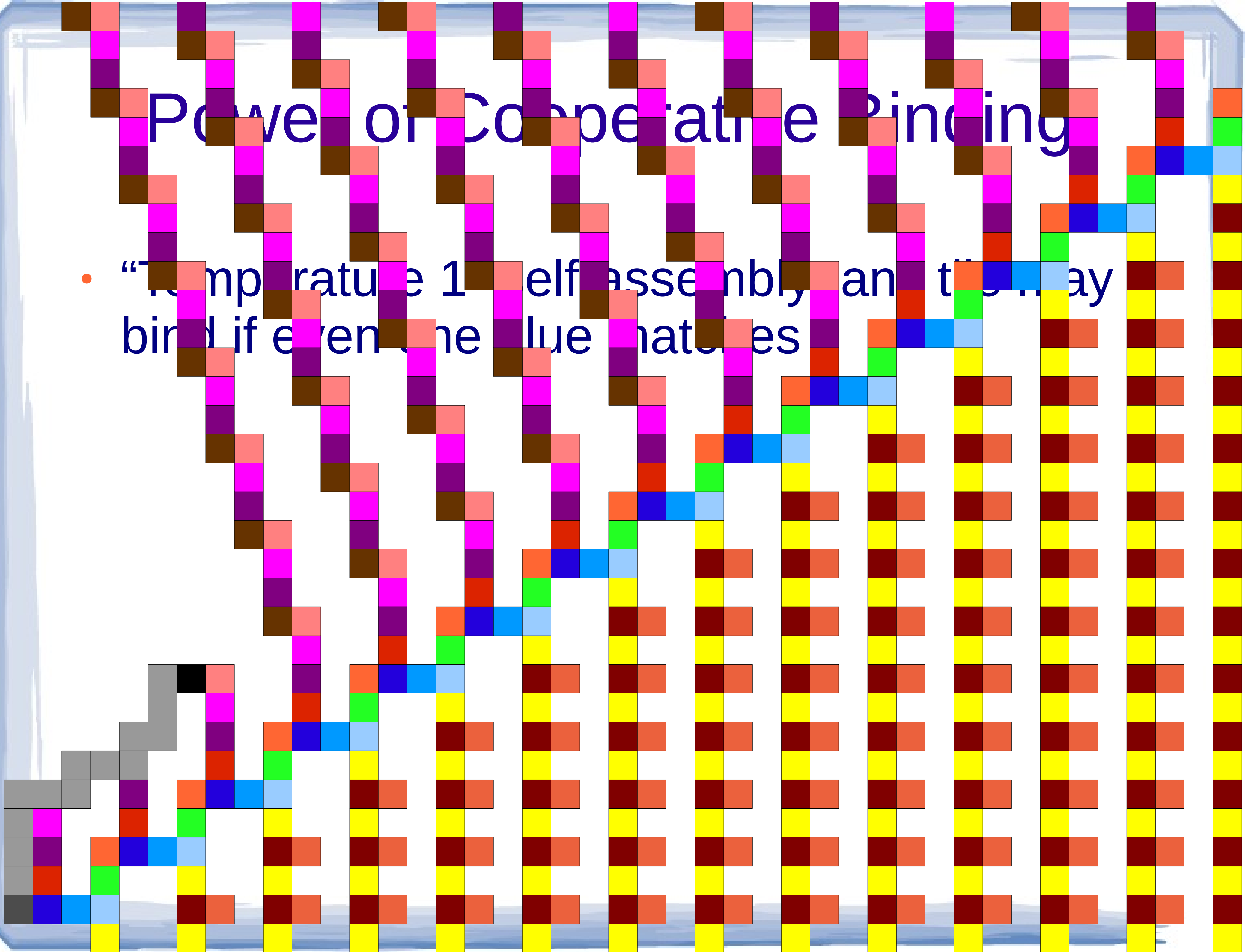
Power of Cooperative Binding

- “Temperature 1” self-assembly and tile may bind if even one glue matches



Power of Cooperative Binding

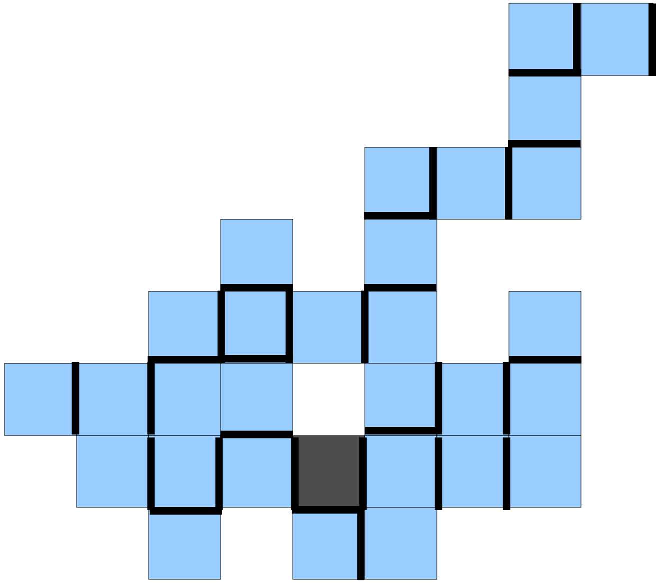
- “Temperature 1” self-assembly and tile may bind if even one glue matches



Pumpability

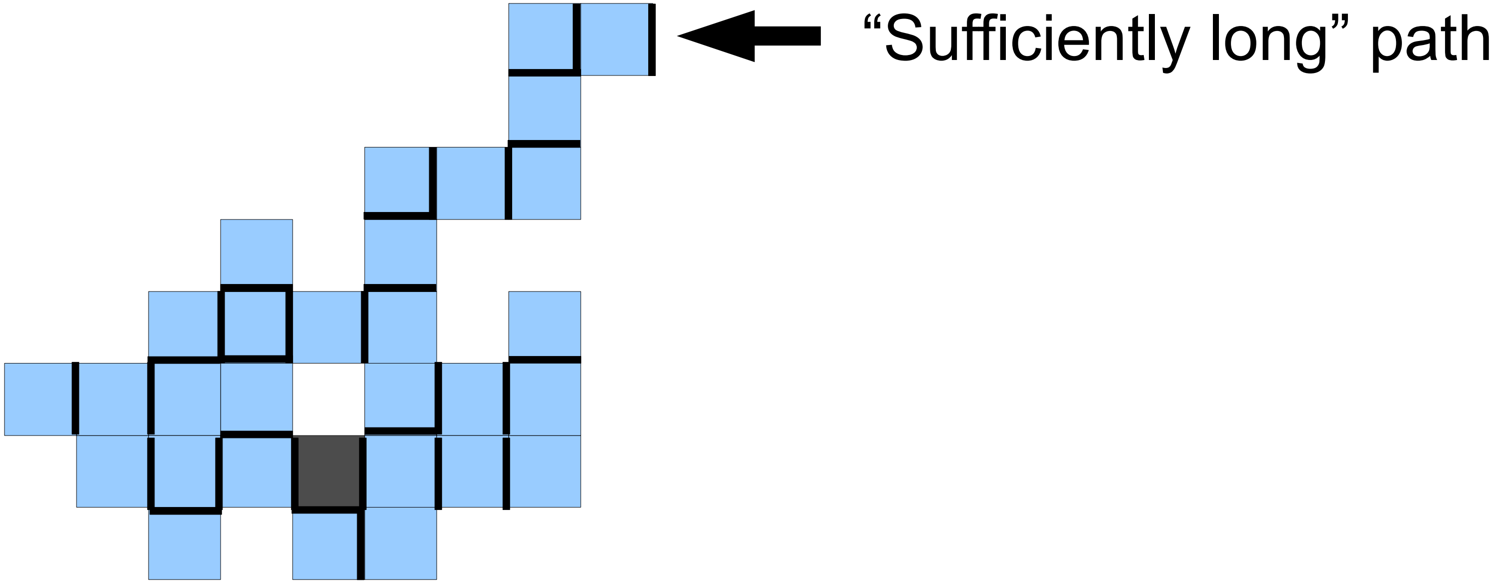
Our result relies on a notion of *pumpable* paths in an assembly.

Partial assembly, with grey seed tile



Pumpability

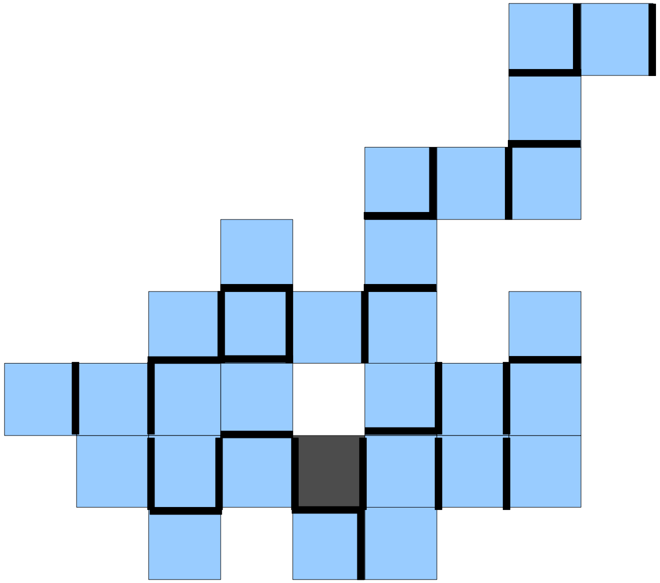
Our result relies on a notion of *pumpable* paths in an assembly.

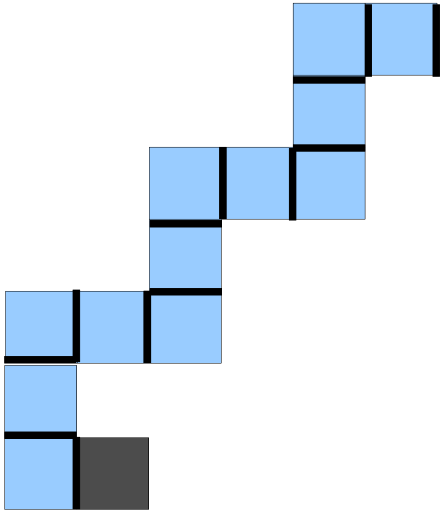


Pumpability

Our result relies on a notion of *pumpable* paths in an assembly.

Look at just this partial path

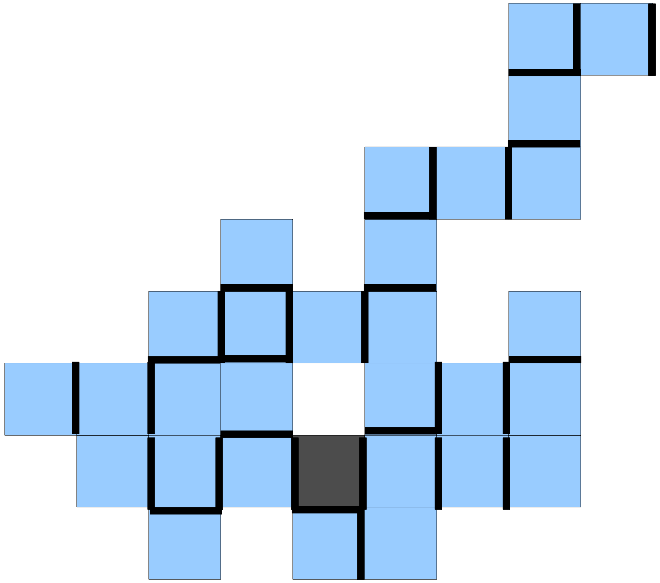


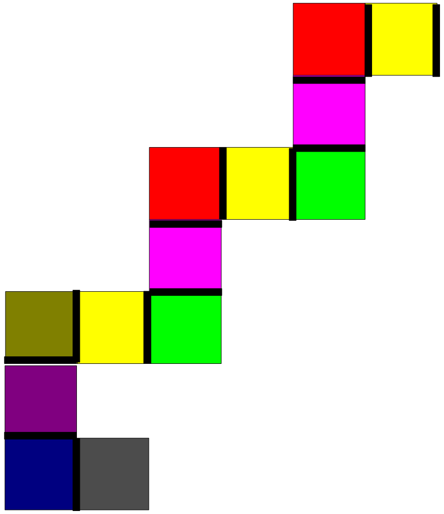


Pumpability

Our result relies on a notion of *pumpable* paths in an assembly.

Uniquely color each tile type

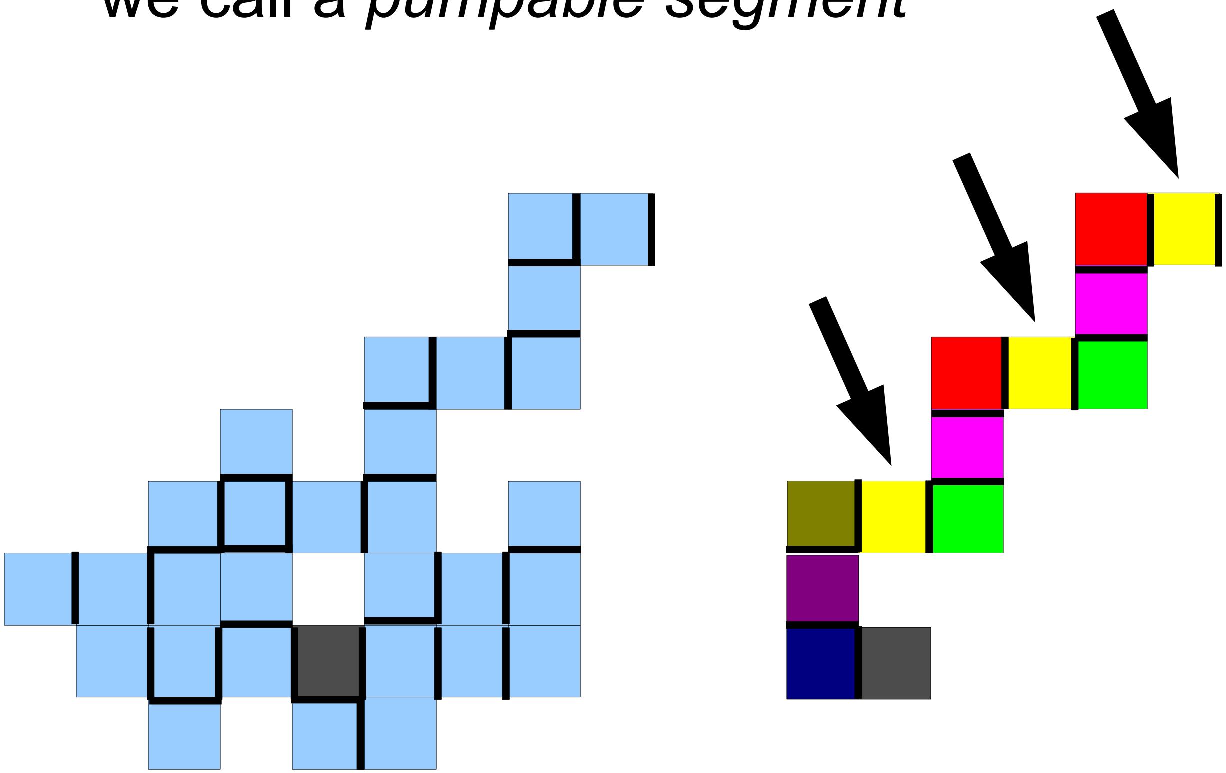




Pumpability

Our result relies on a notion of *pumpable* paths in an assembly.

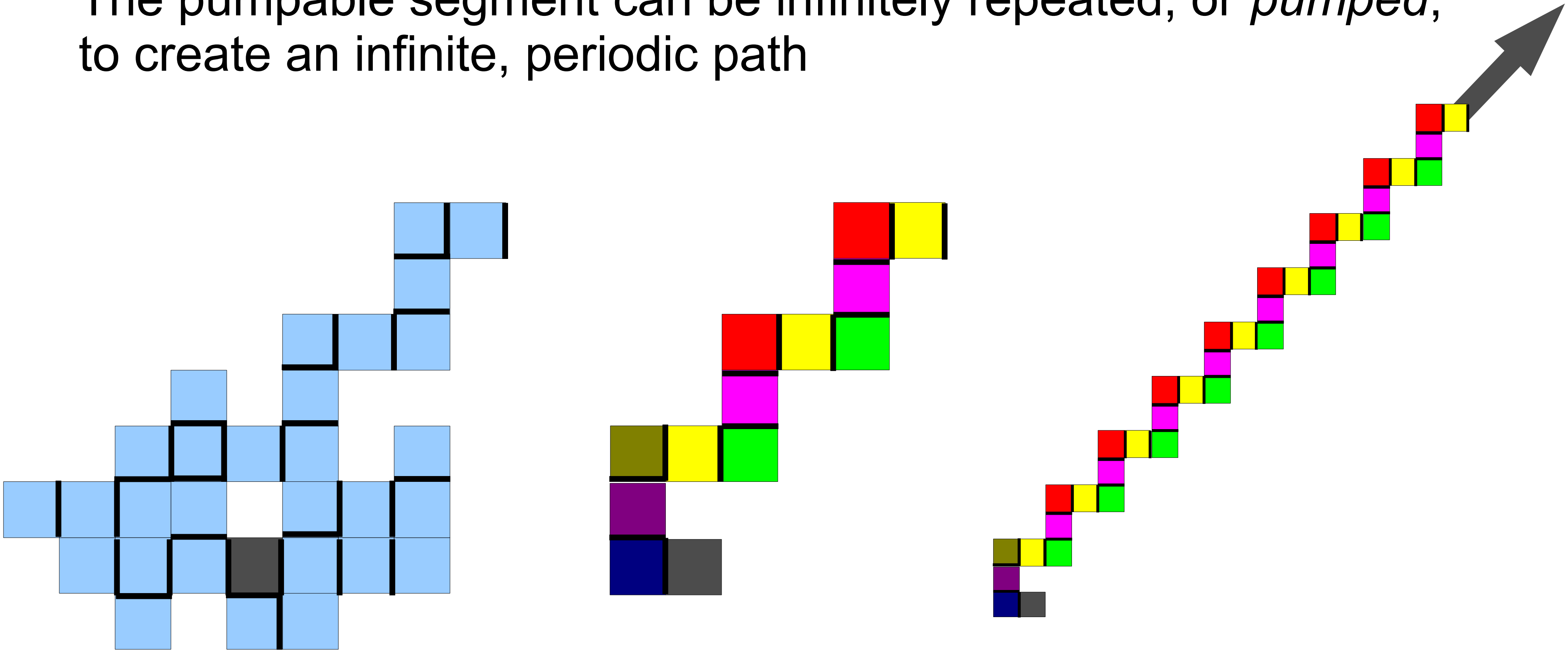
Note the repeating pattern, beginning with yellow tiles, which we call a *pumpable segment*



Pumpability

Our result relies on a notion of *pumpable* paths in an assembly.

The pumpable segment can be infinitely repeated, or *pumped*, to create an infinite, periodic path



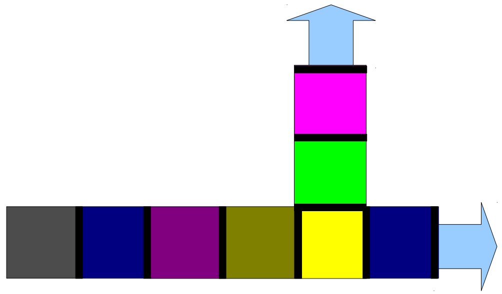
Pumpable Tile Assembly System

A directed temperature 1 TAS **T** is *c*-pumpable if, given any two points *p* and *q* at least distance *c* apart in the terminal assembly of **T**, there is a path from *p* to *q* that contains a pumpable segment within the first *c* points on the path.

In other words, every long path contains repetitions of a tile type (an obvious consequence of the pigeonhole principle) that can be pumped (repeated infinitely many times) to create a periodic path without colliding with the assembly up to that point.

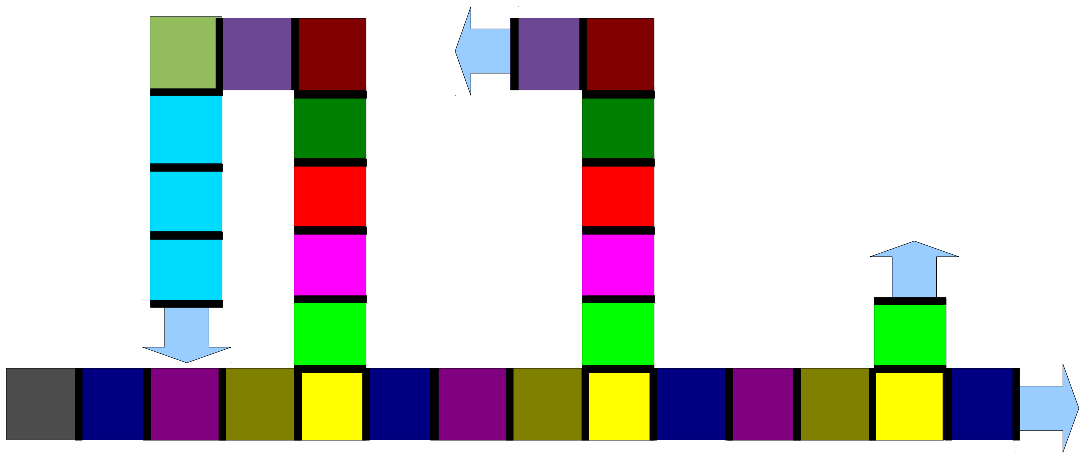
Pumpability

Not all repeating patterns are pumpable!



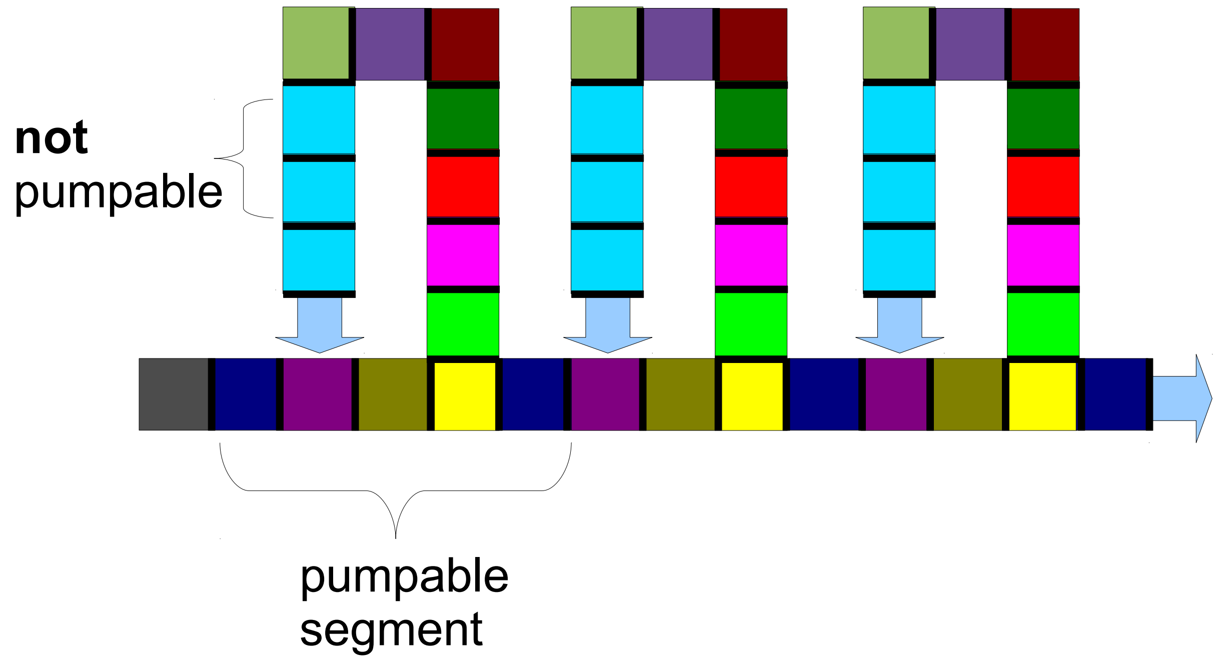
Pumpability

Not all repeating patterns are pumpable!



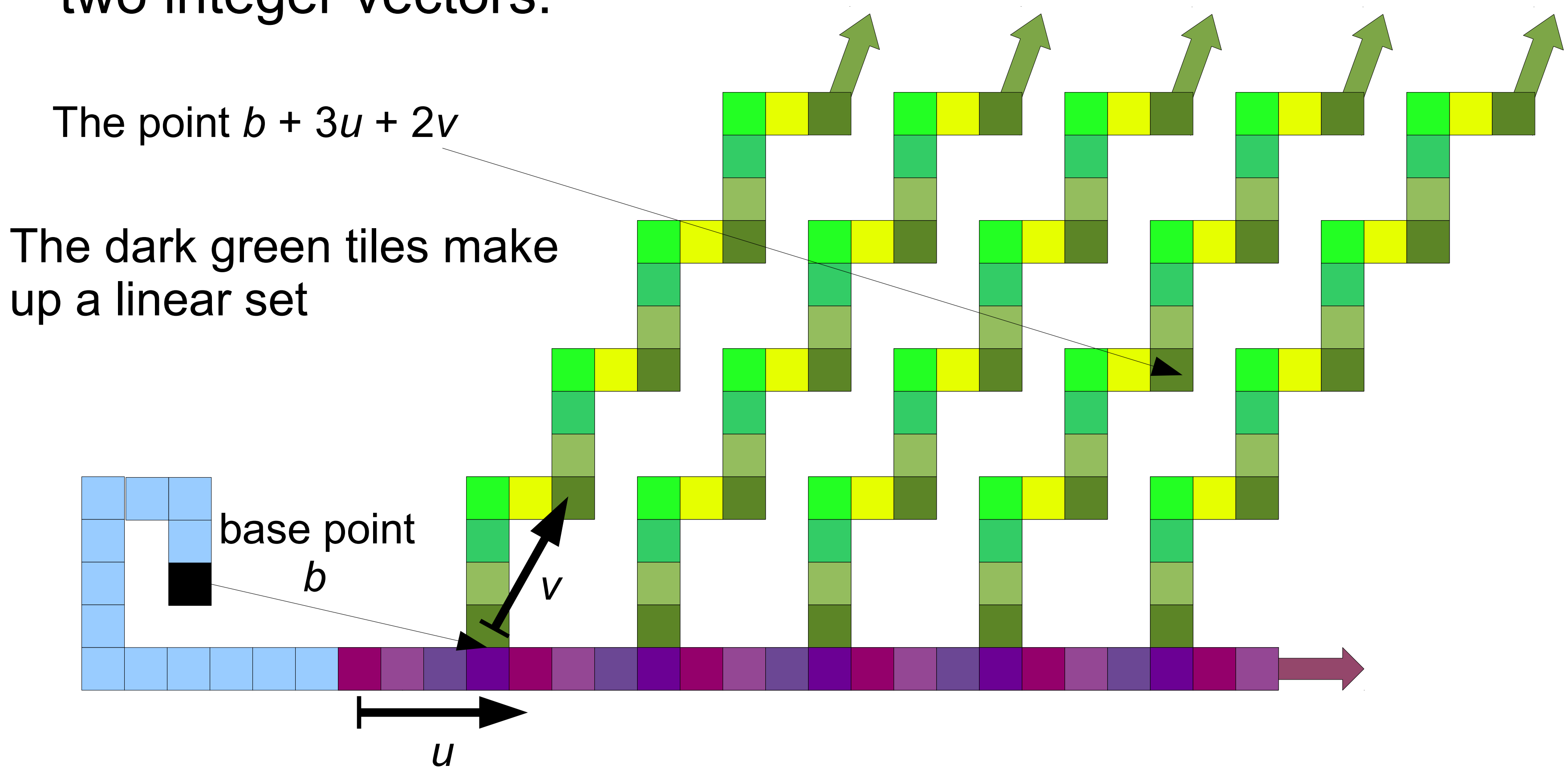
Pumpability

Not all repeating patterns are pumpable!



Linear Sets

A set of points is *linear* if every point in the set can be expressed as a nonnegative integer affine combination of two integer vectors:



An initial offset *b* from the origin, plus a multiple of *u* plus a multiple of *v*