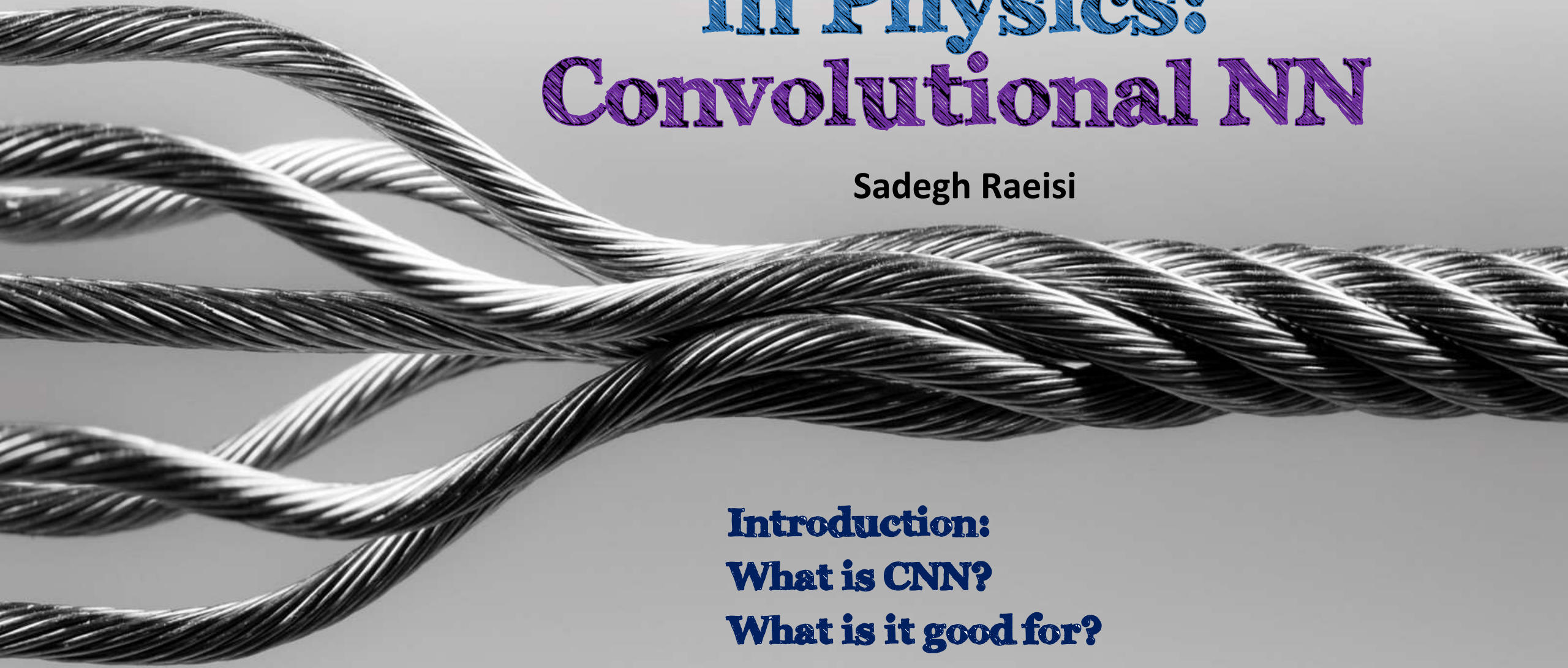
# Machine Learning in Physics: Convolutional NN

Sadegh Raeisi



**Introduction:**

**What is CNN?**

**What is it good for?**

**Why?**

# Plan for the next part

## Intuition

- Problem
- Symmetry
- Parameter sharing

## Convolution

- Example: Edge detection

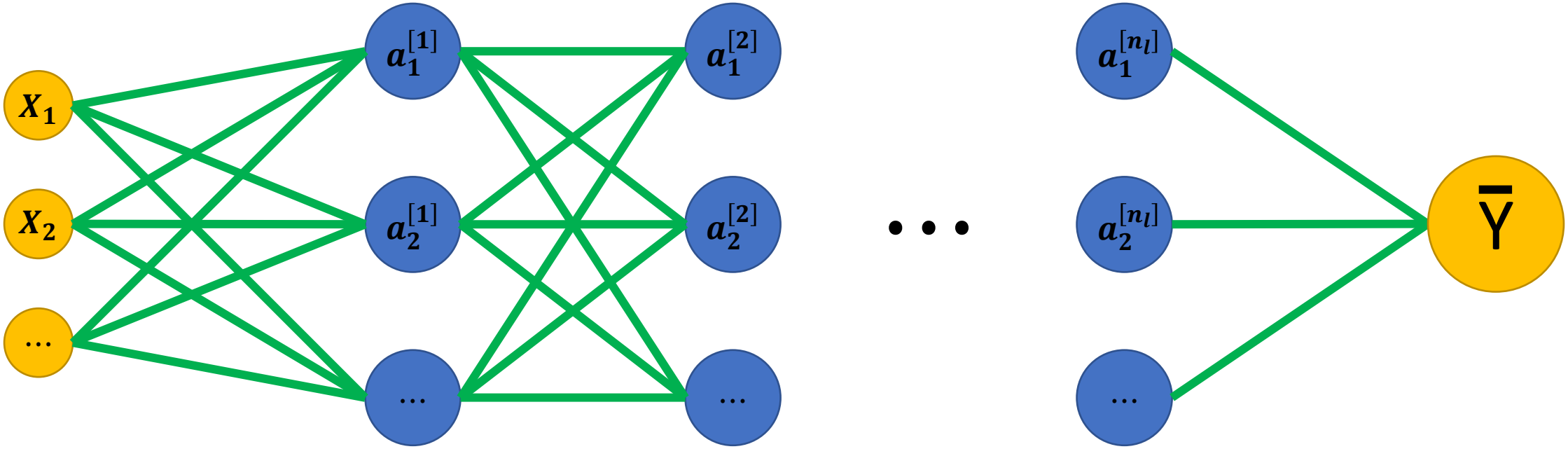
## A CNN model

- Convolution Layers
- Max Pooling
- FC layers

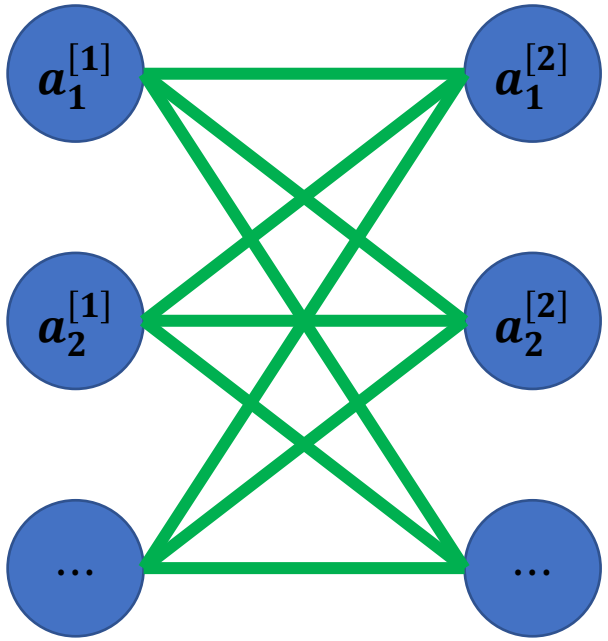
## A bit of history

# What is the problem?

# Normal NN



# How many parameters in each layer?




$$(n_{l-1} + 1) \times n_l$$

Example:

Input: $32 * 32 \approx 1000$

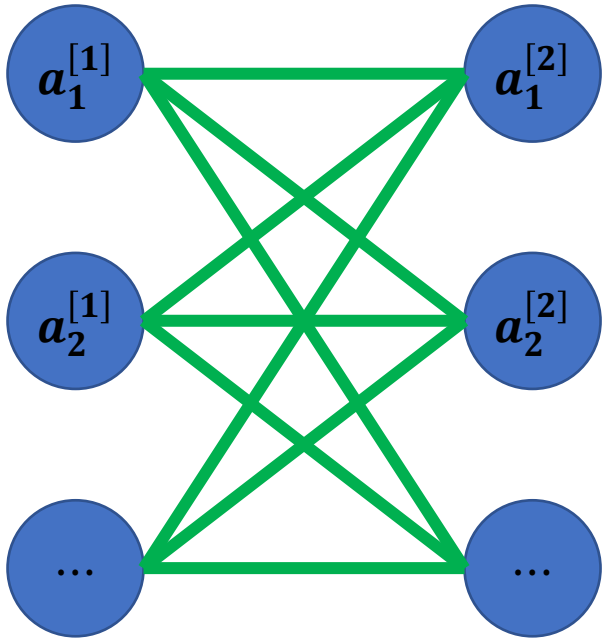
First layer : 100

Only **100,000** parms for 1 layer

$\Rightarrow$ **Slow training**

$\Rightarrow$ **Overfitting**

# How can we reduce the params?

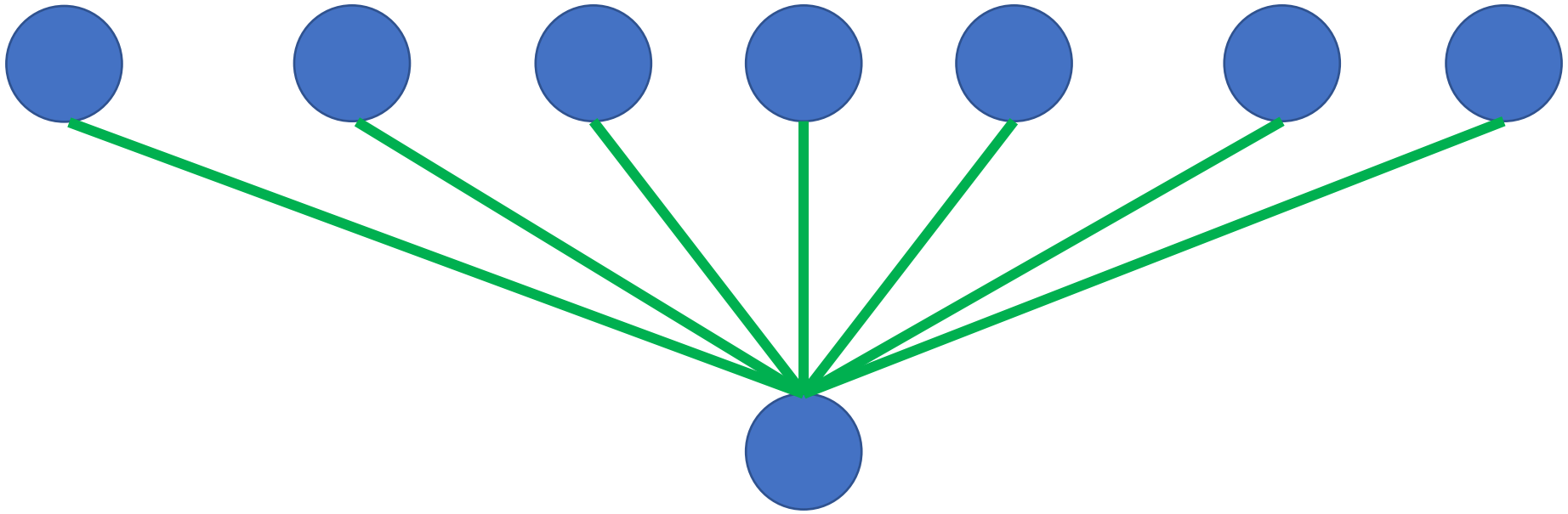



1. **Locality**

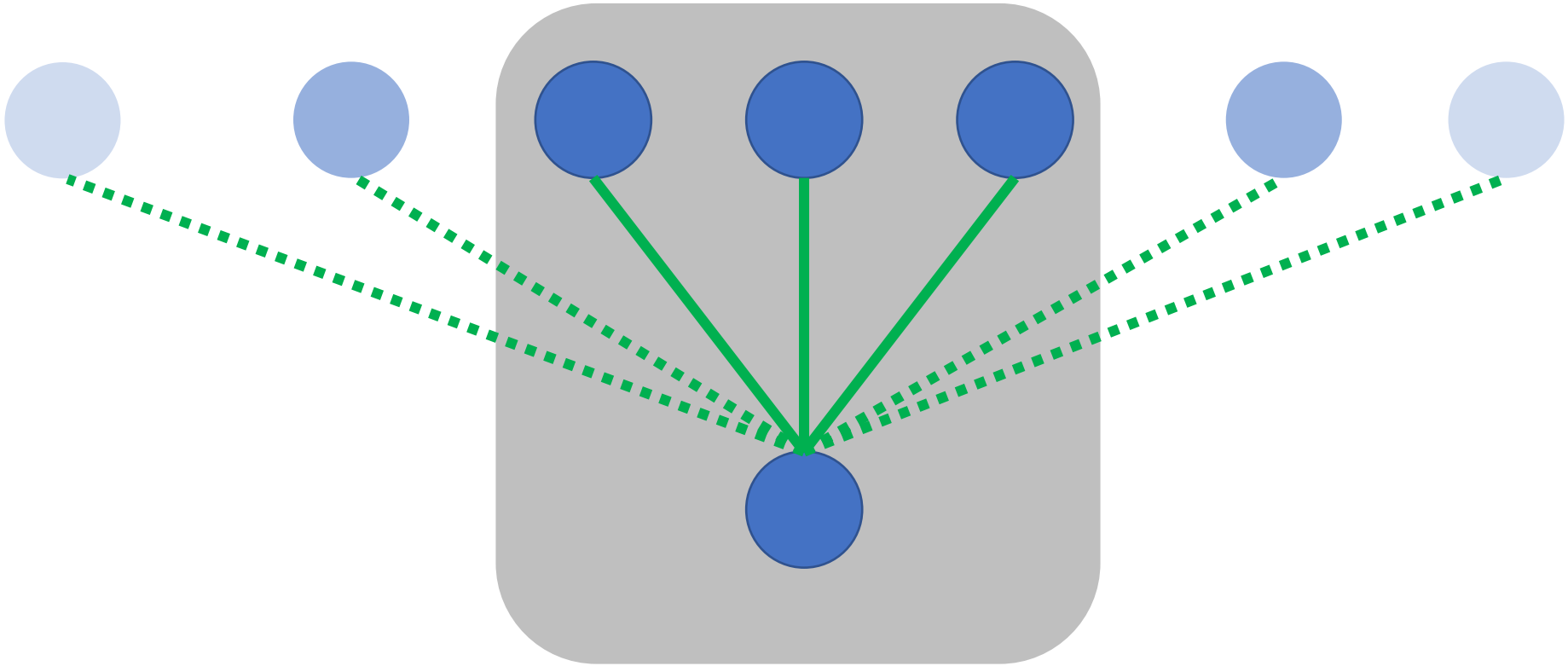
2. **Symmetry (Param sharing)**

$$(n_{l-1} + 1) \times n_l$$

# Locality



# Locality



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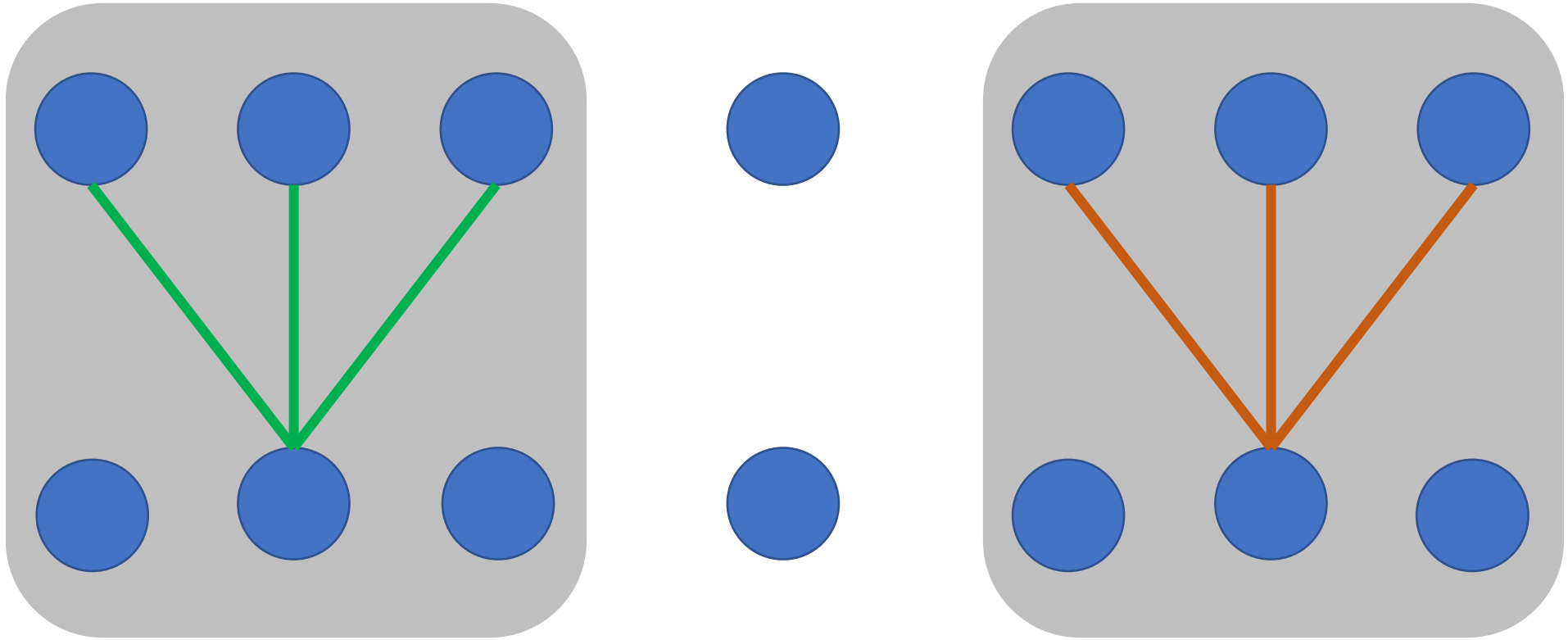
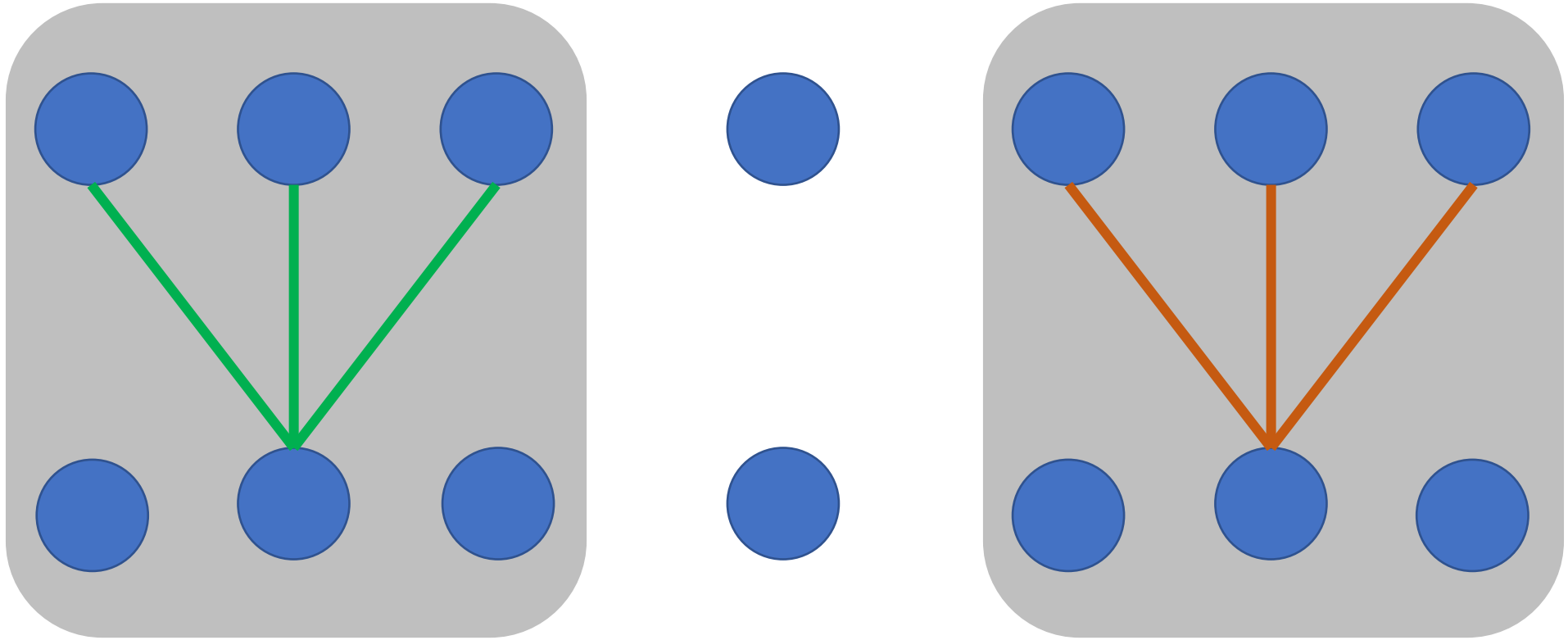


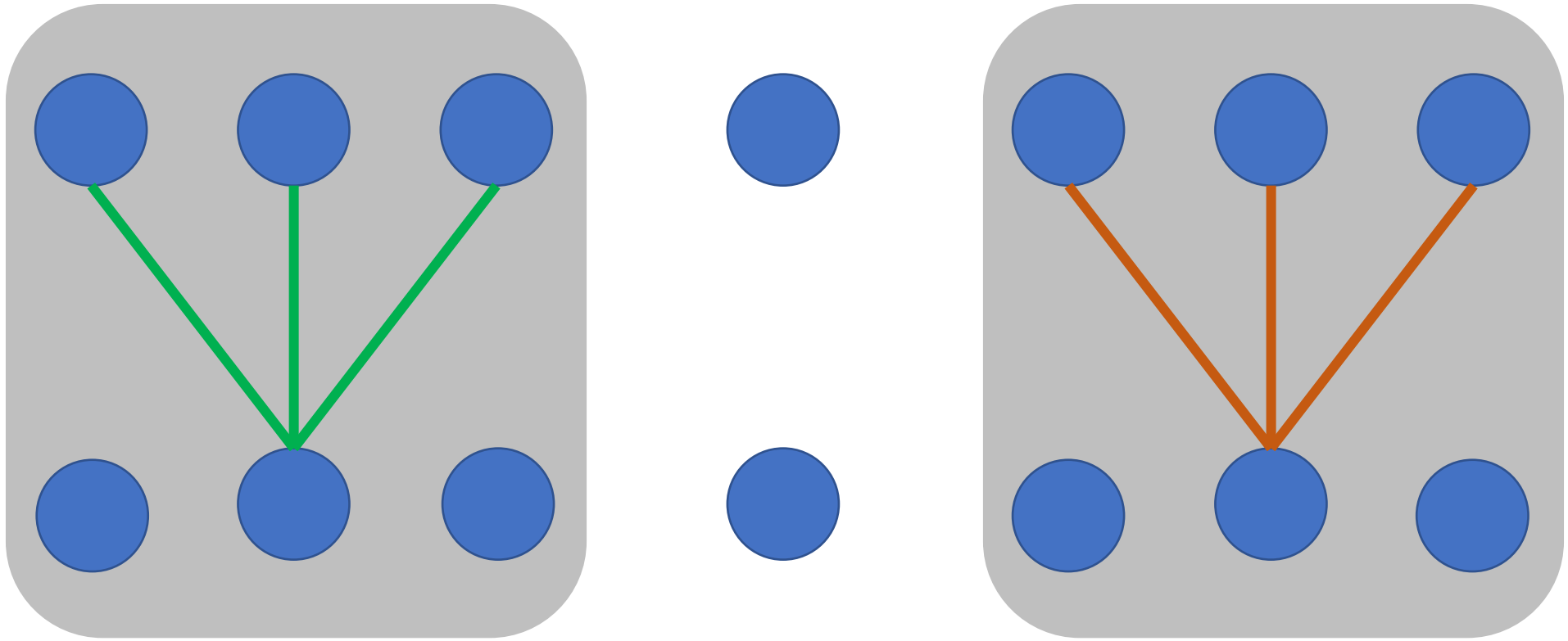
# Locality: How many are left?



# Symmetry

Some of these params may be the same.

# Symmetry



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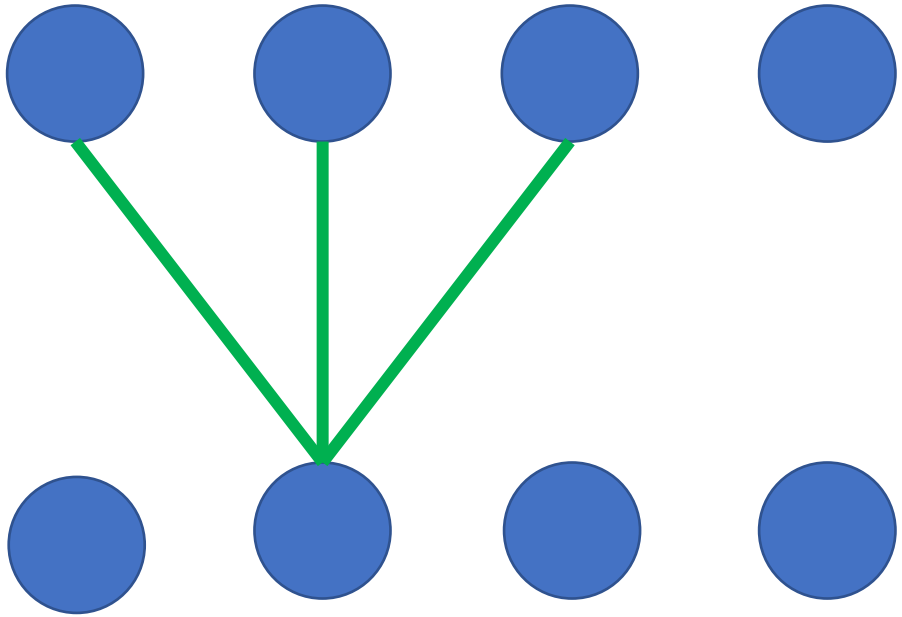

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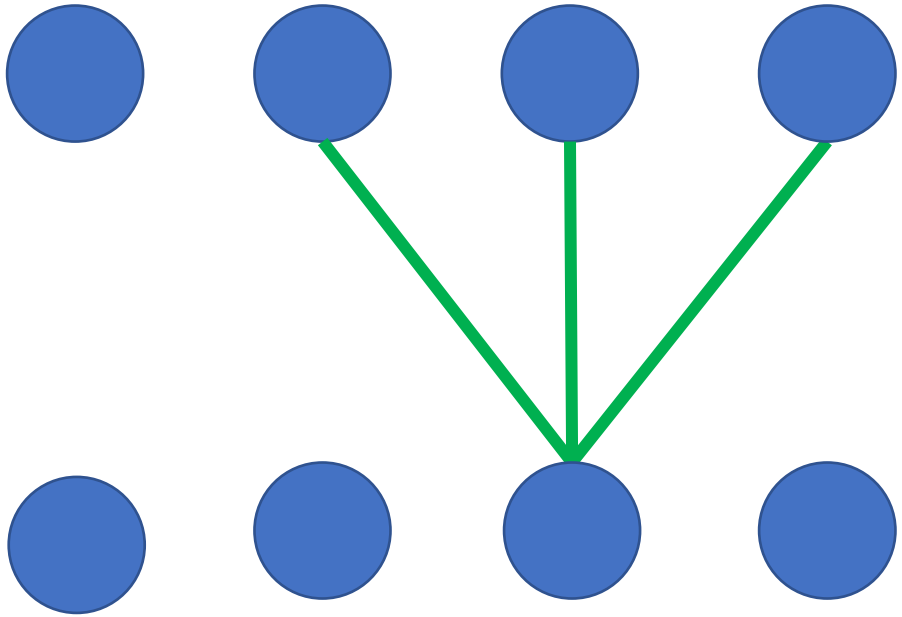
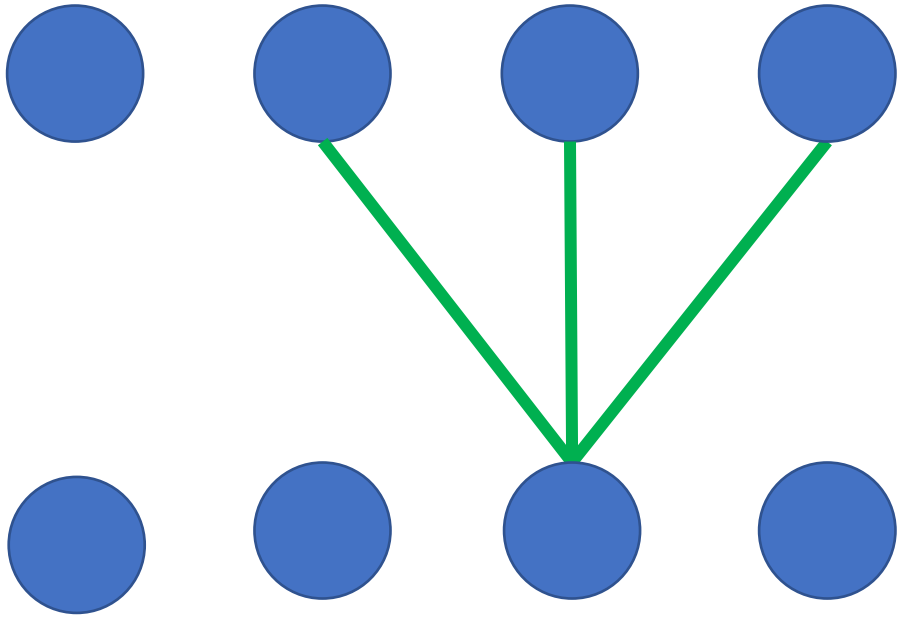
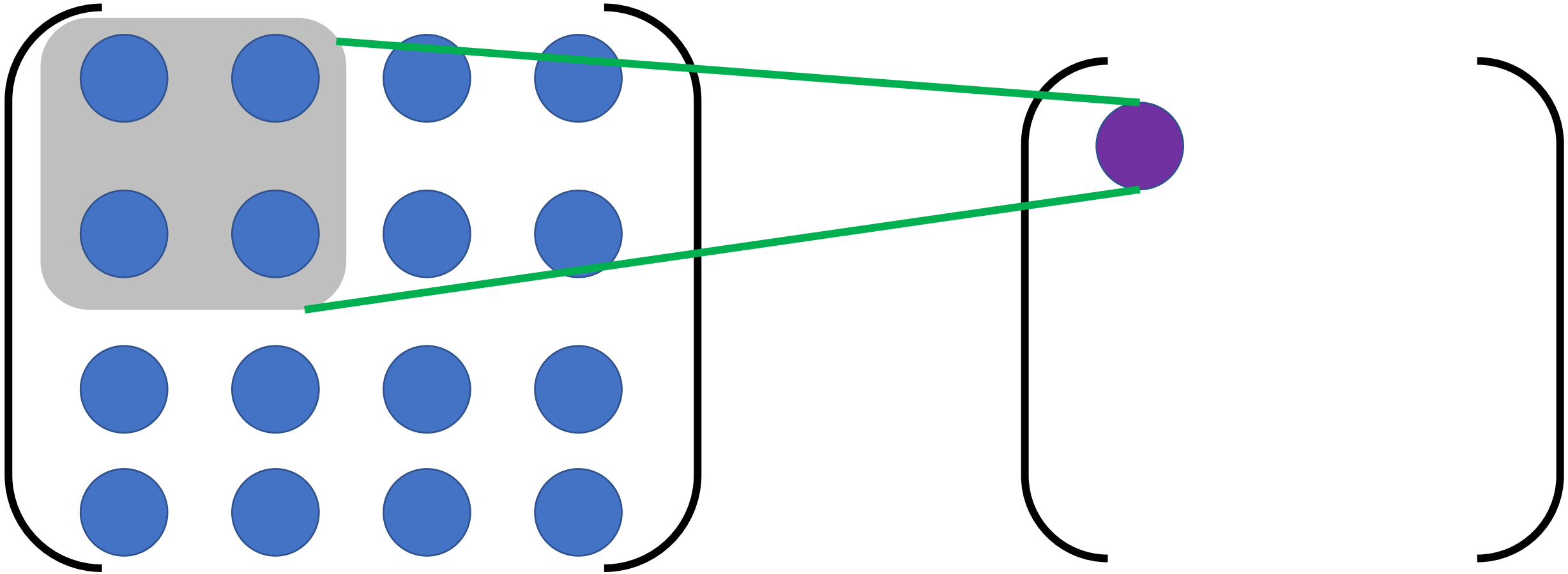


# Symmetry: How many params?



# Let’s take a look at this in 2D



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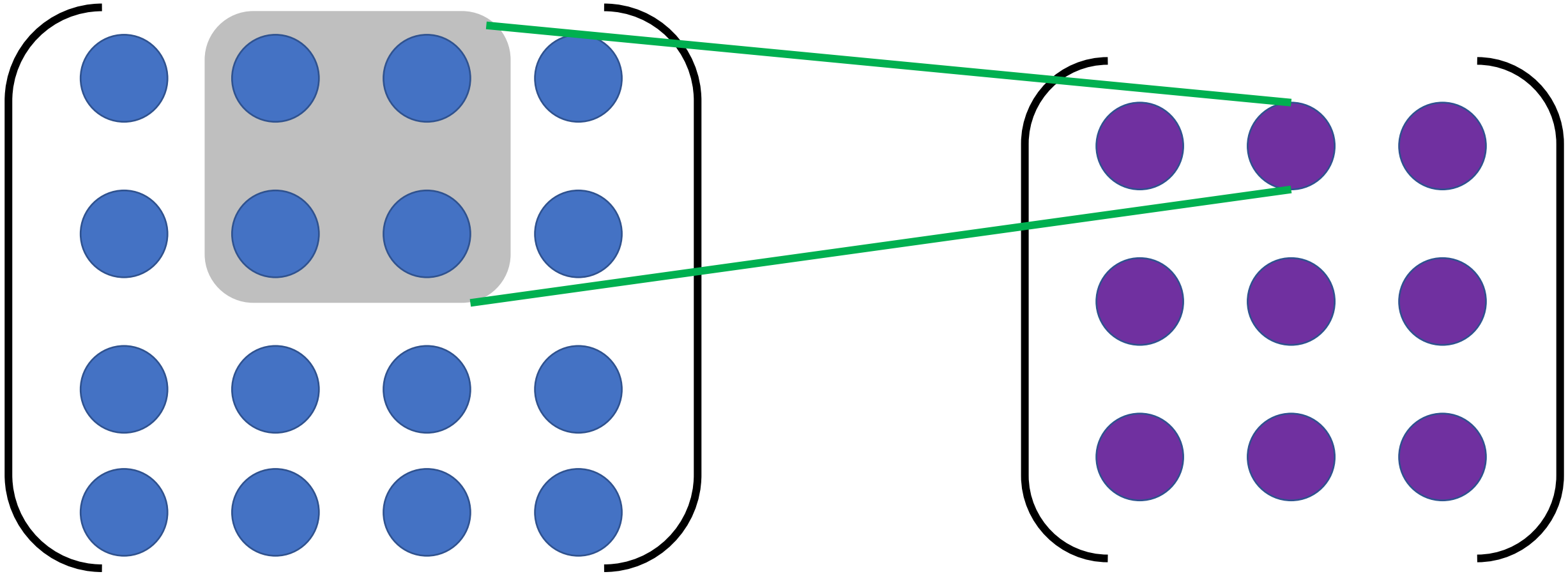
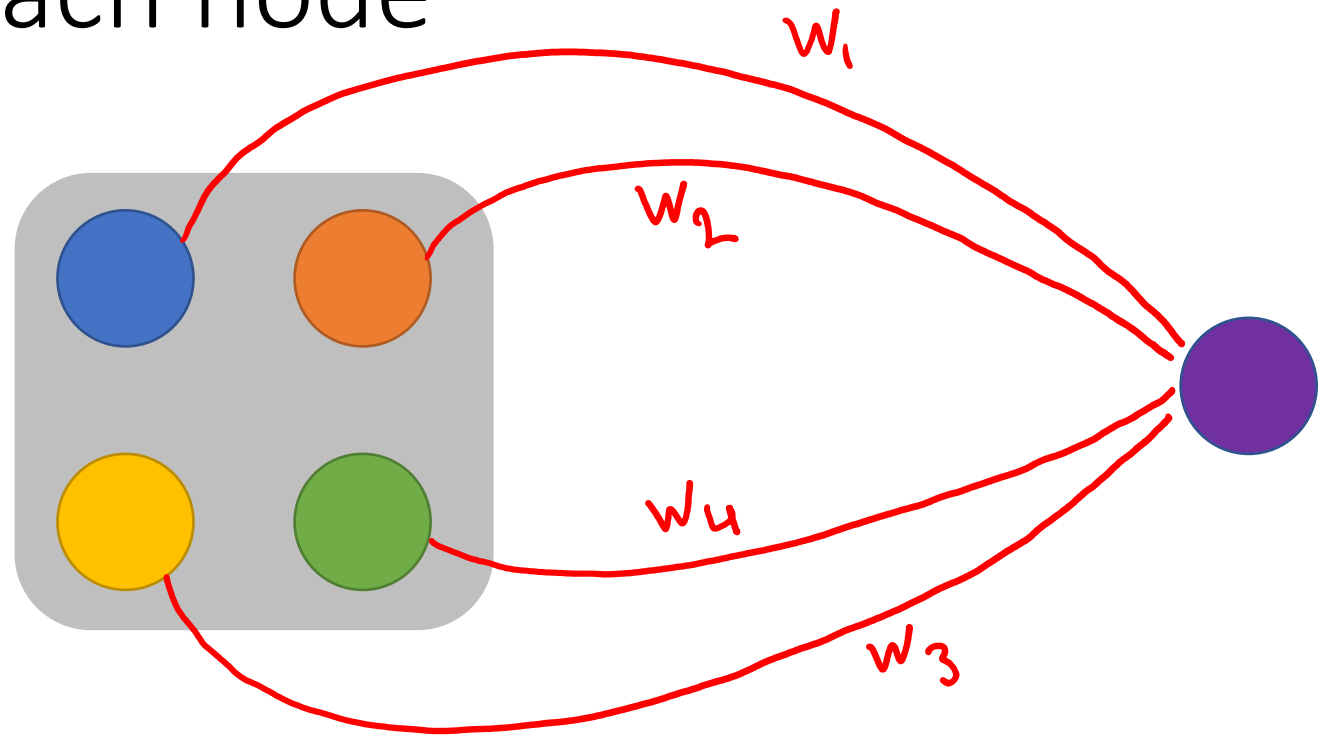
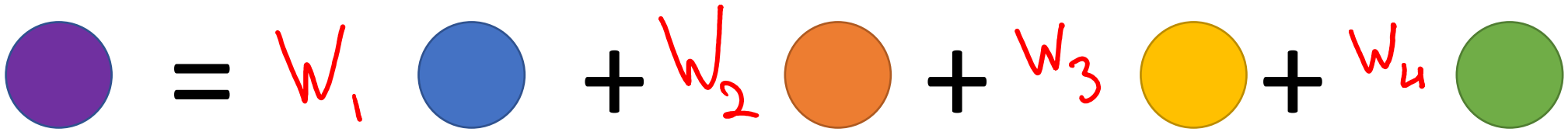
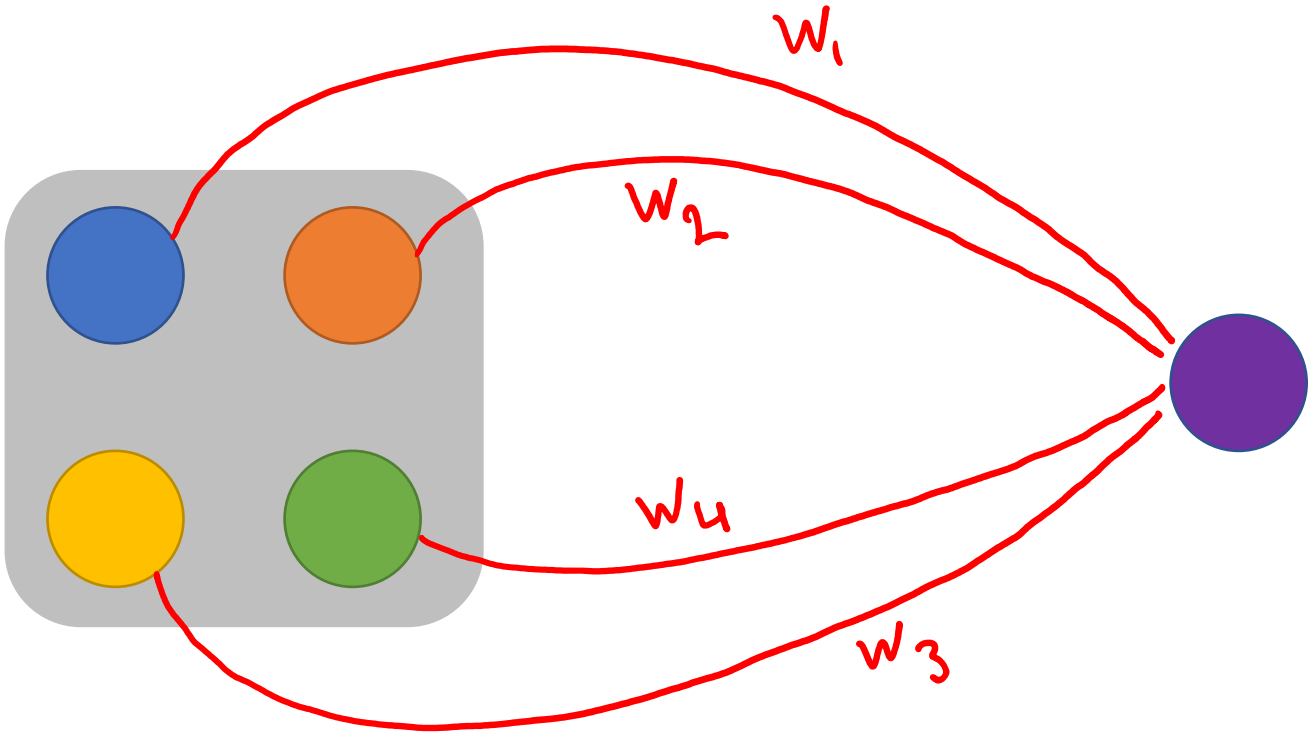


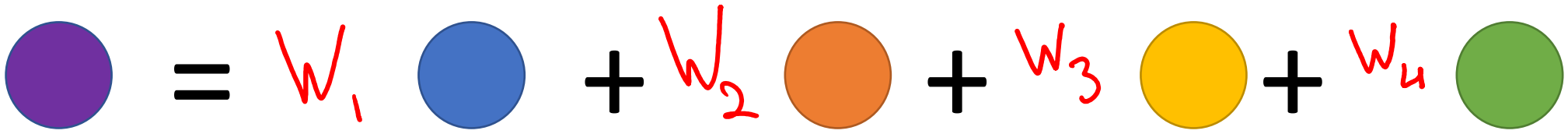
# For each node



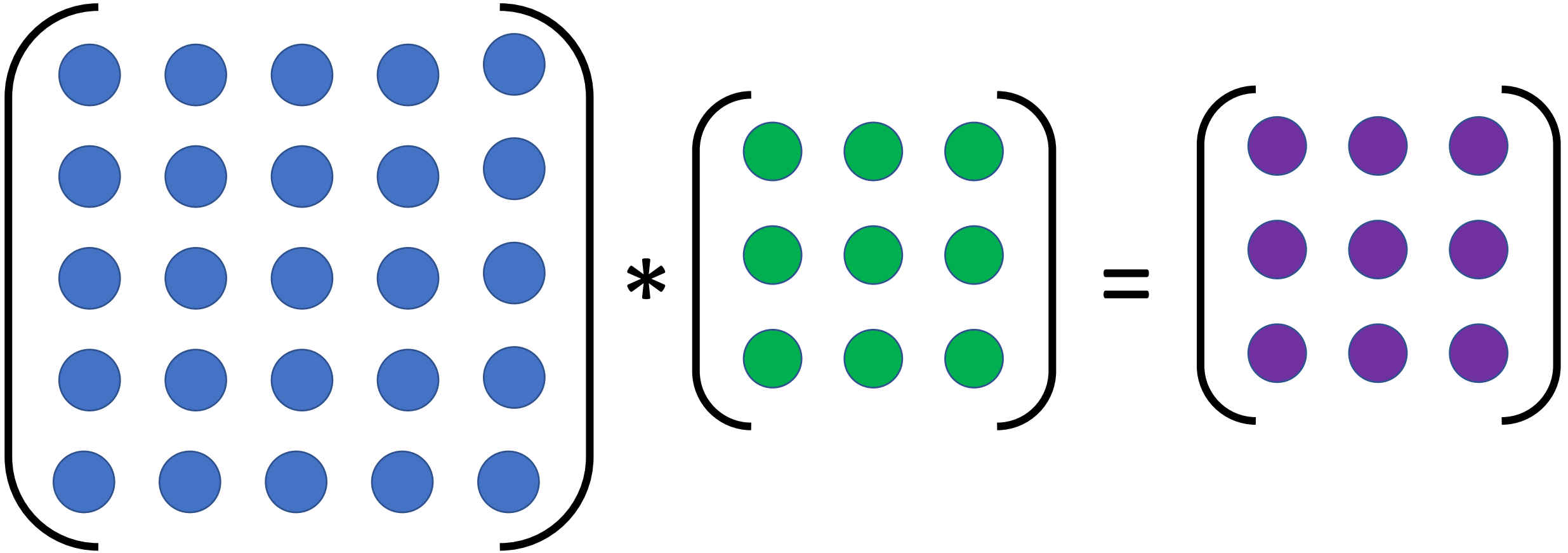



# This is called **Convolution**



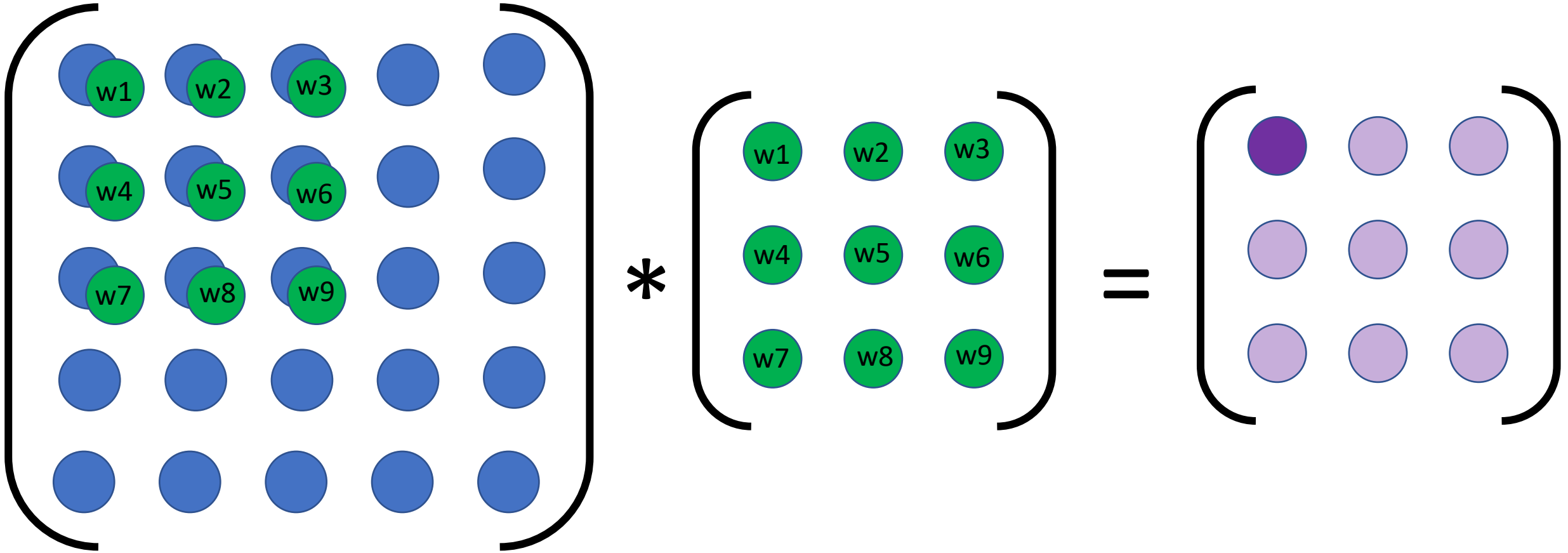



# Convolution

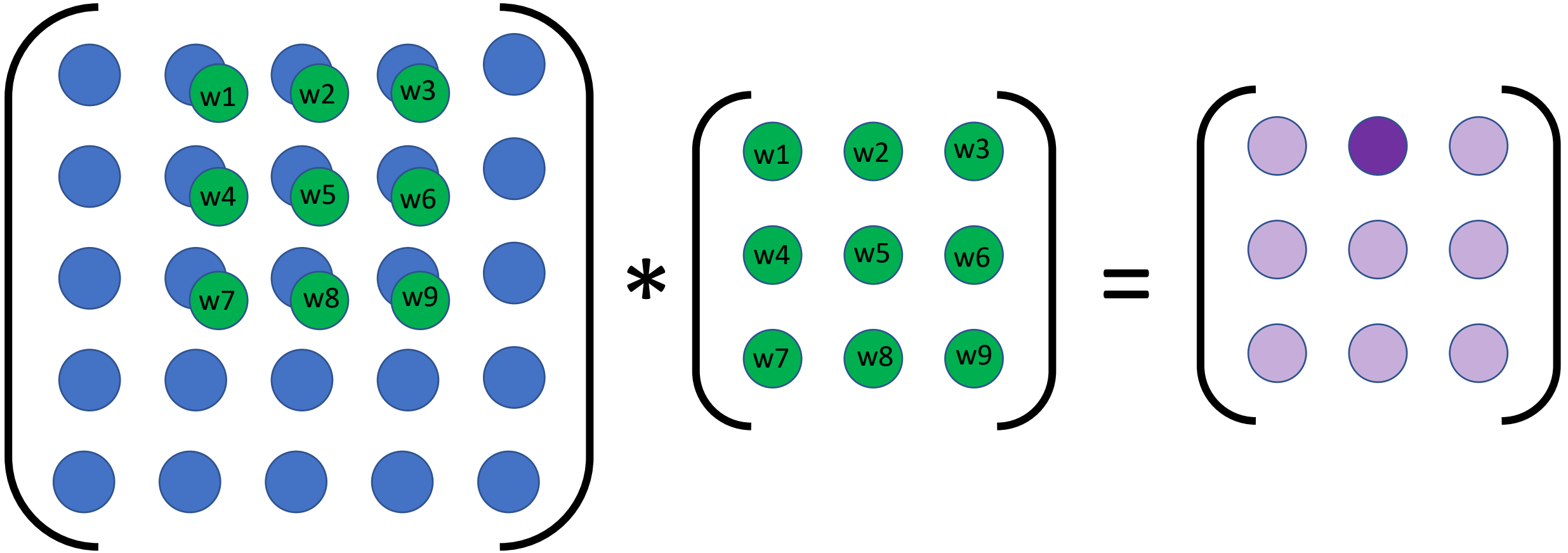



Input Filter Output

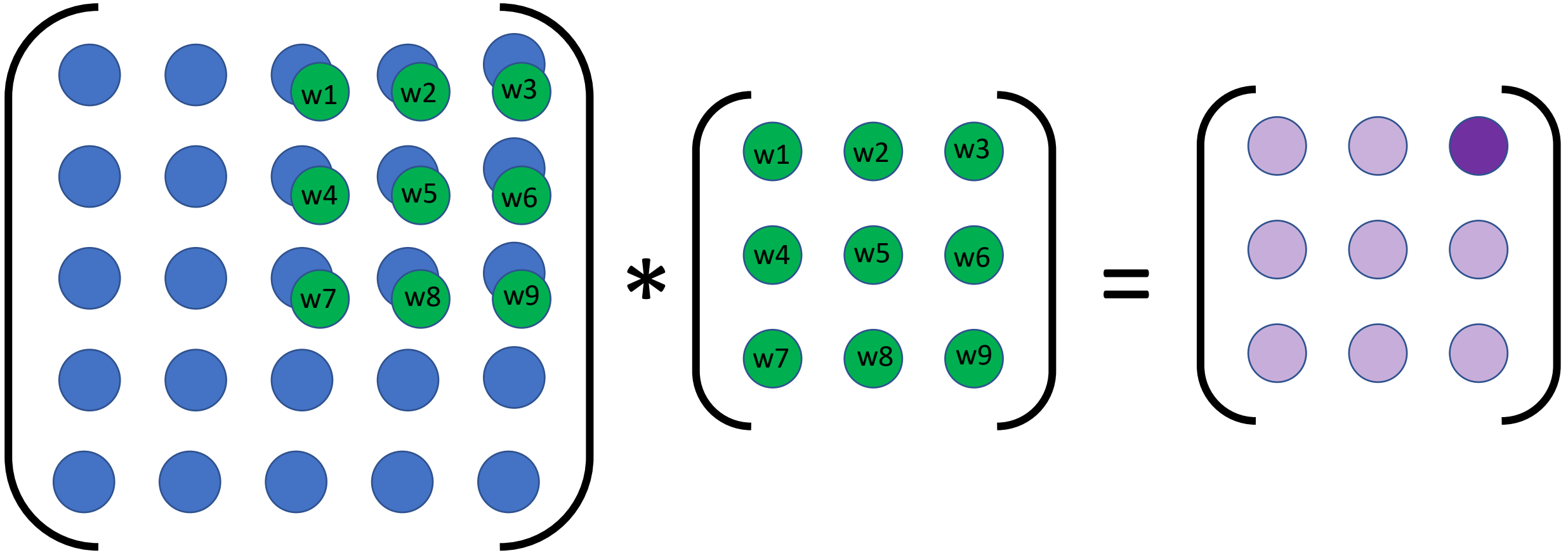
# Convolution



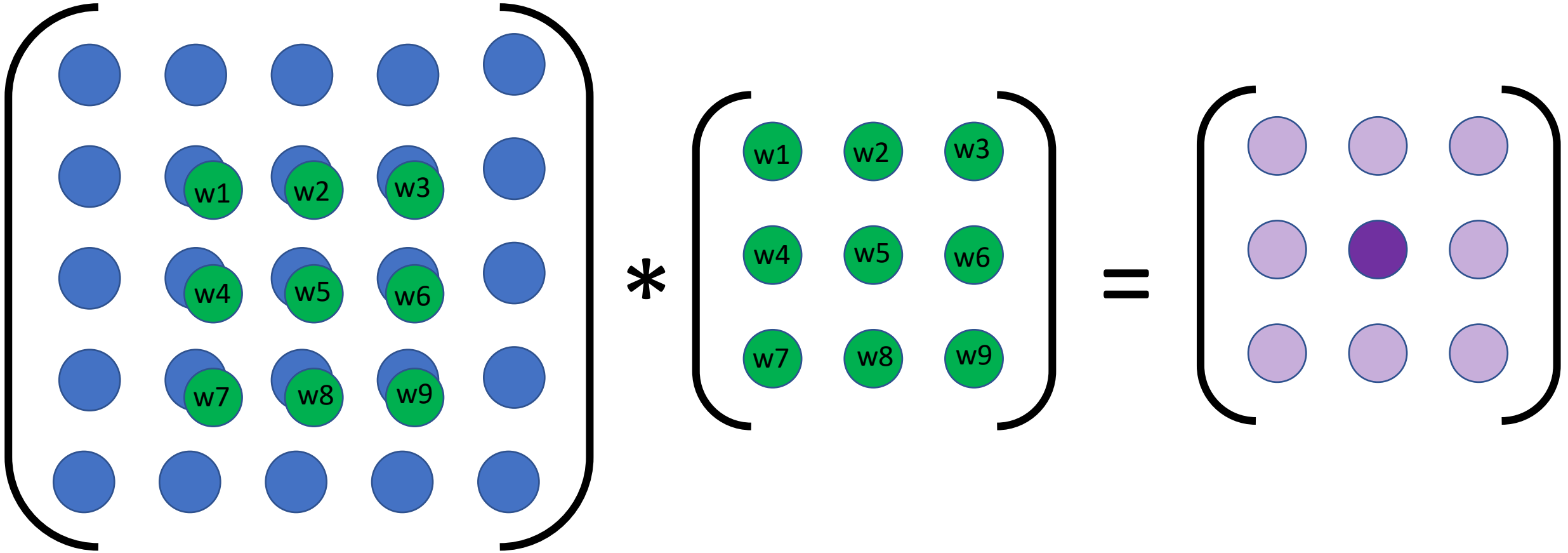
# Convolution



# Convolution



# Convolution



# Let’s take a look at the code

# Parameters & Hyperparameters of convolution