Motion perception and pursuit eye movements

Topics:

Neuronal responses to motion in cortex

Method for stimulating V1 RFs with moving targets

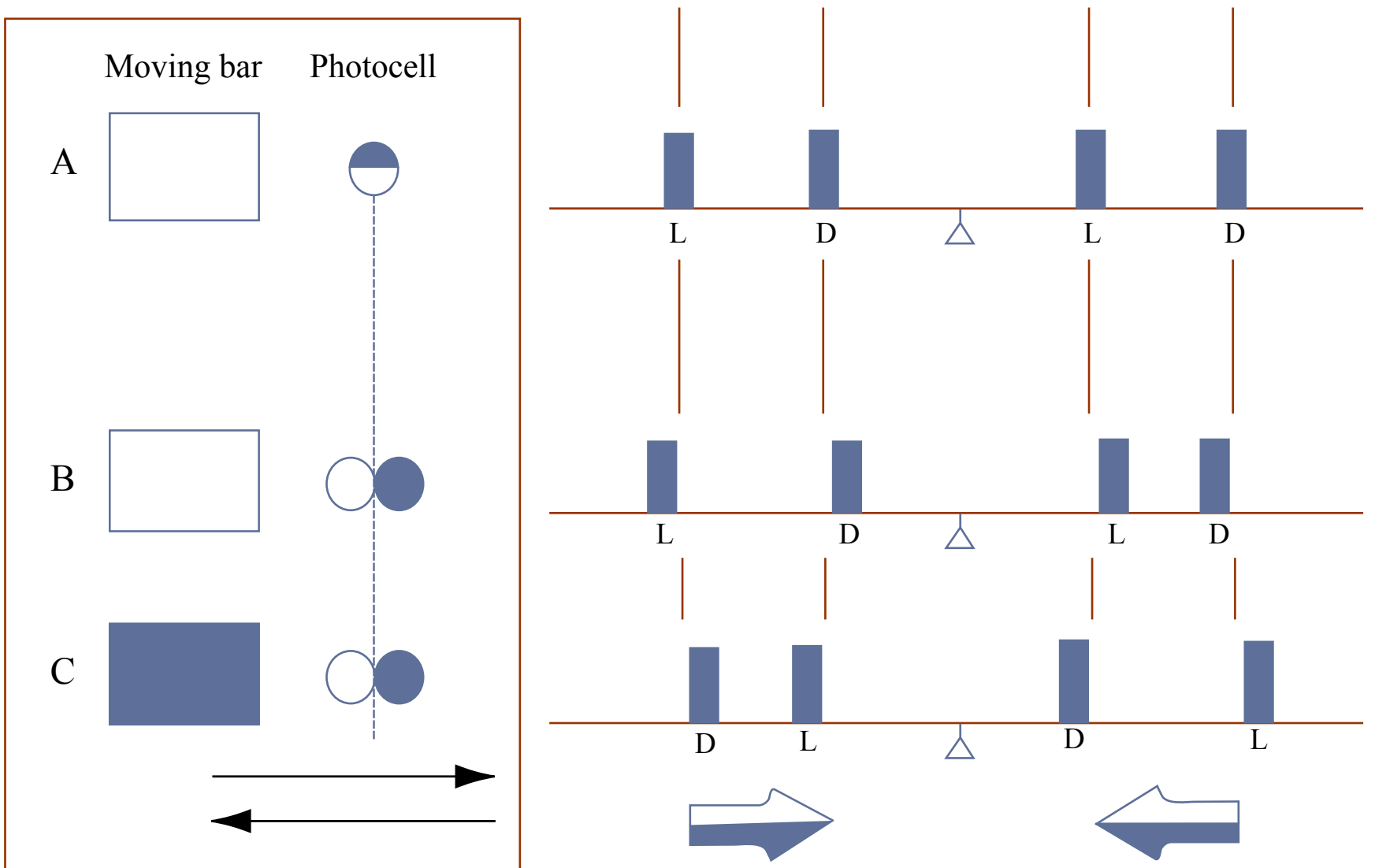
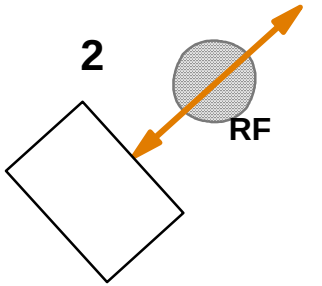
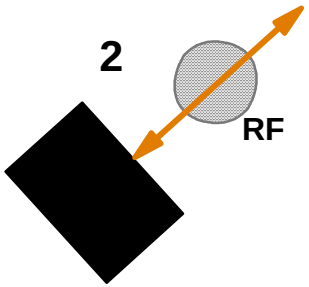
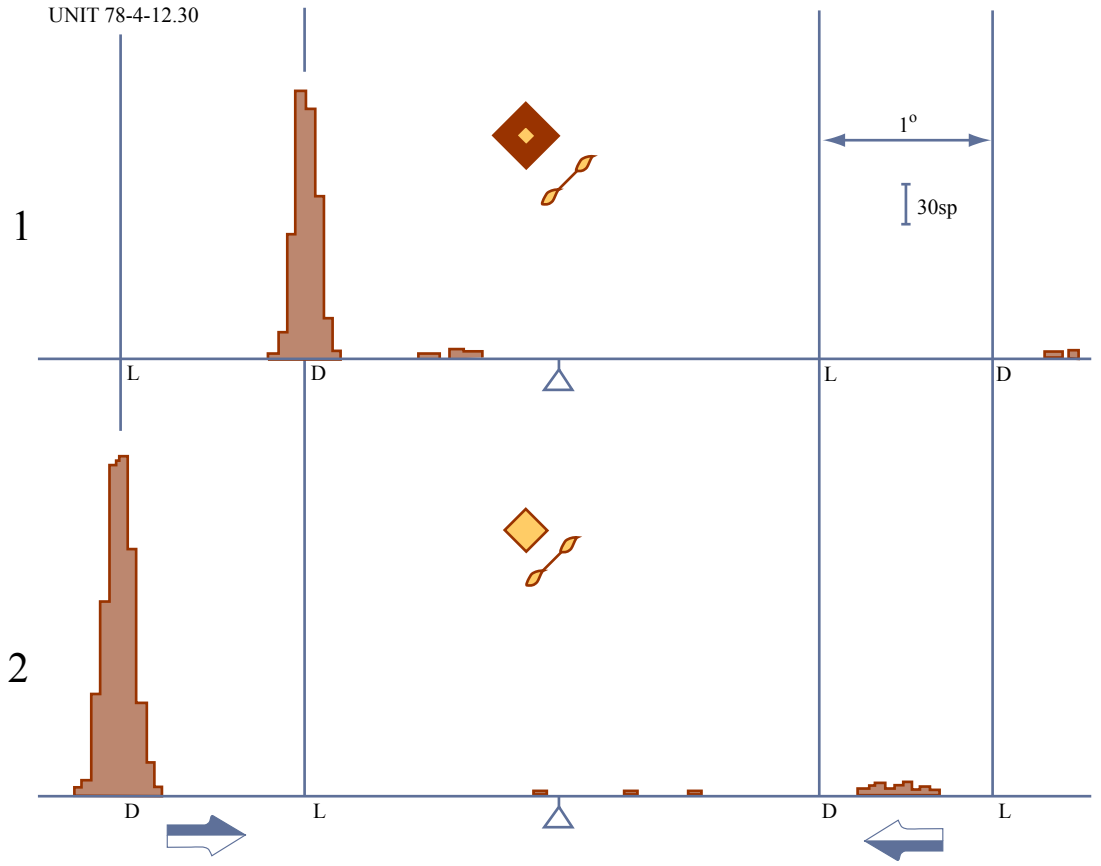


Figure by MIT OCW.

Response of an S1 cell in striate cortex to drifting bars







Spatio-temporal organization of receptive field

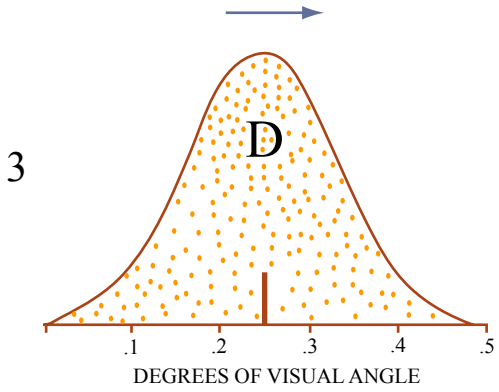


Figure by MIT OCW.

Response of an S2 cell in striate cortex to drifting bars

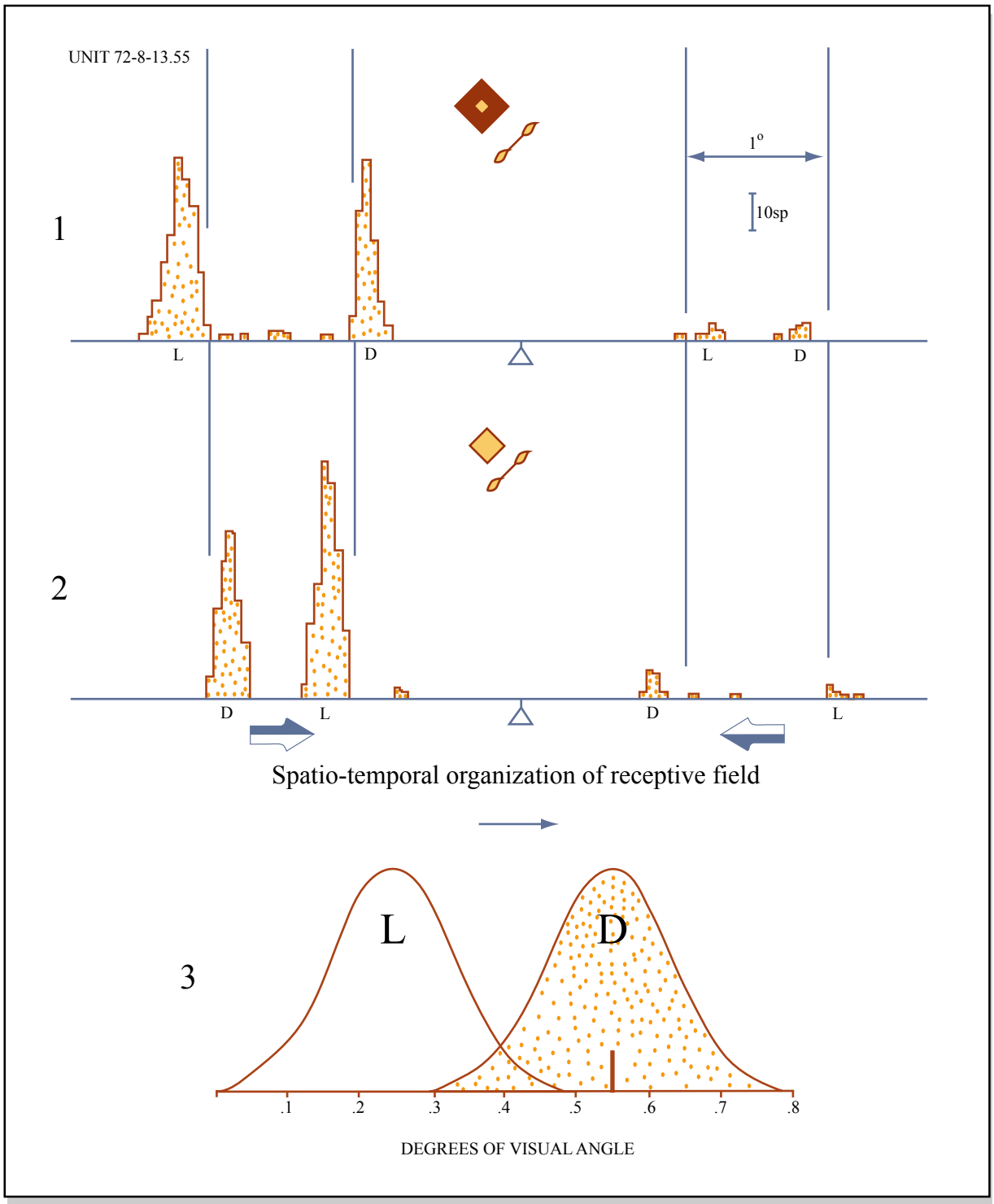


Figure by MIT OCW.

Response of an S2 cell in striate cortex to drifting bars

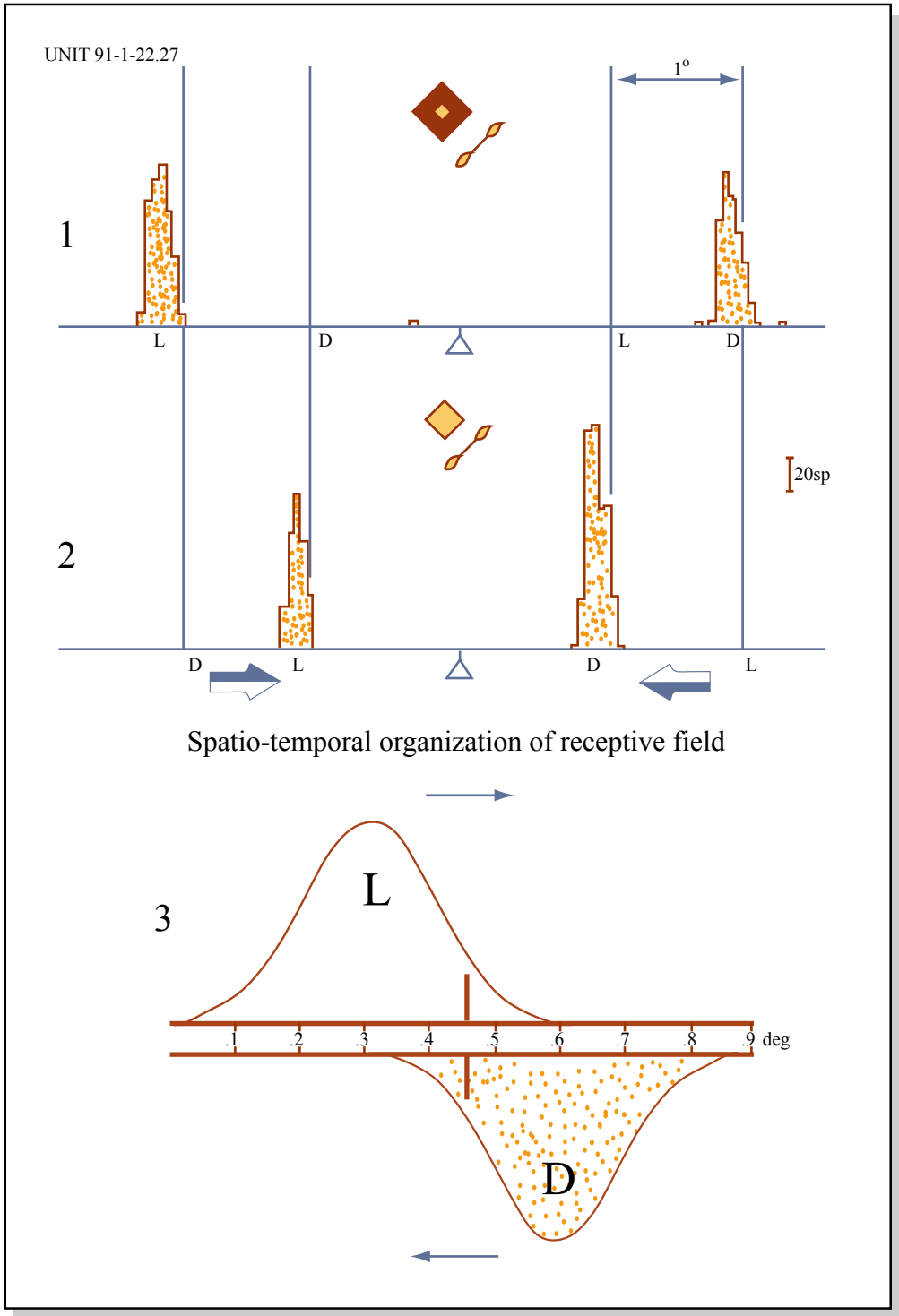


Figure by MIT OCW.

Summary of cell types in V1

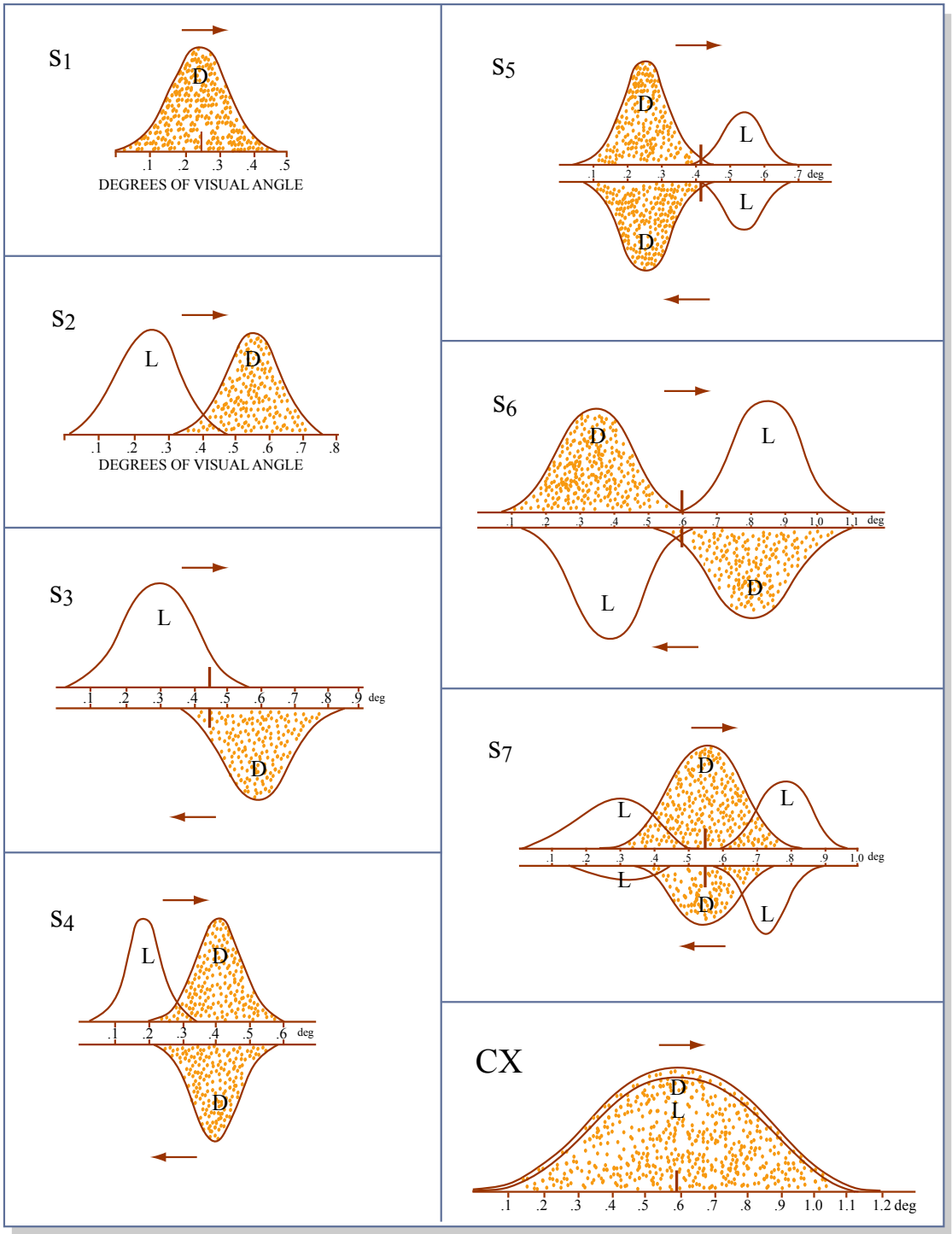


Figure by MIT OCW.

A conceptual scheme for types of motion

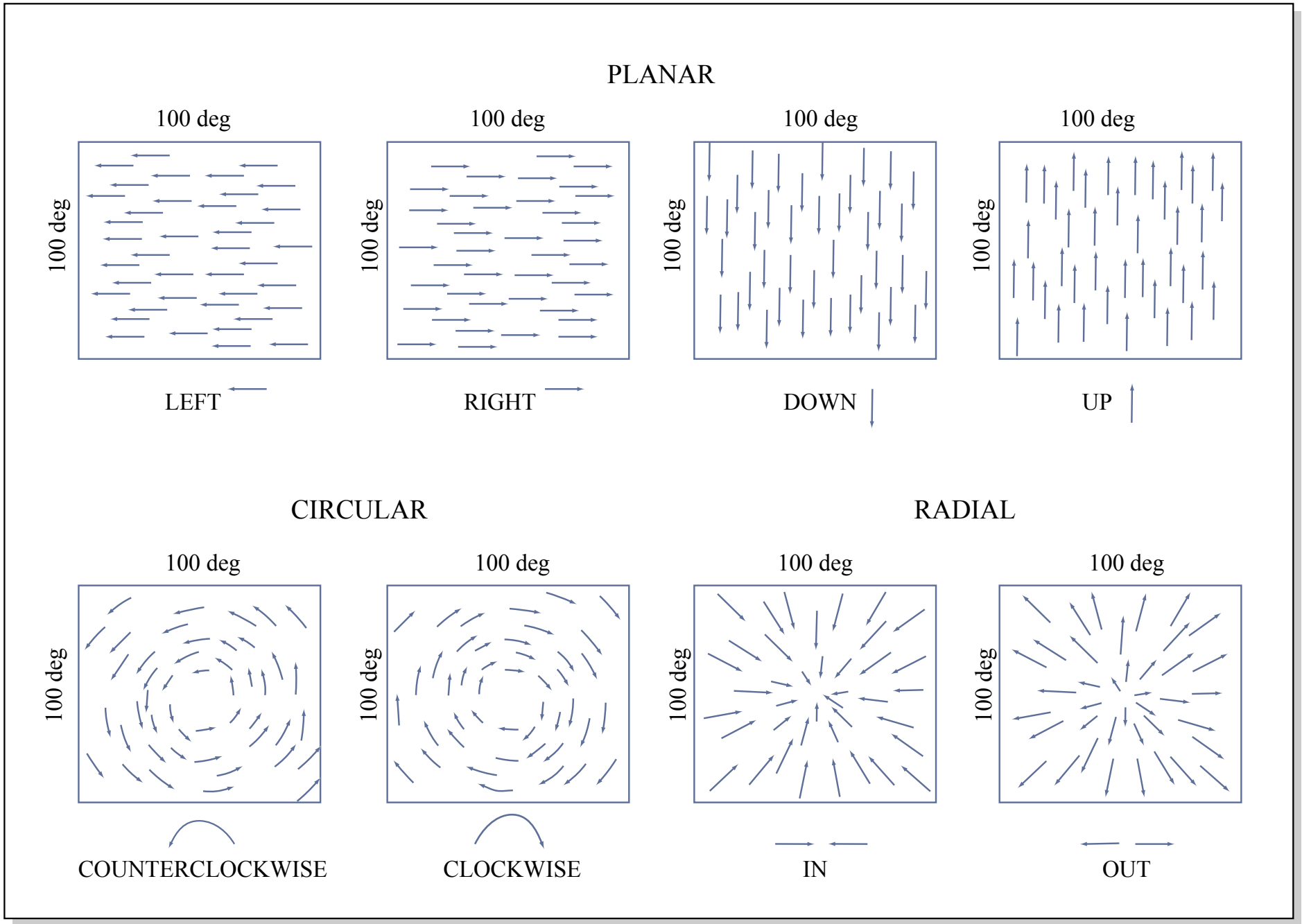


Figure by MIT OCW.

Specificity of directional attributes in MST

40% of the cells respond to all three types of motion

30% of the cells respond to two types of motion

20% of the cells respond to one type of motion

Specificity of directional attributes in MST

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Models for directional specificity

Simple inhibitory model with spatial specificity

spatially specific inhibition

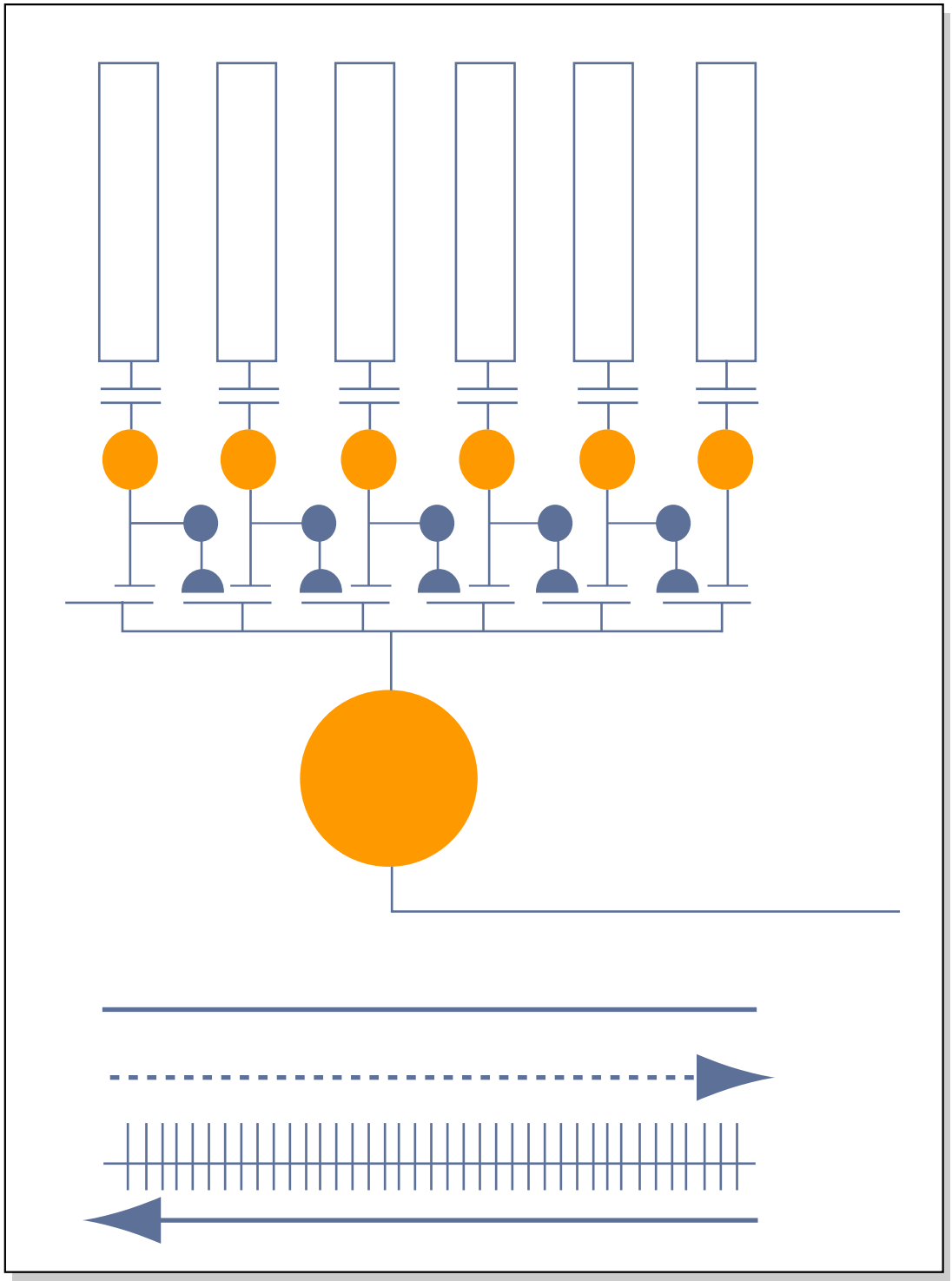


Figure by MIT OCW.

Reichardt model

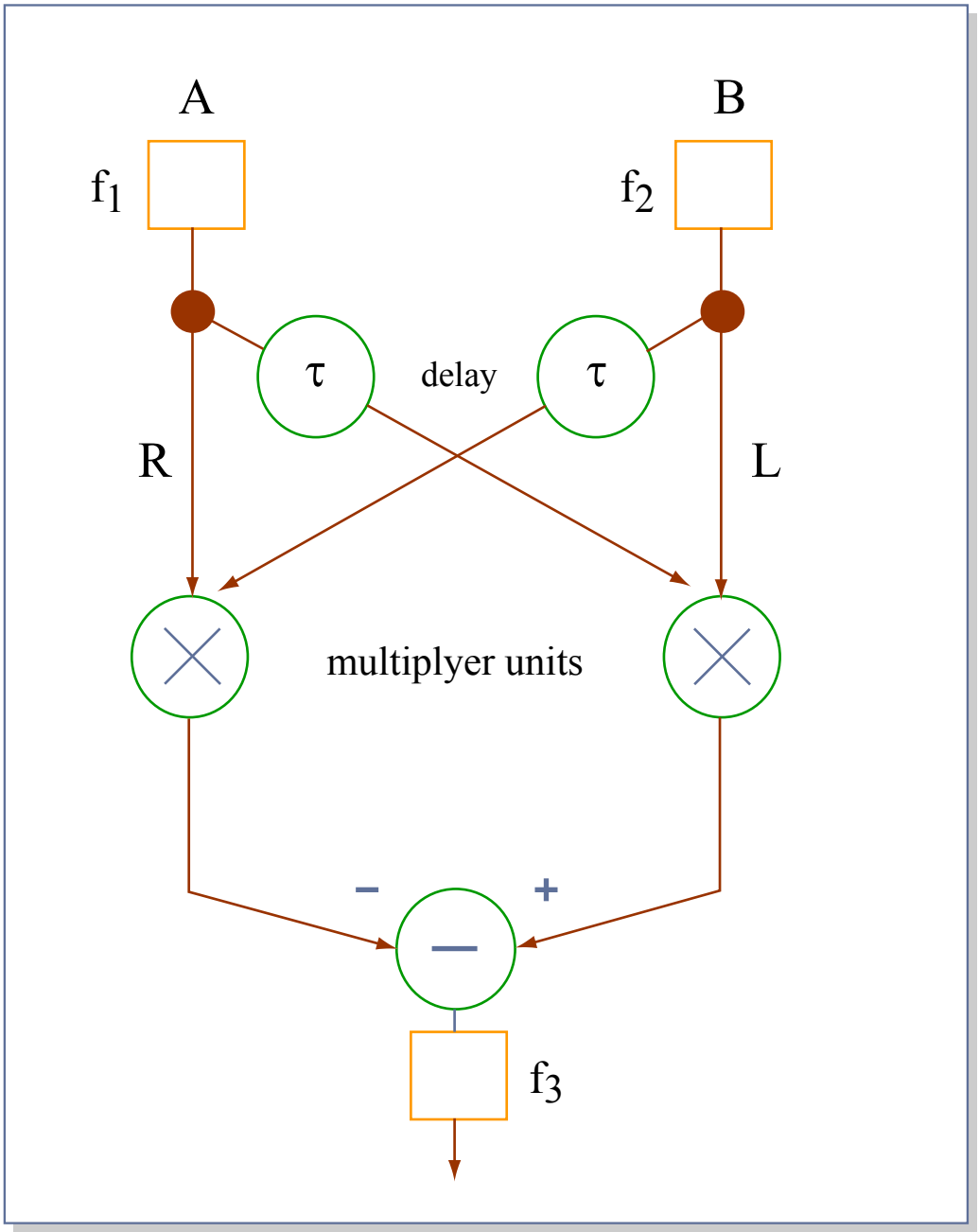
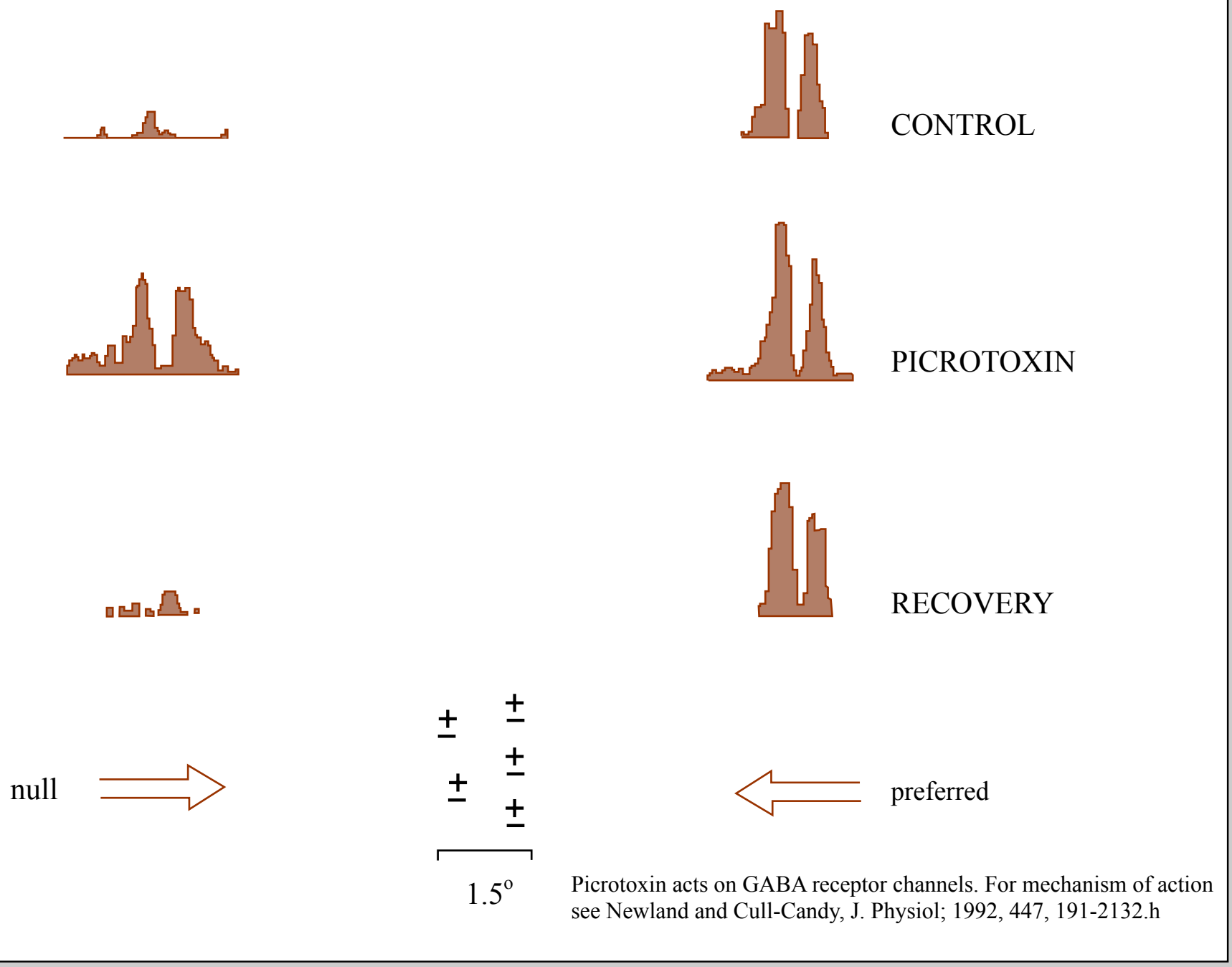


Figure by MIT OCW.

The effect of picrotoxin on direction selectivity in retina



Picrotoxin acts on GABA receptor channels. For mechanism of action see Newland and Cull-Candy, J. Physiol; 1992, 447, 191-2132.h

Figure by MIT OCW.

The effects of lesions on motion perception

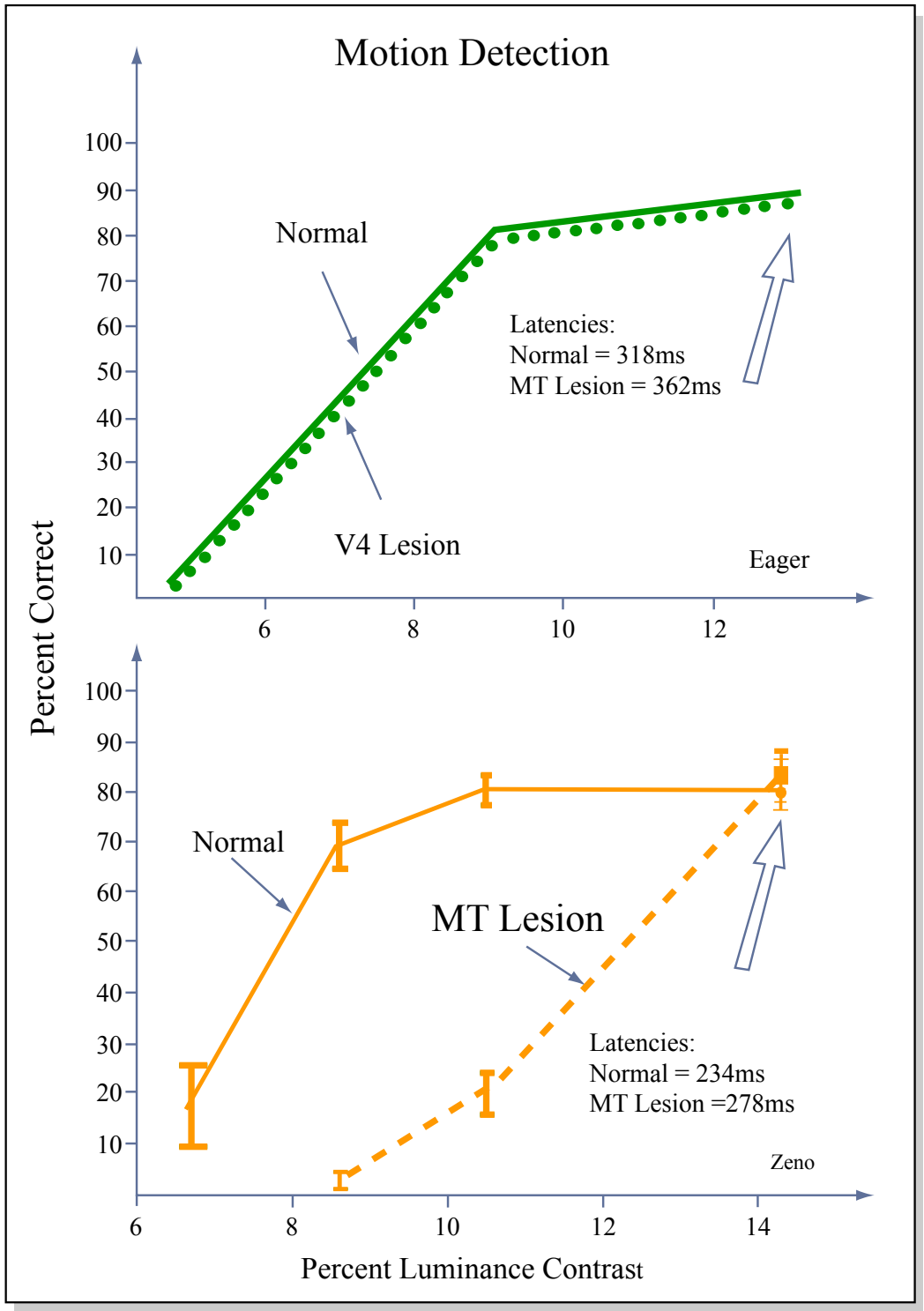


Figure by MIT OCW.

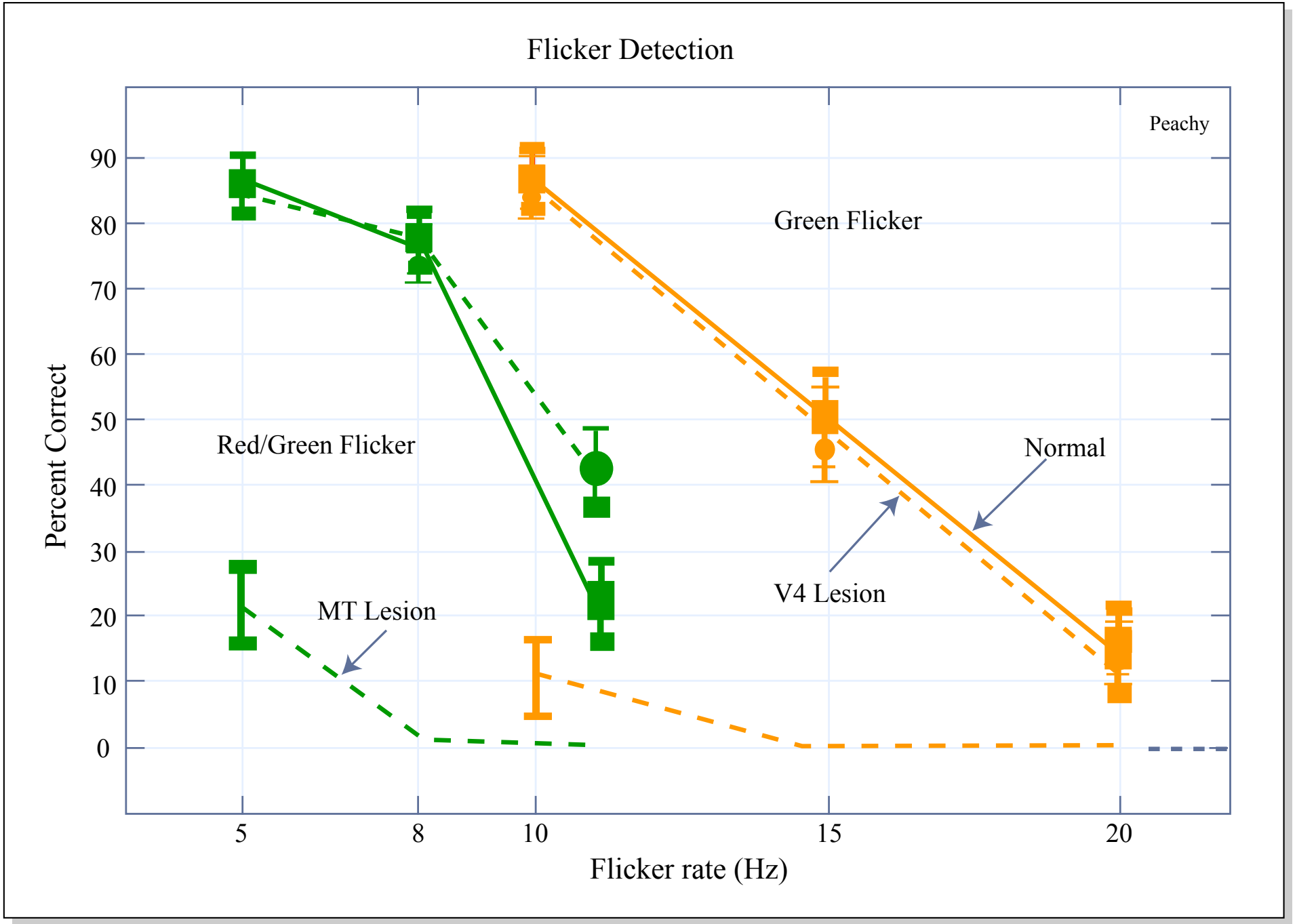
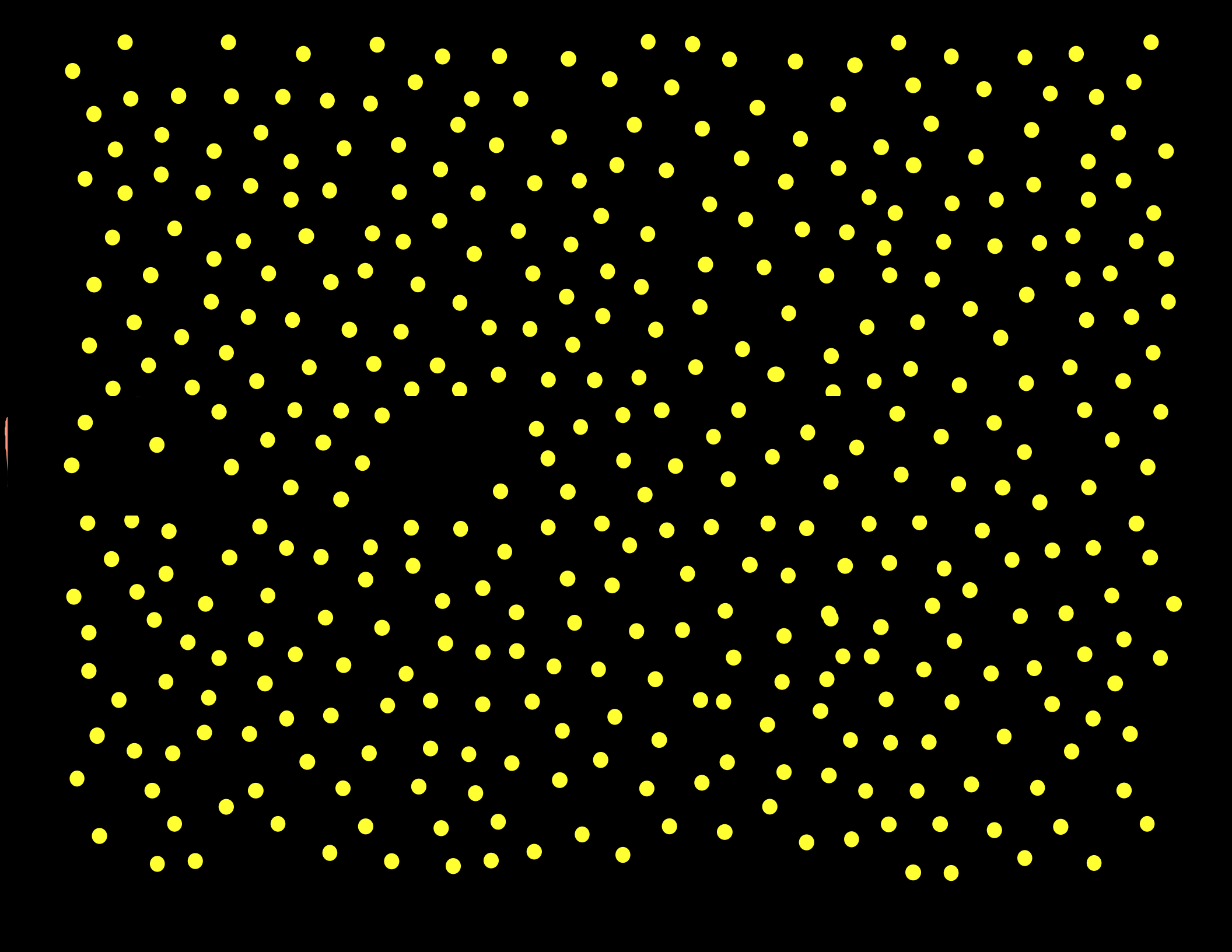


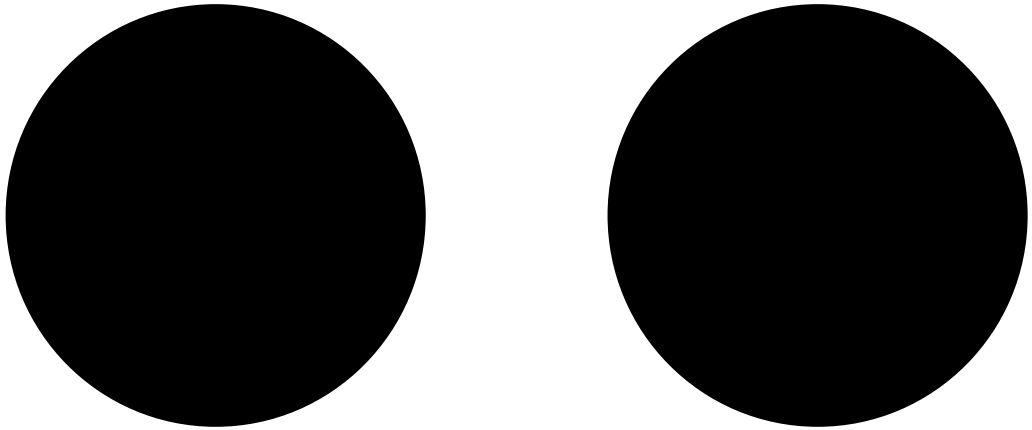
Figure by MIT OCW.

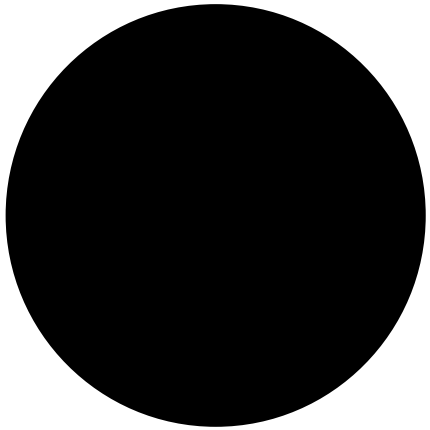
Structure from motion

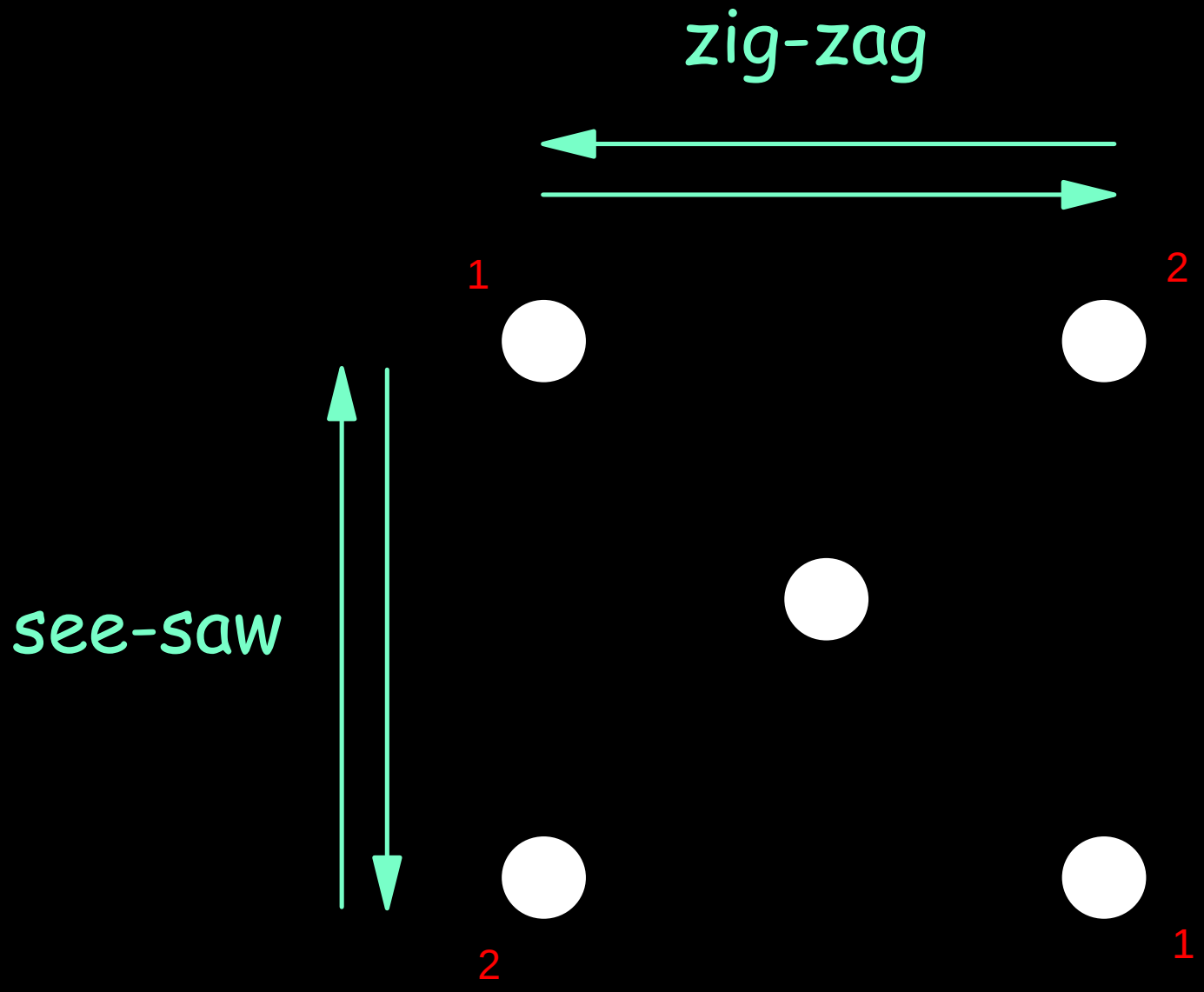


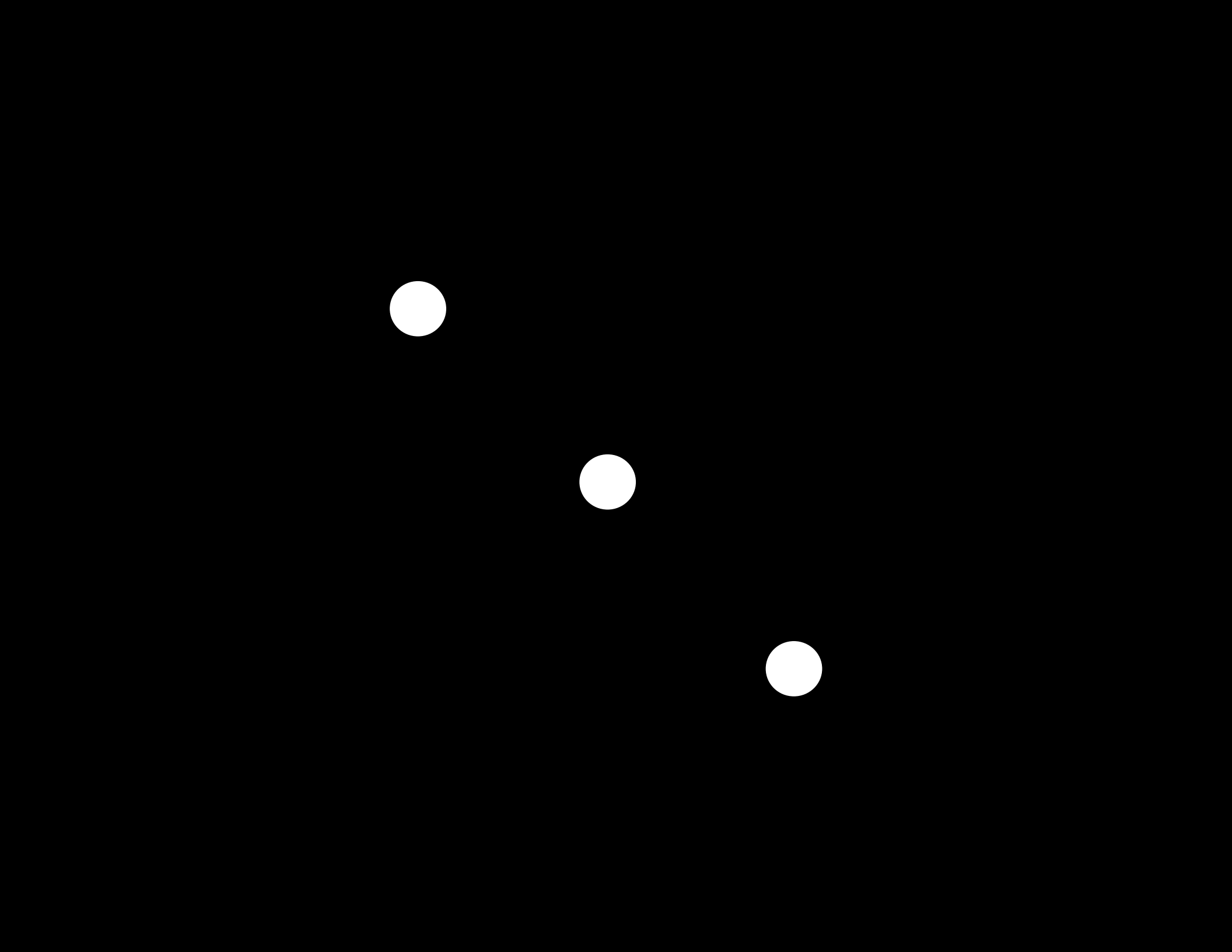
Apparent motion

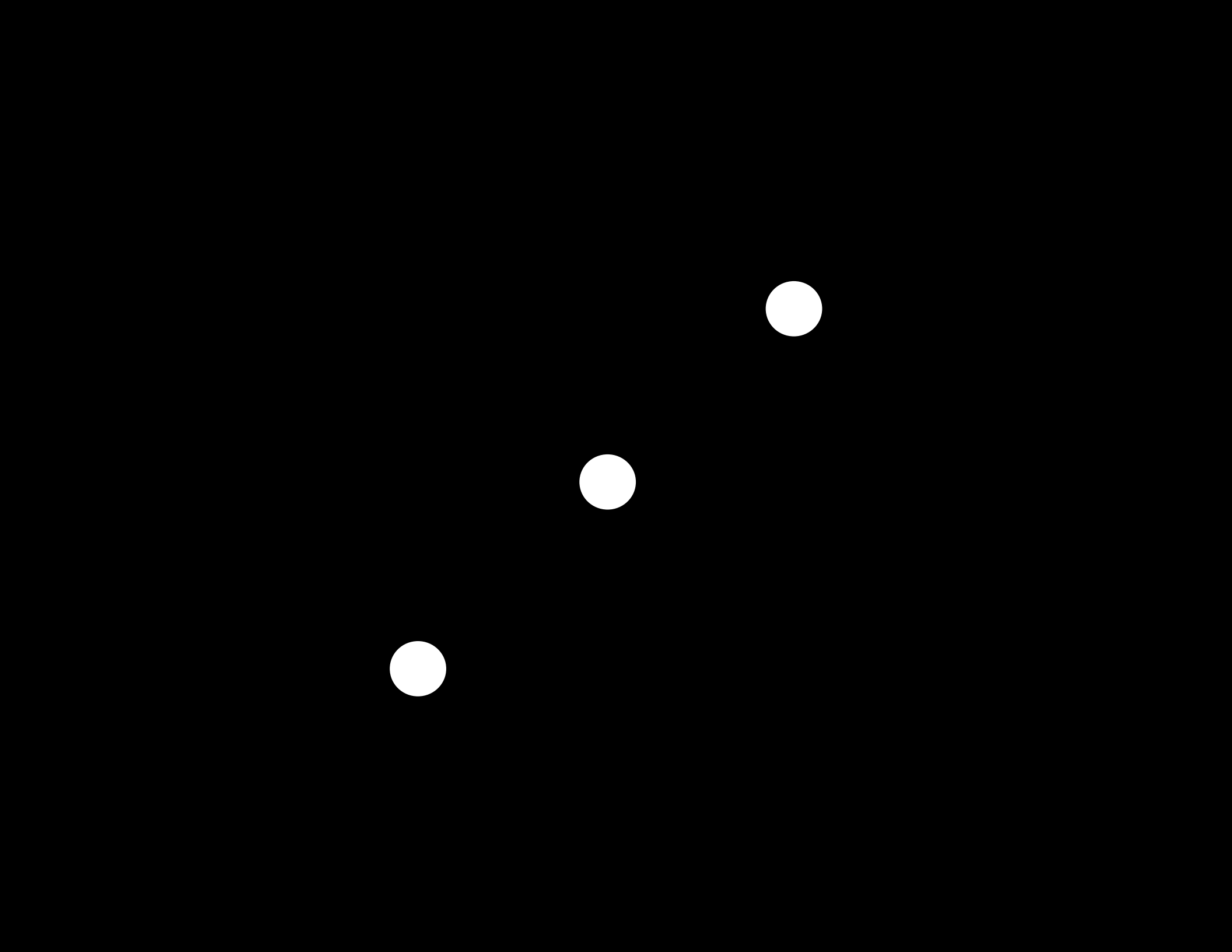
The jumping disk

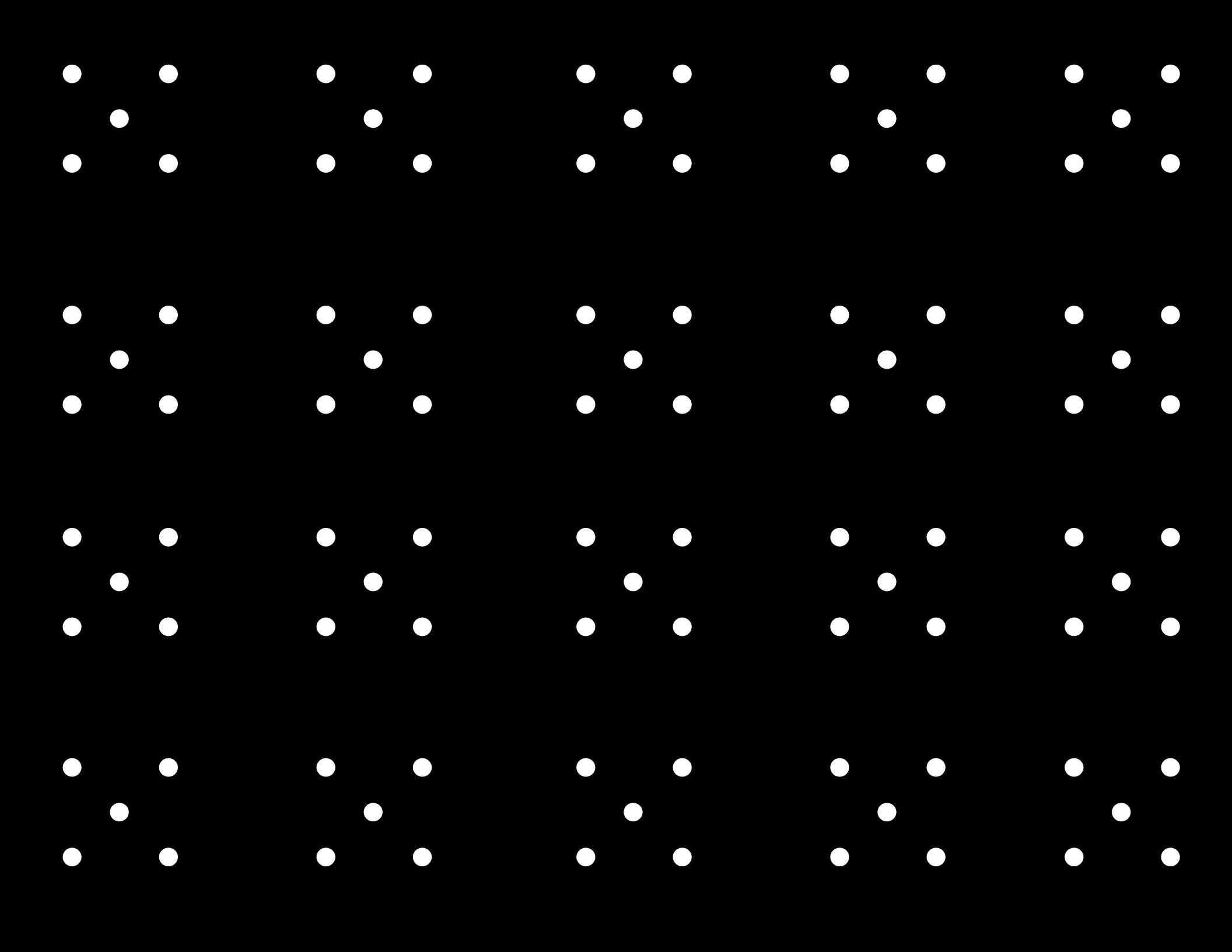


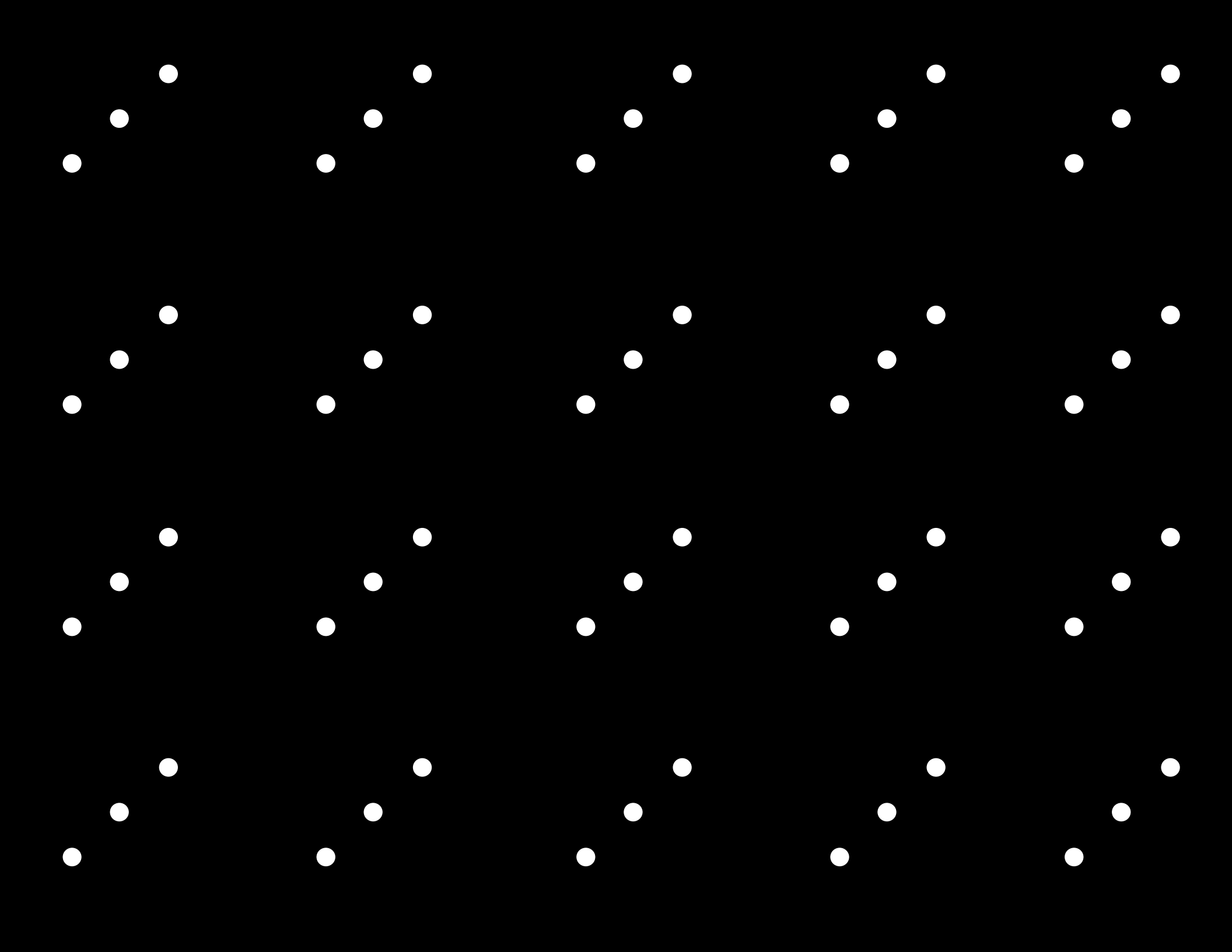


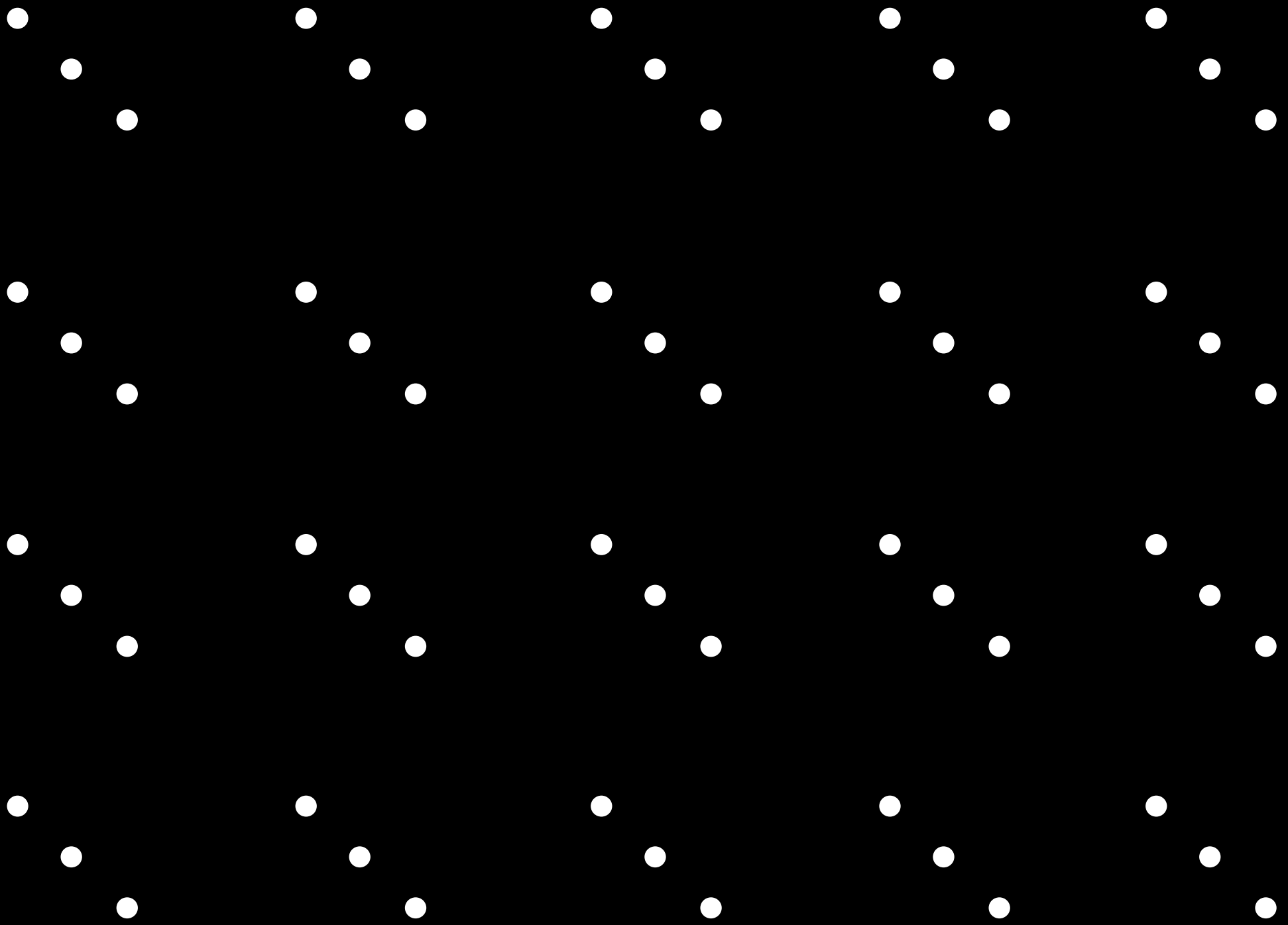

zig-zag
see-saw
1
2
2
1

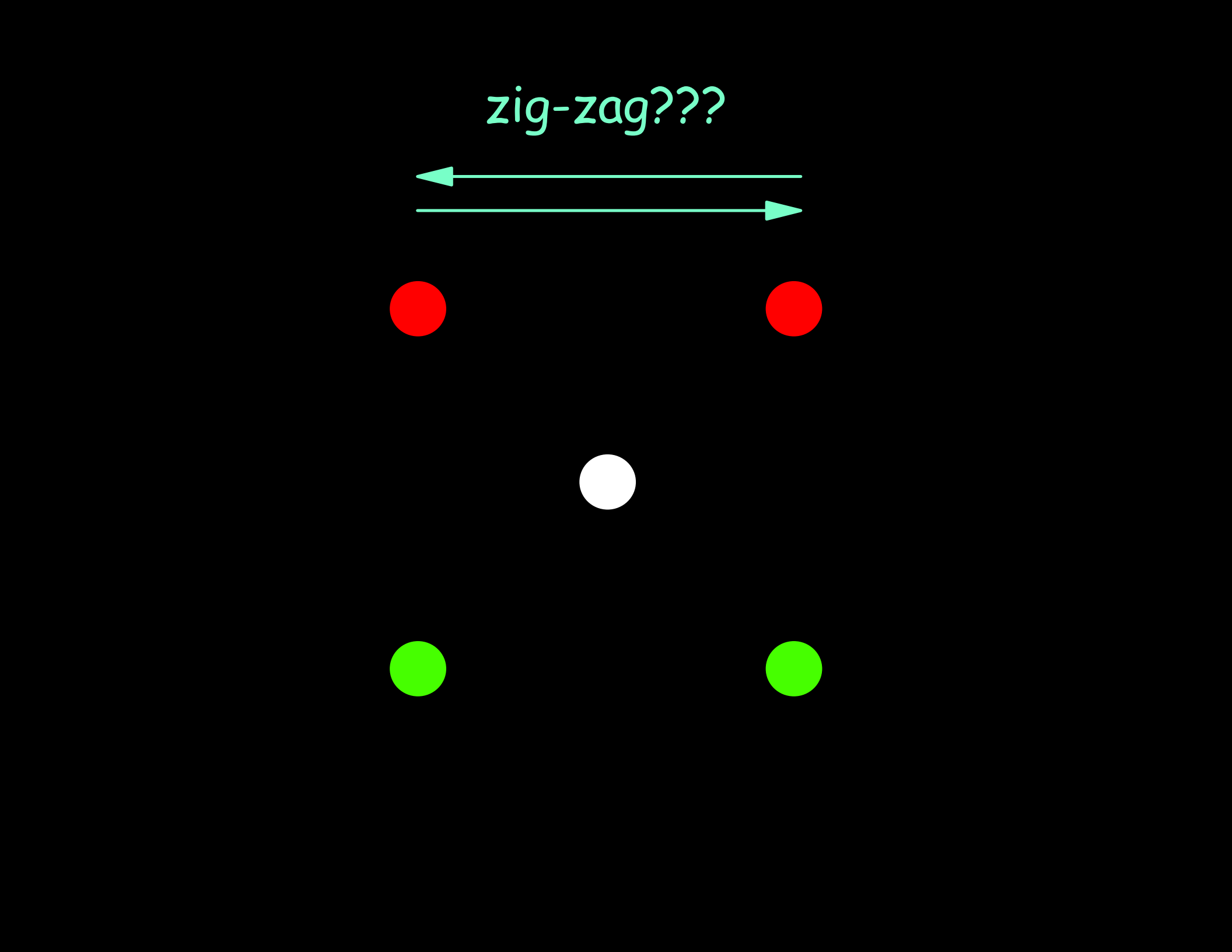








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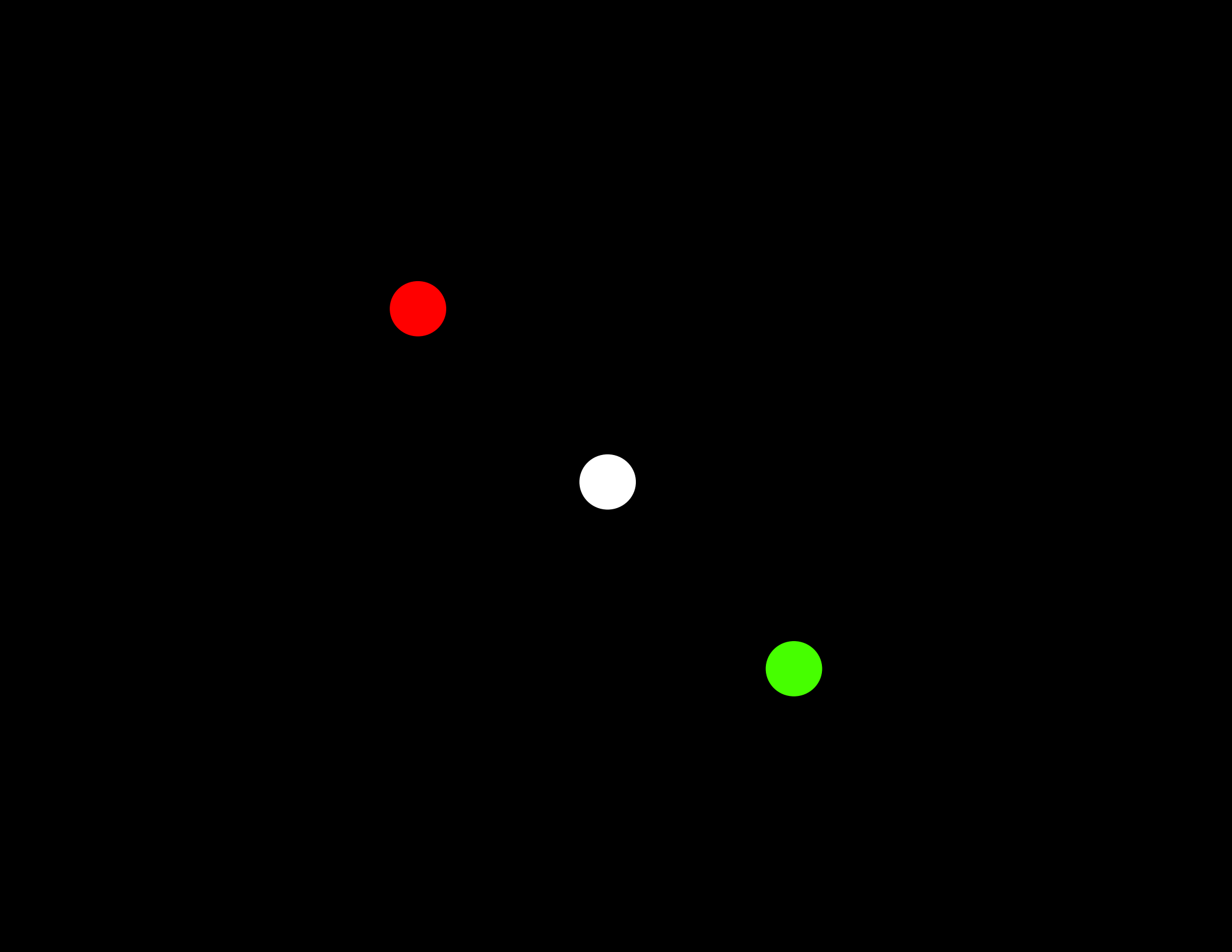
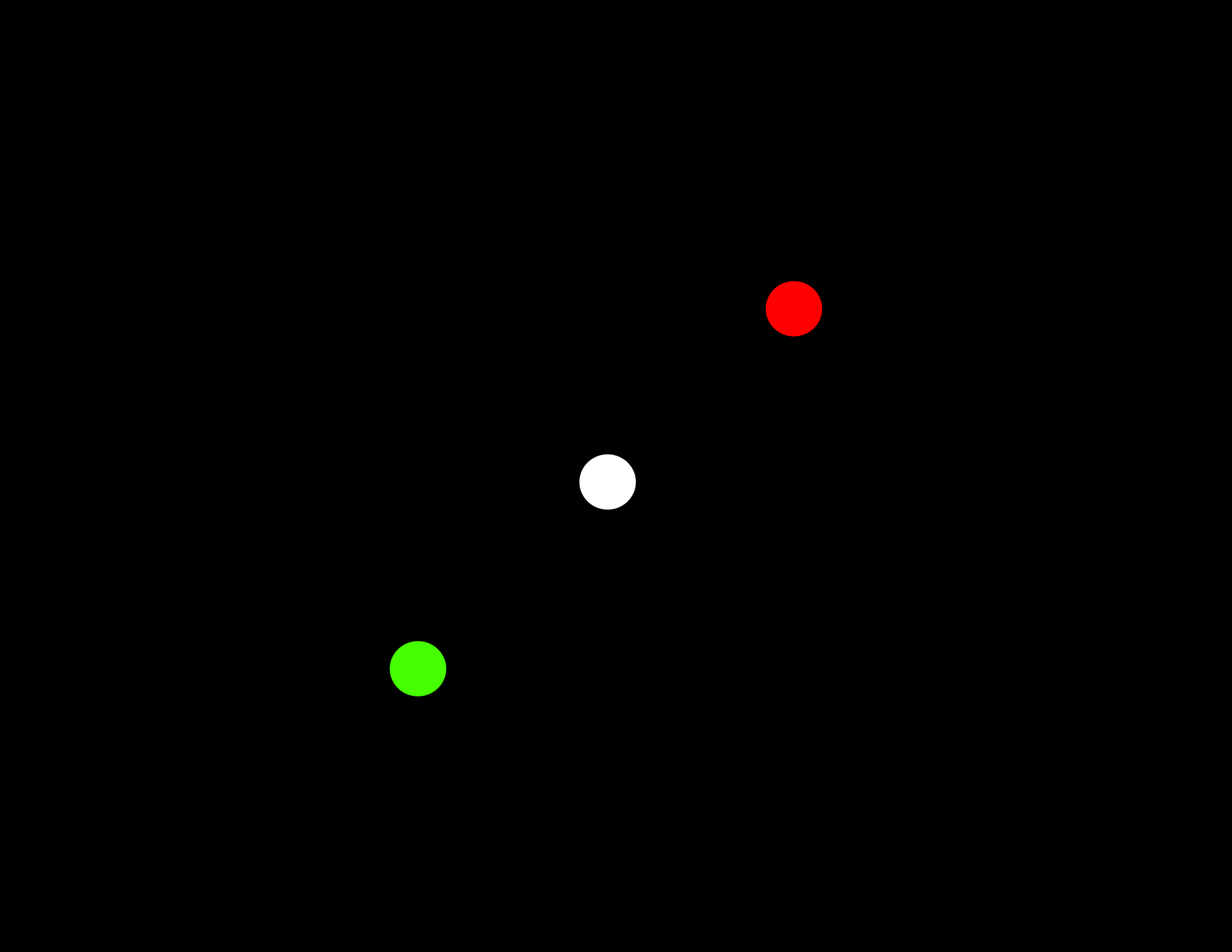
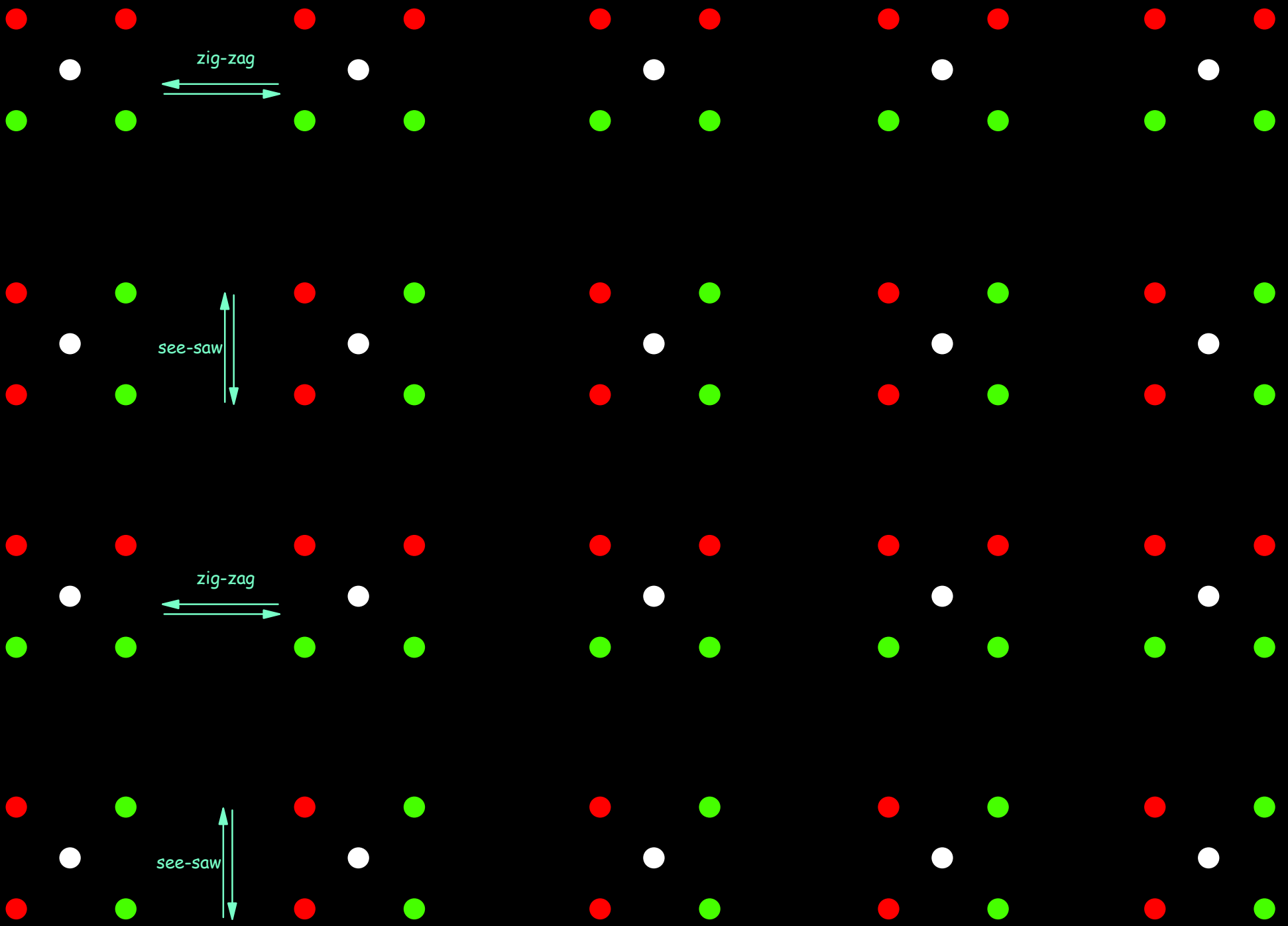
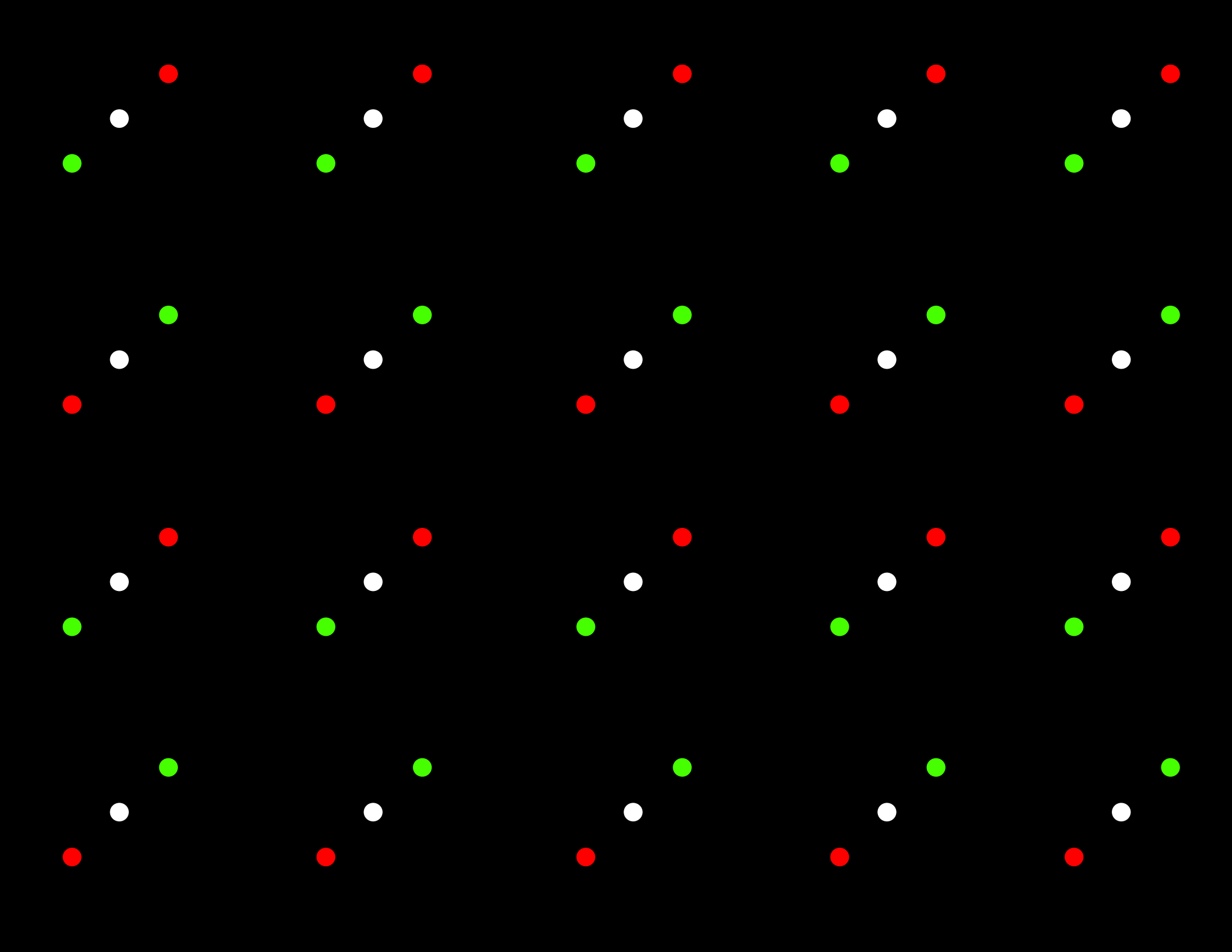
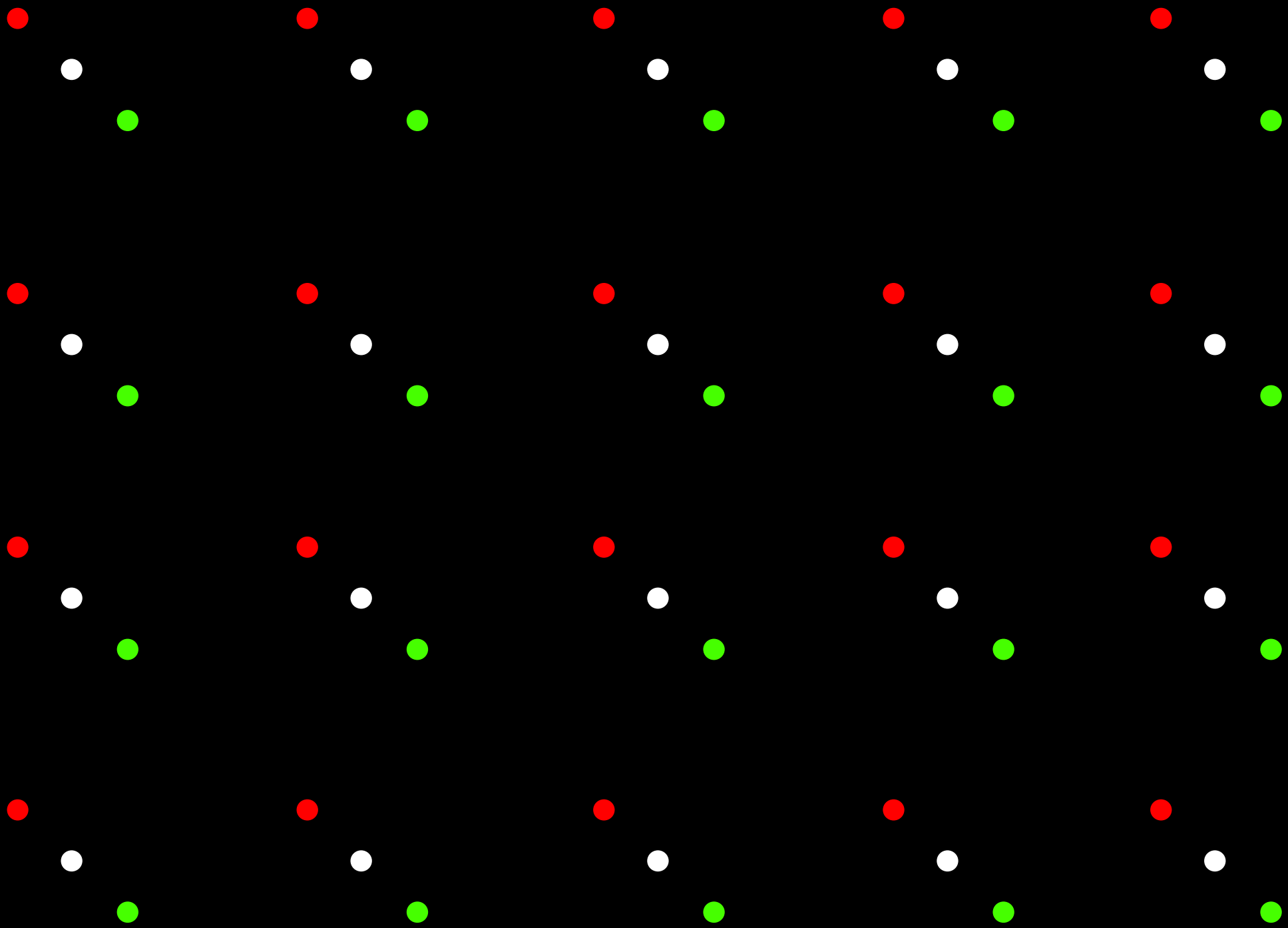
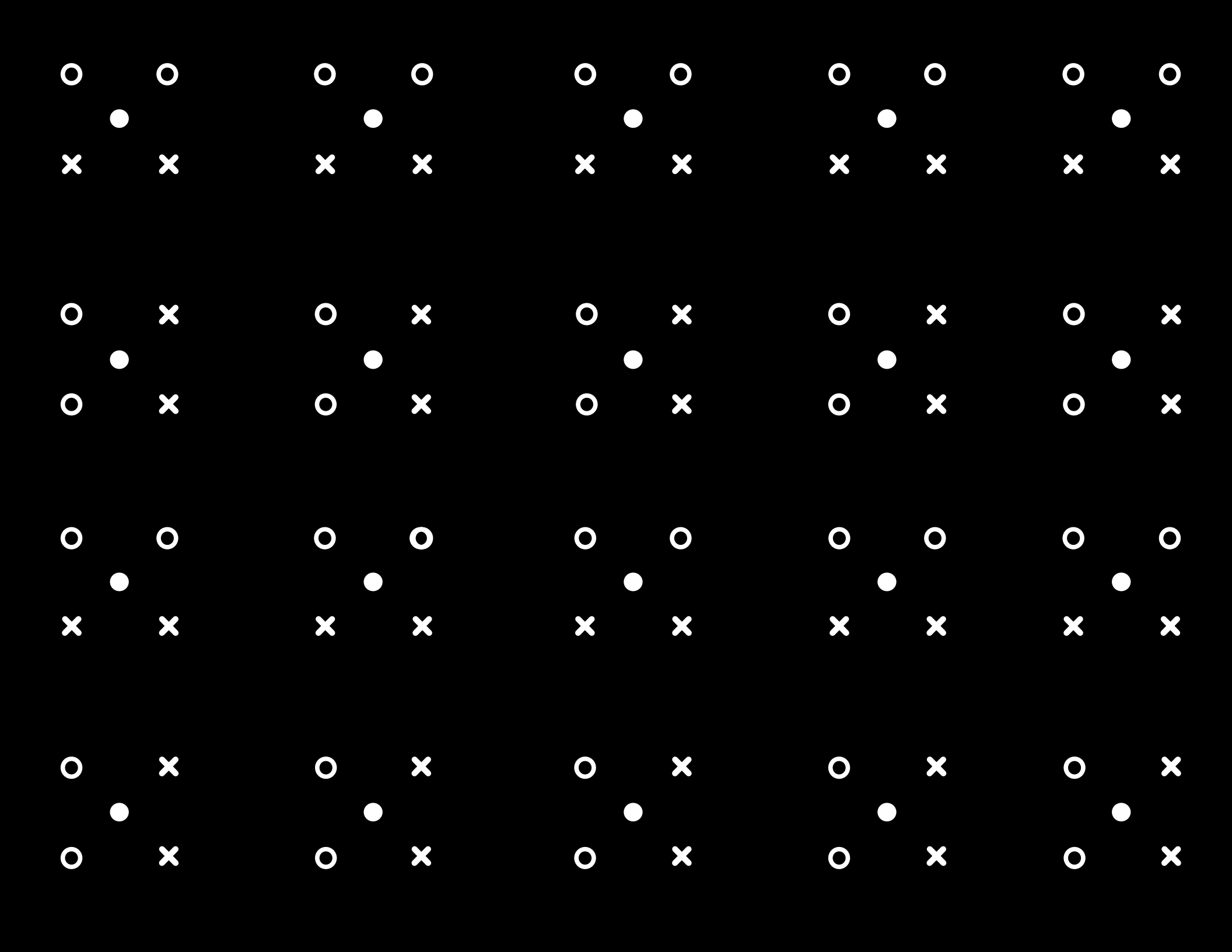


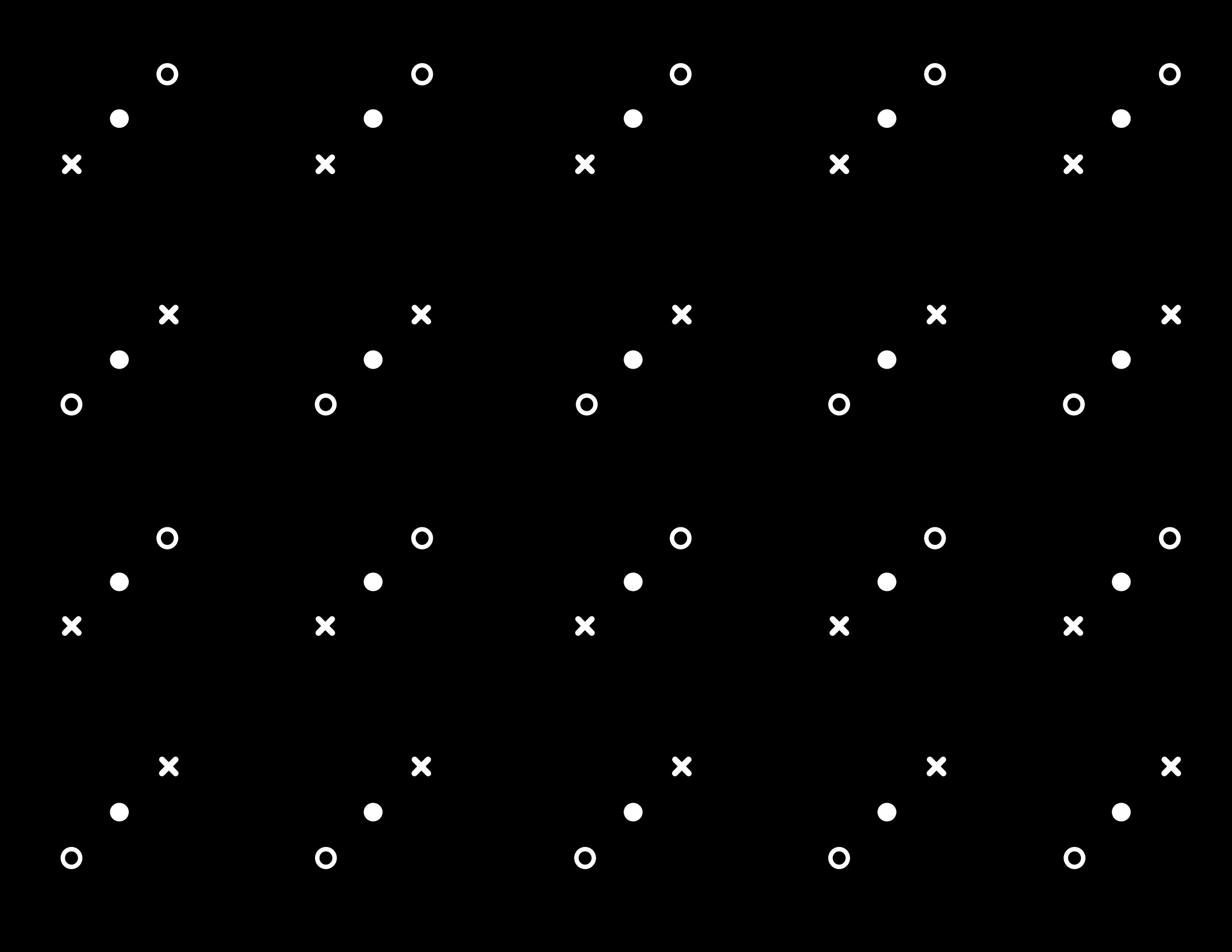


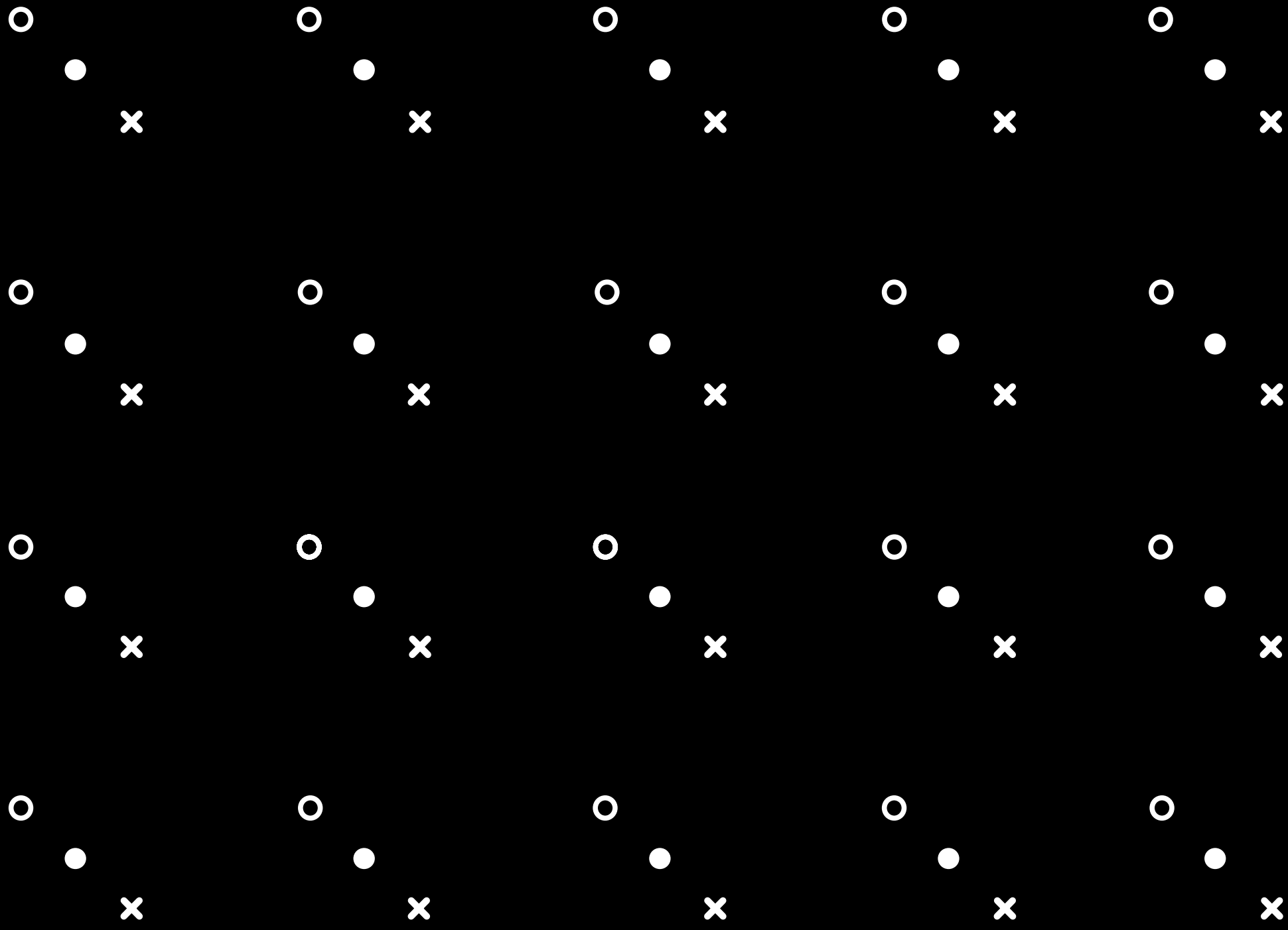

zig-zag
see-saw
zig-zag
see-saw

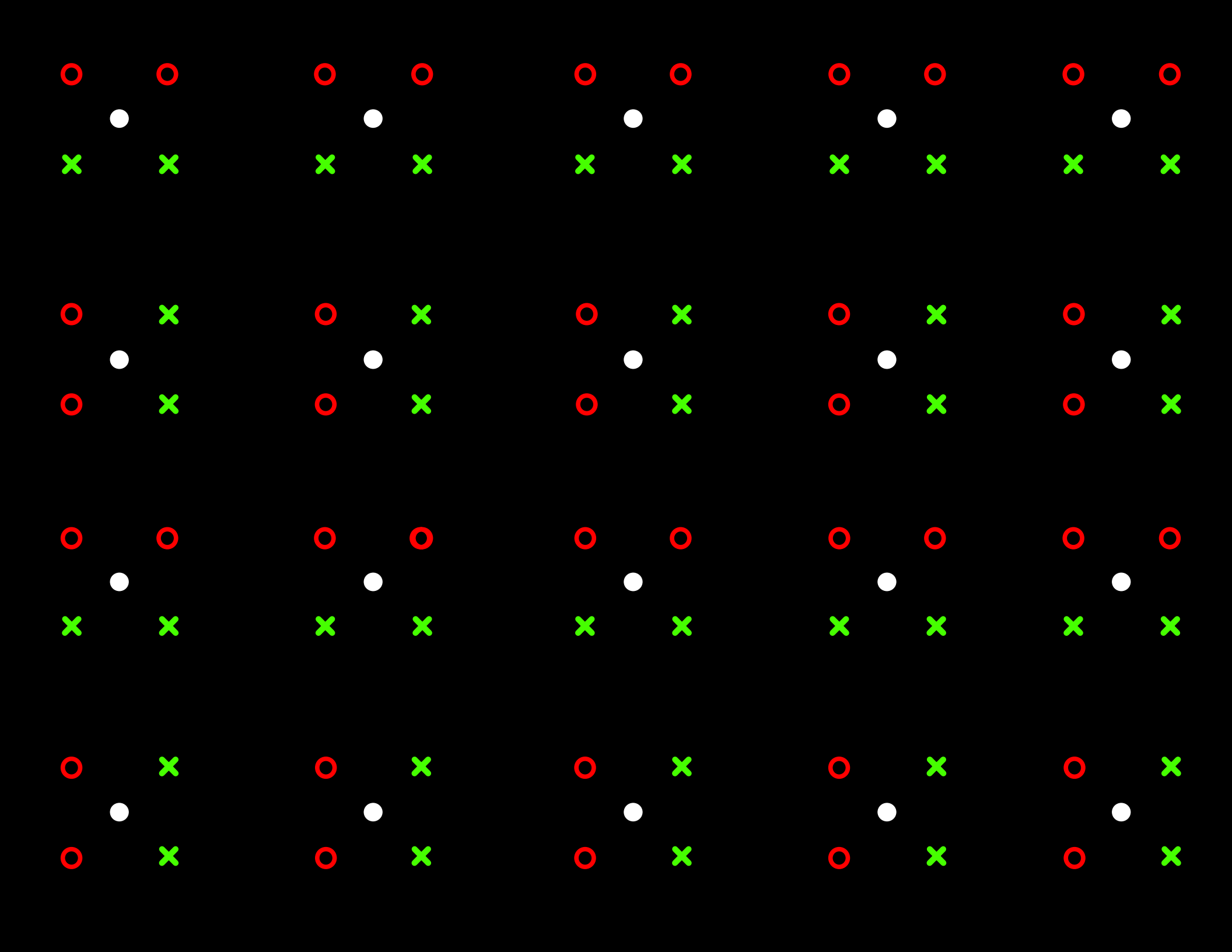


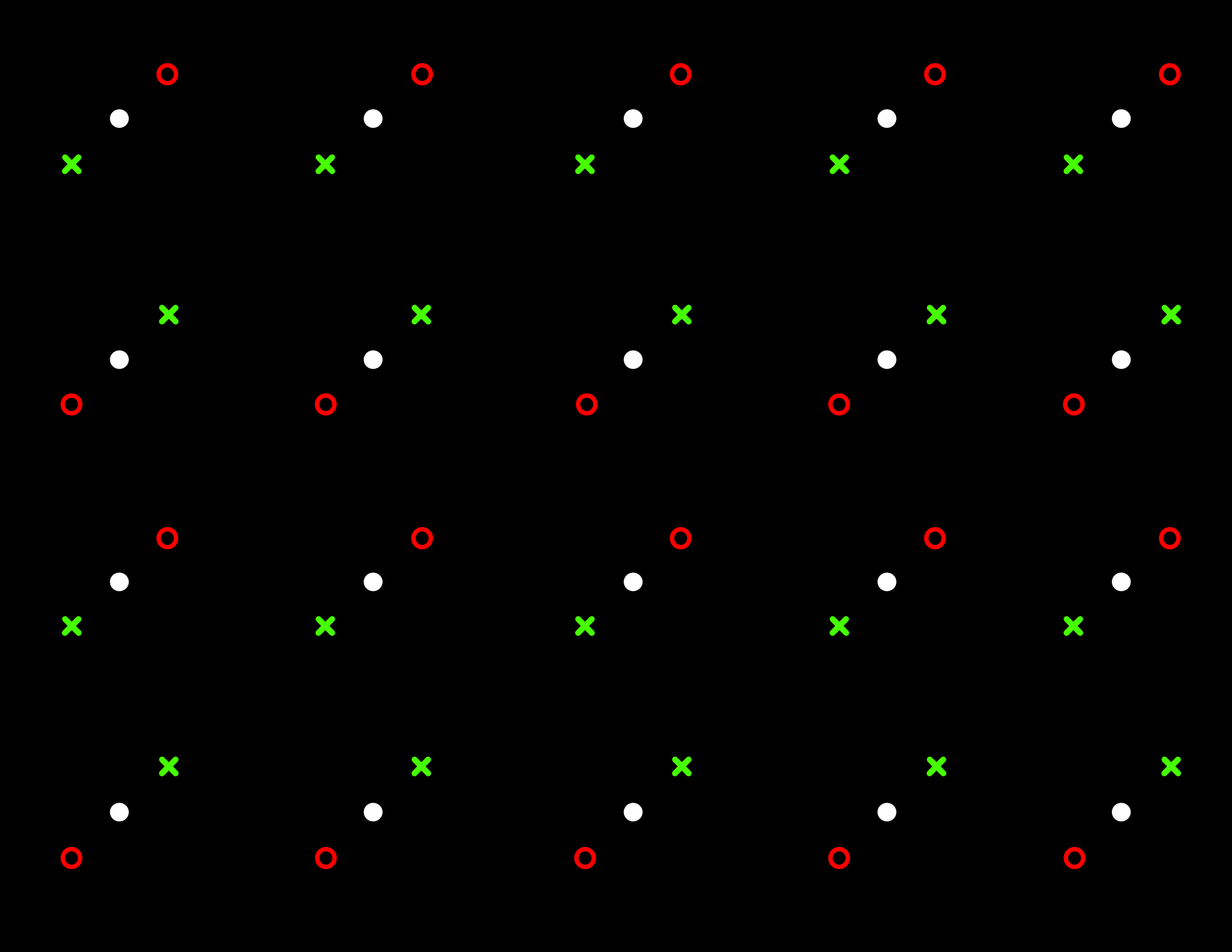


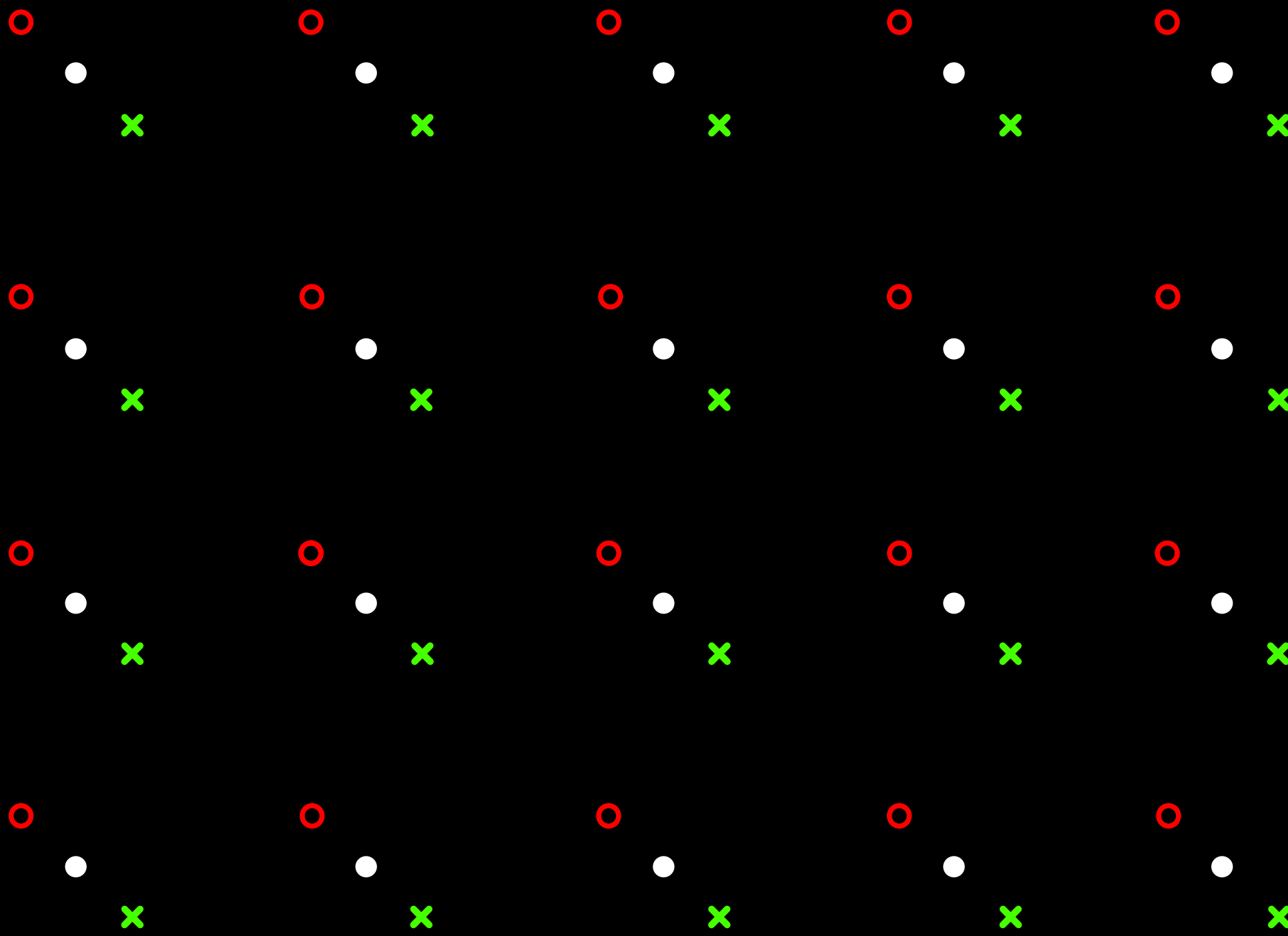


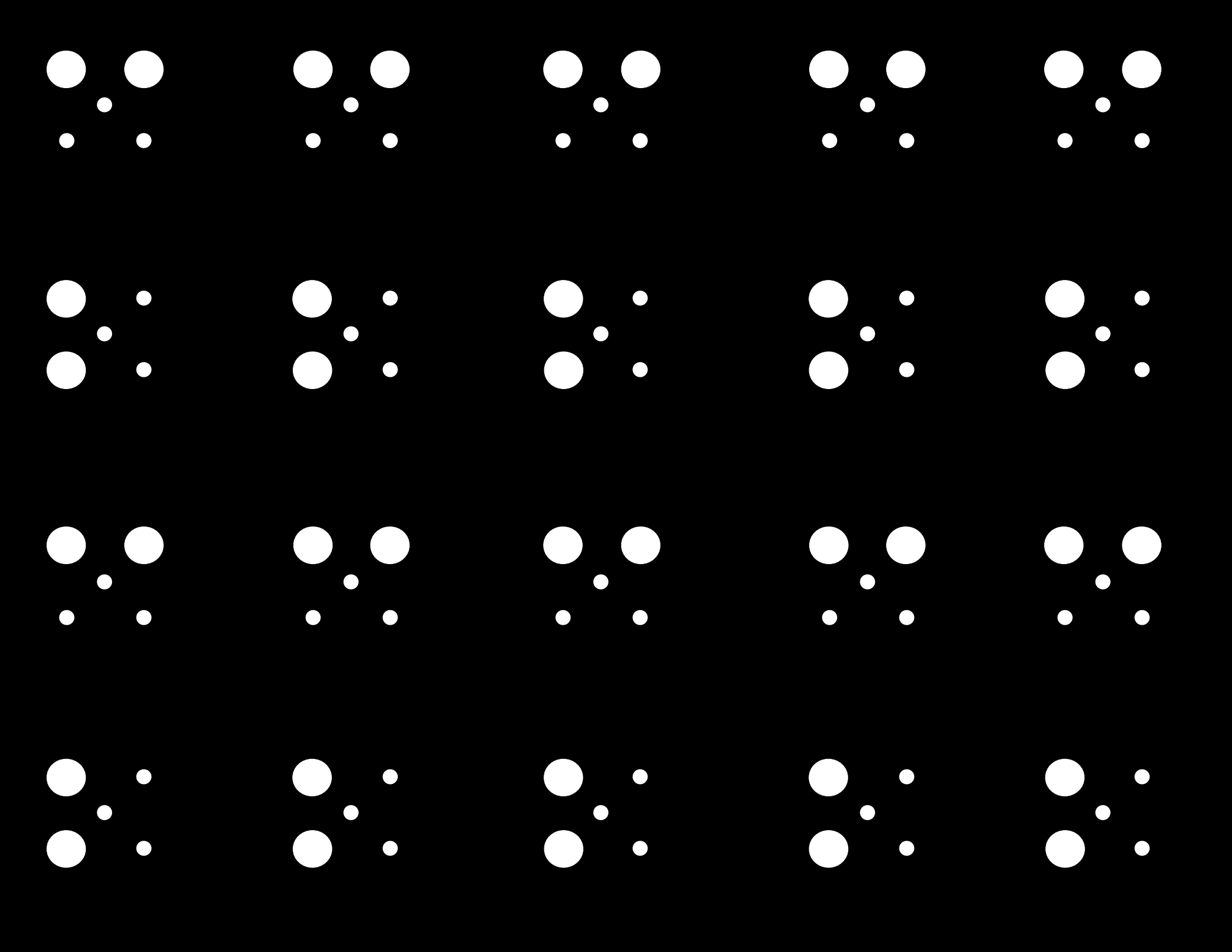


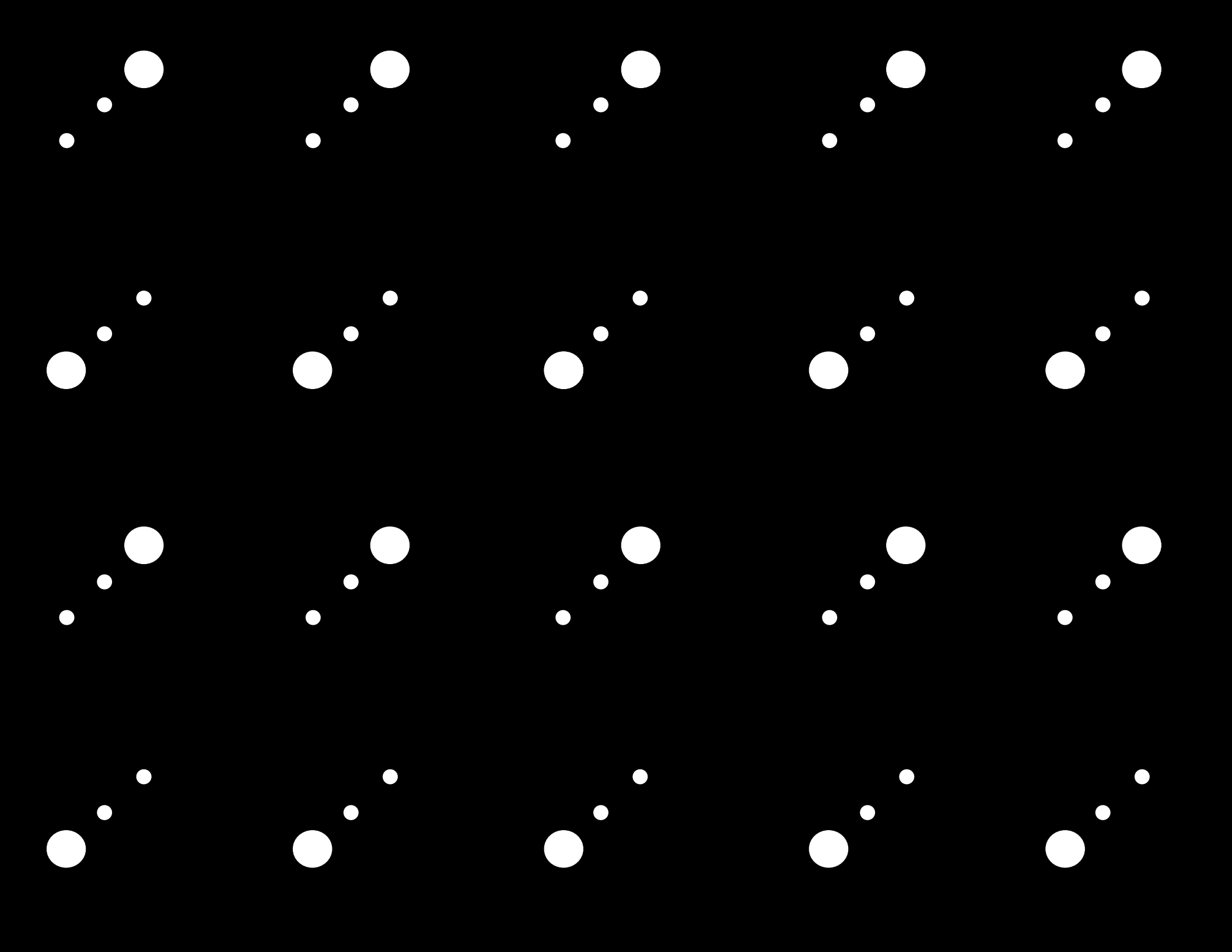


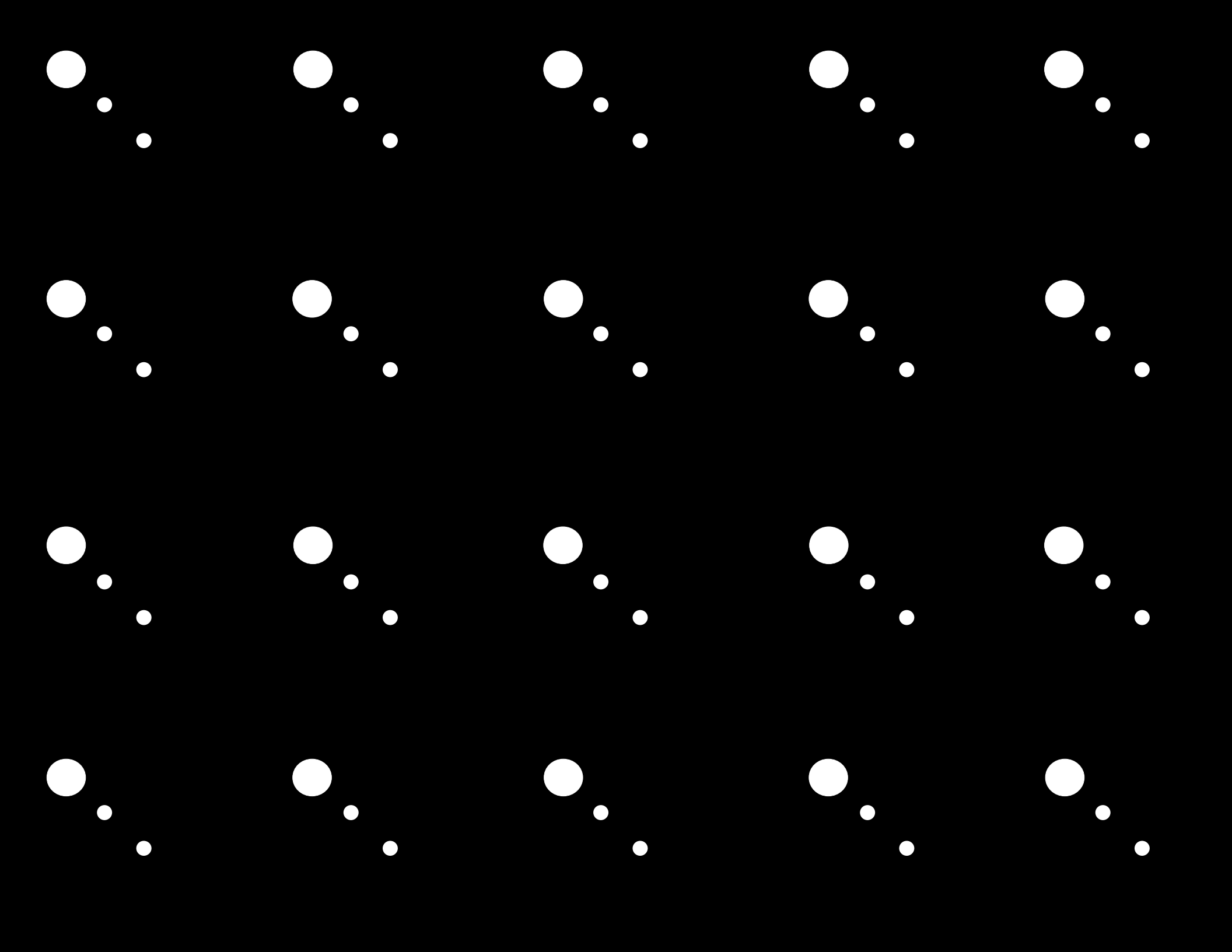


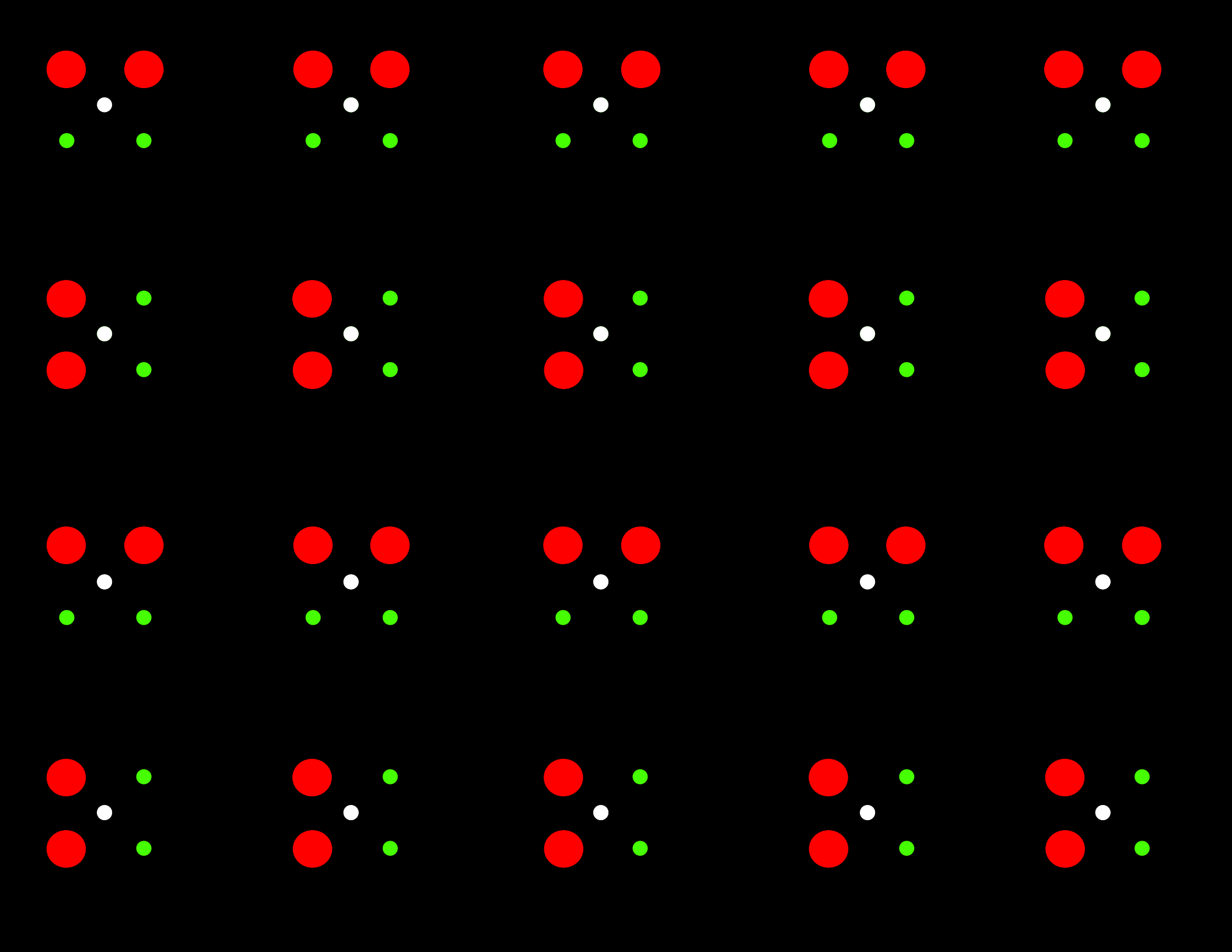


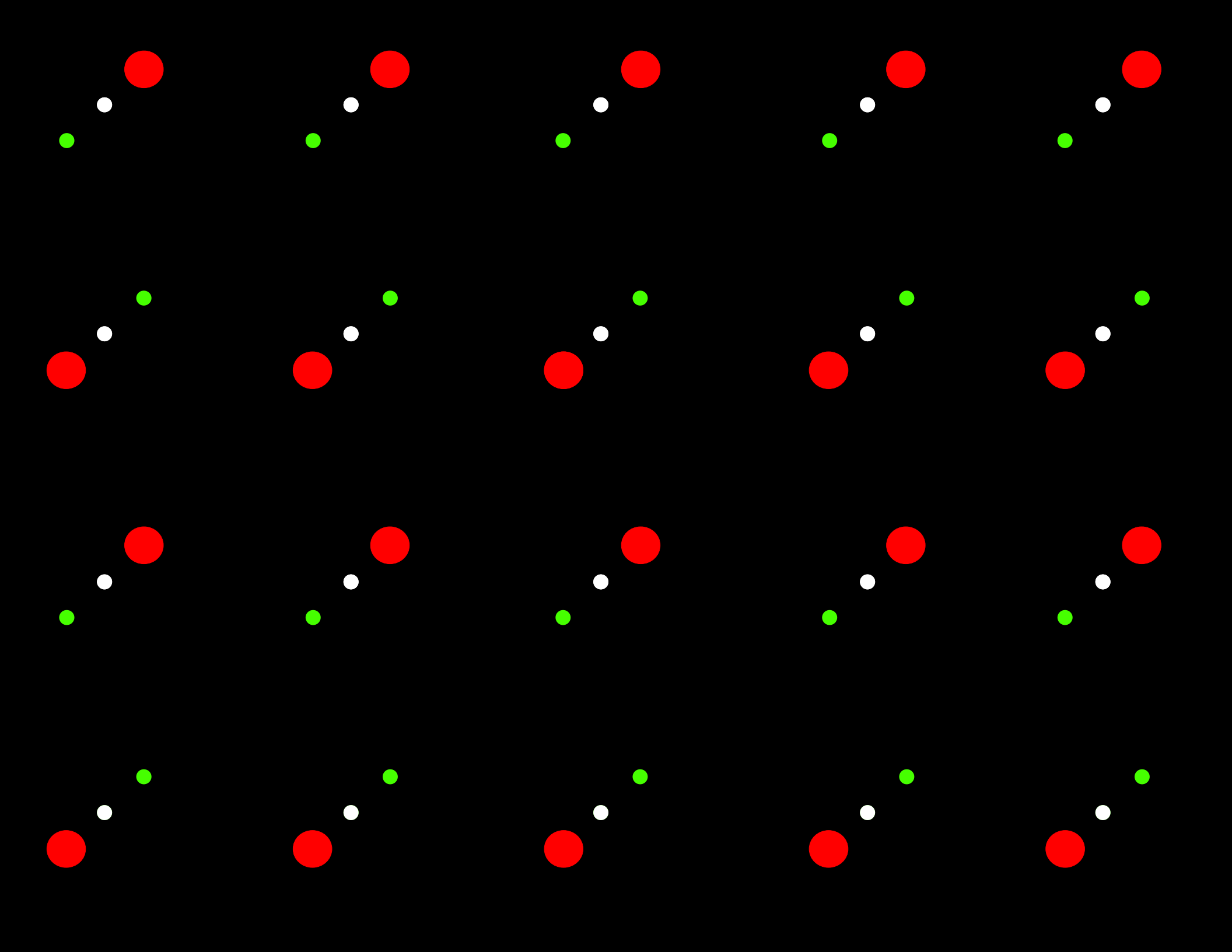


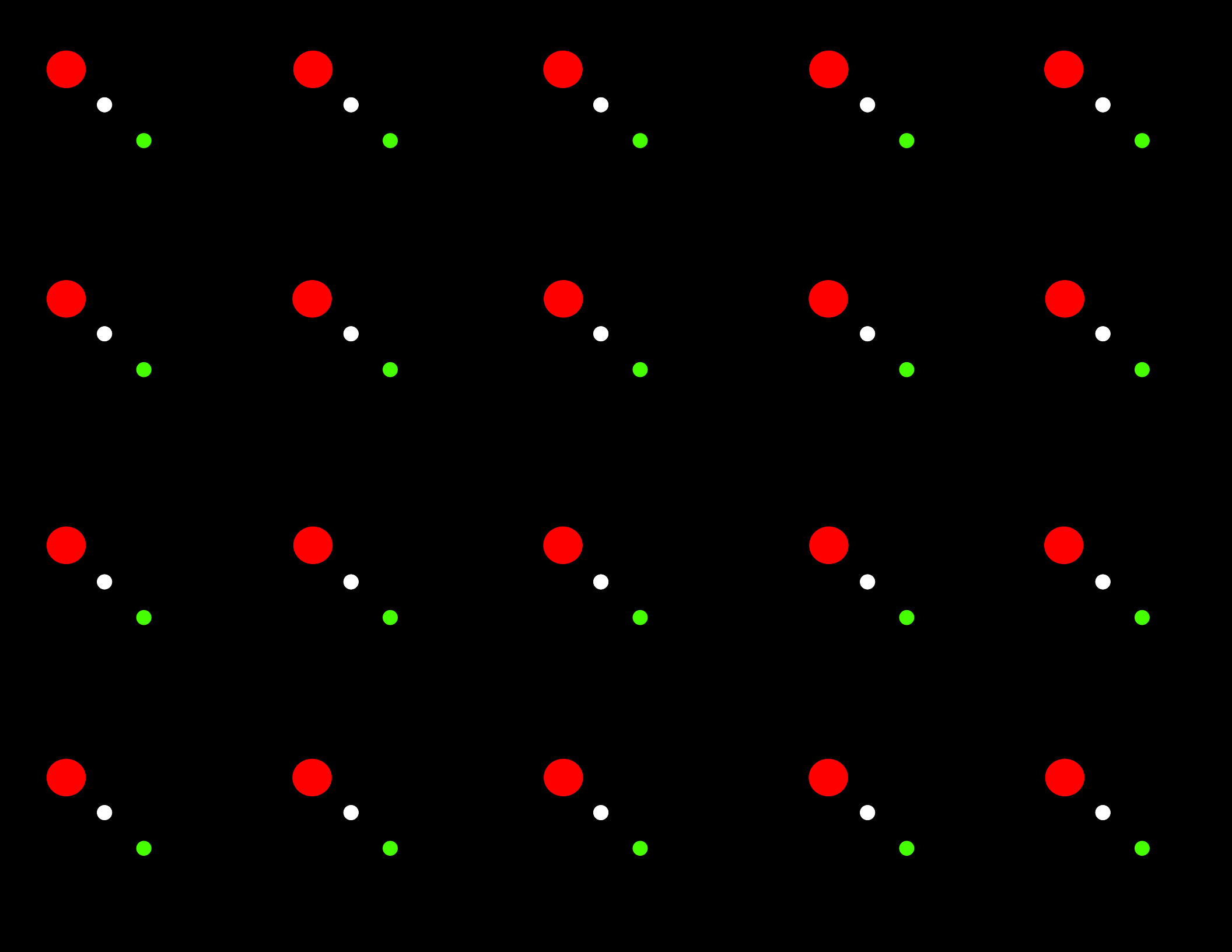


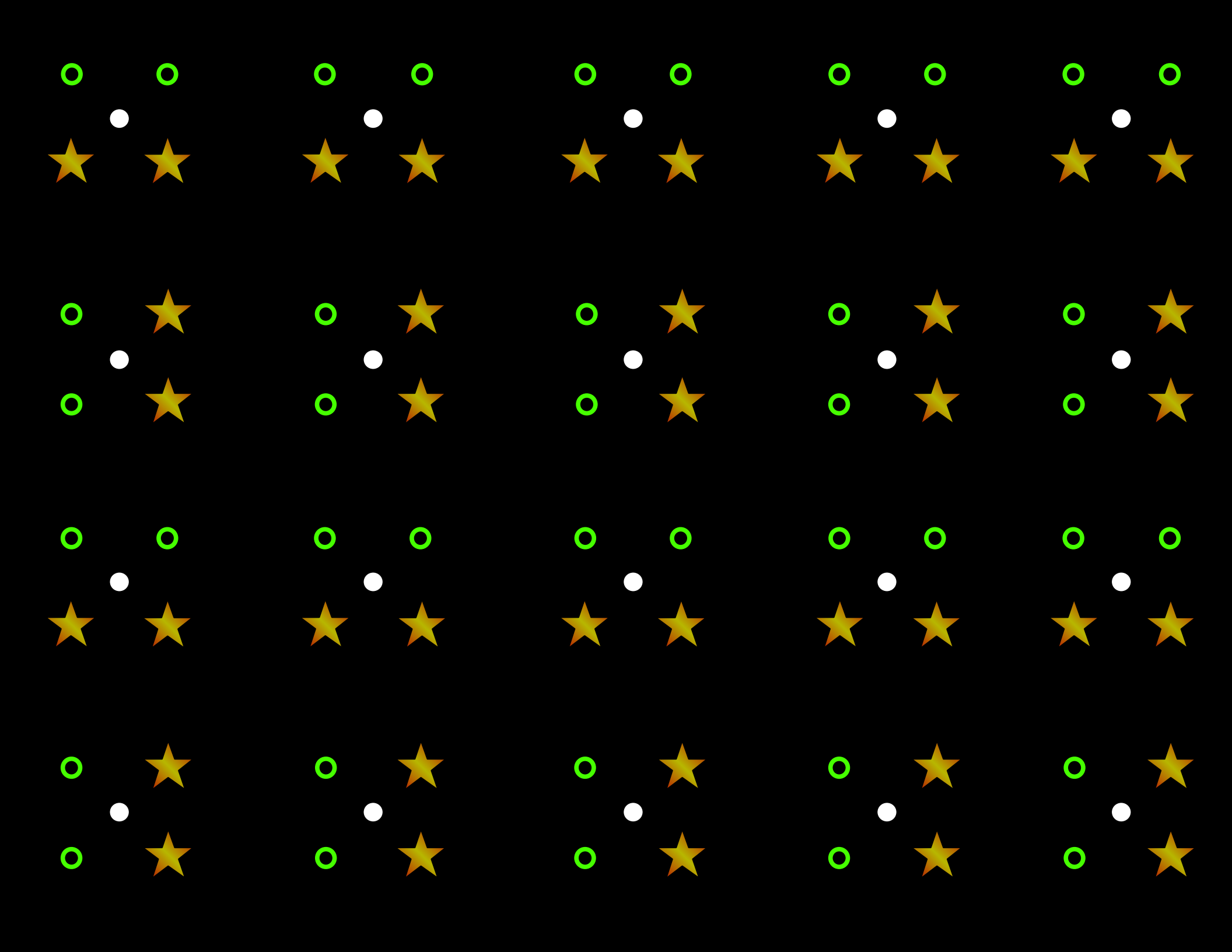


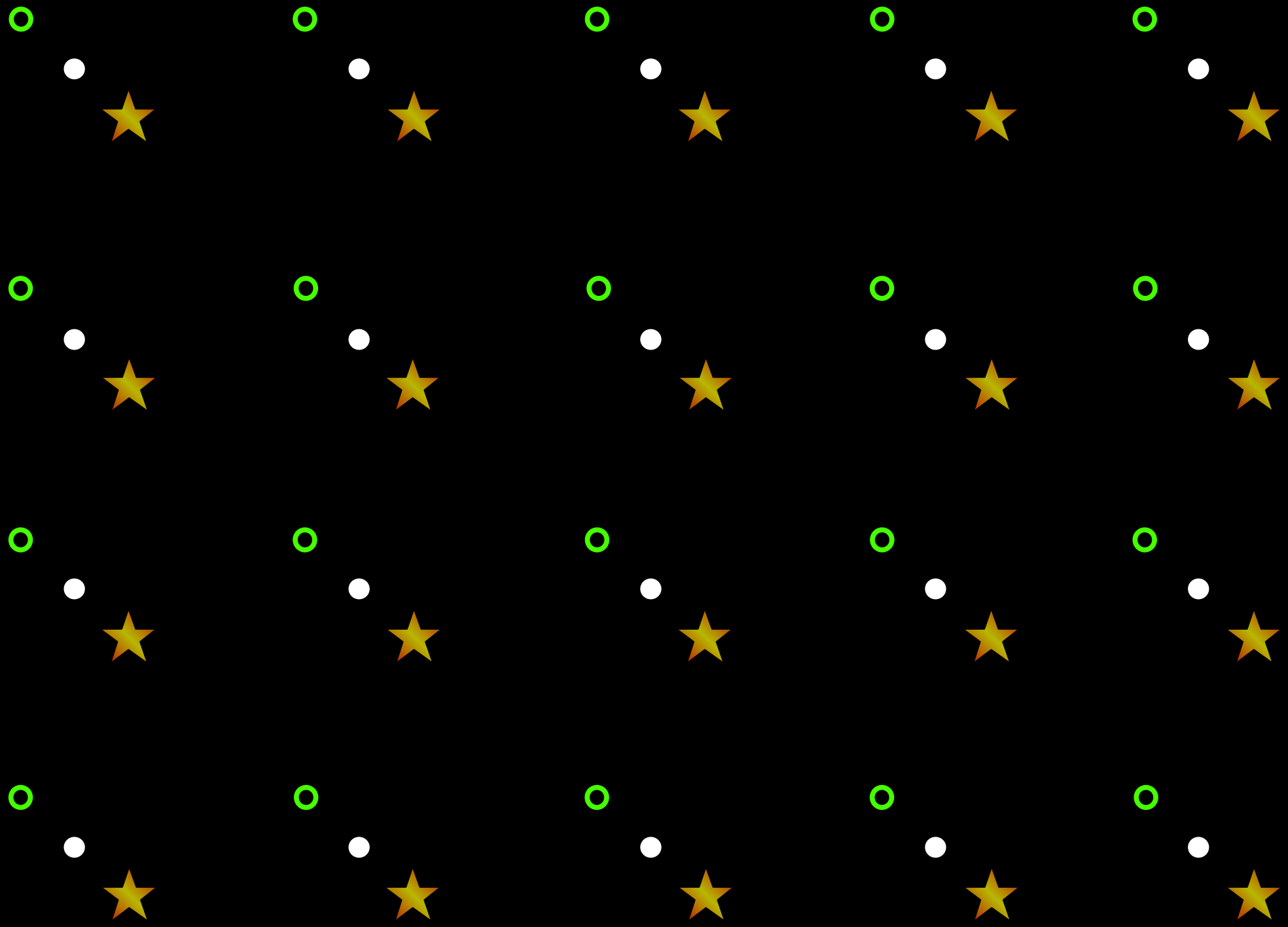


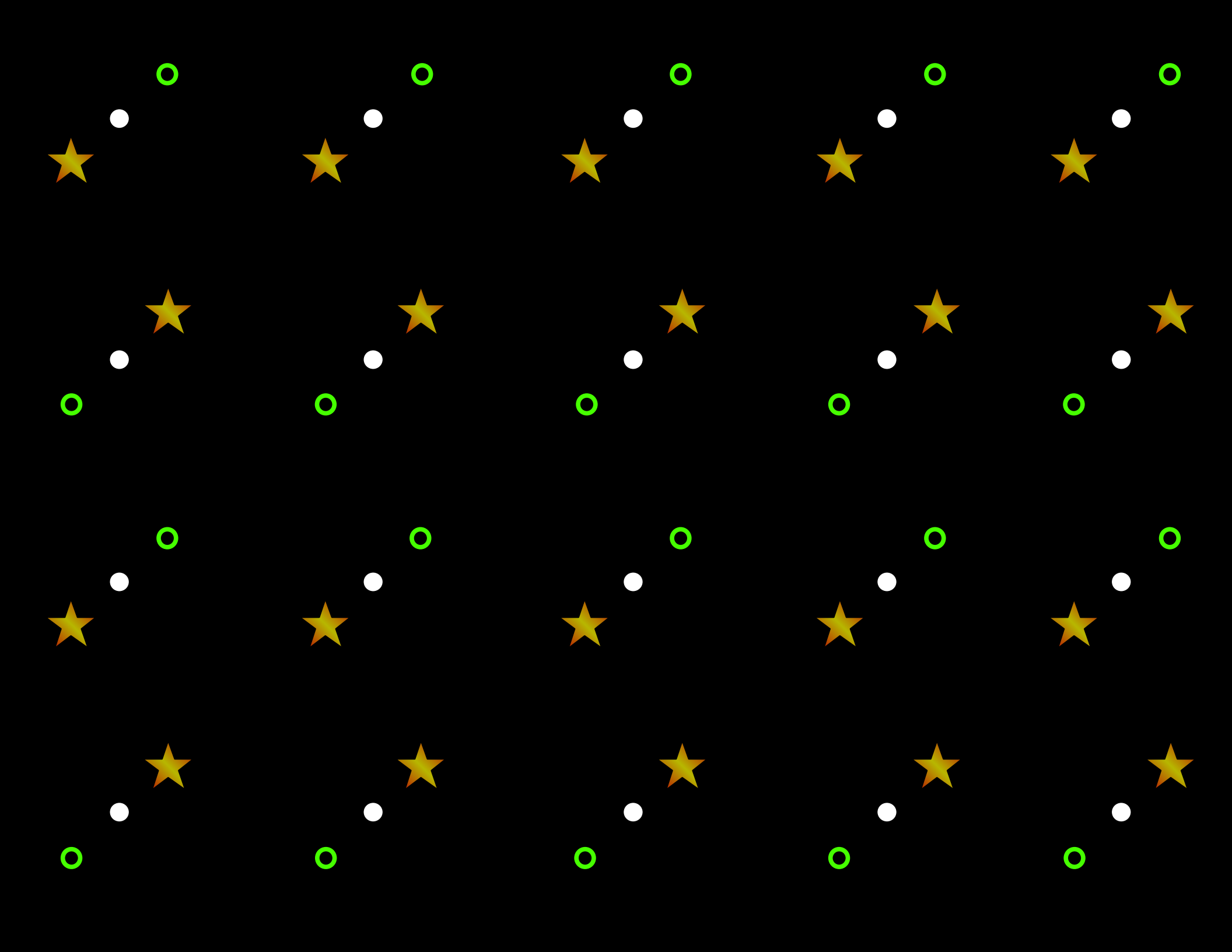






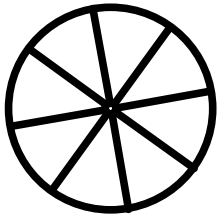




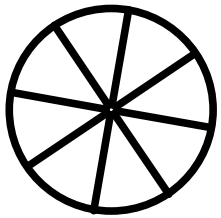


Why we see wheels rotate backwards in the movies

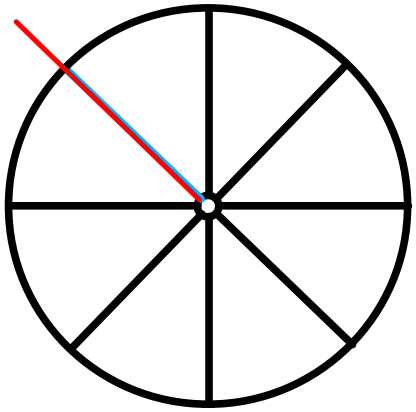
A wheel rotating slowly



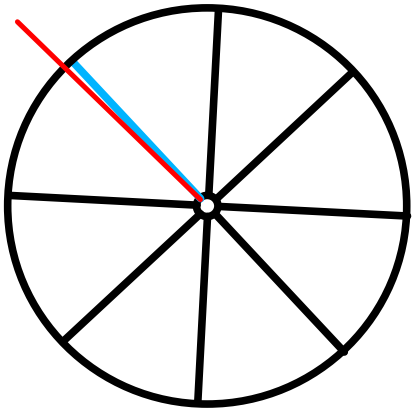
A wheel rotating rapidly



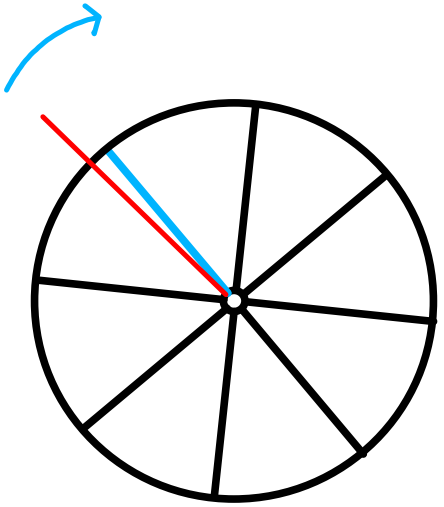
Slow rotation



Frame 1

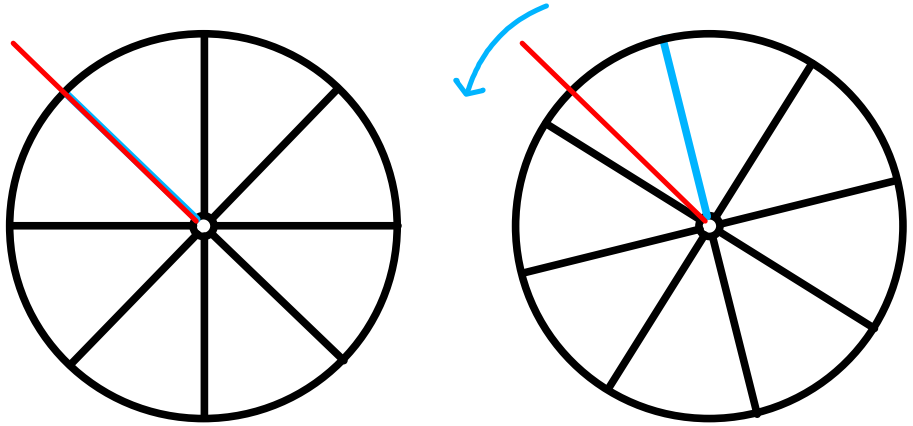


Frame 2



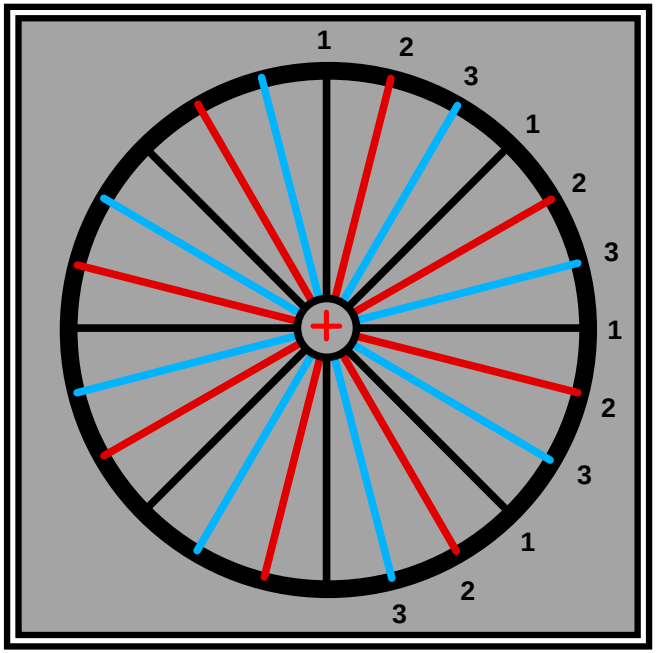
Frame 3

Rapid rotation



Frame 1 Frame 2

Interocular integration


1
2
3
1
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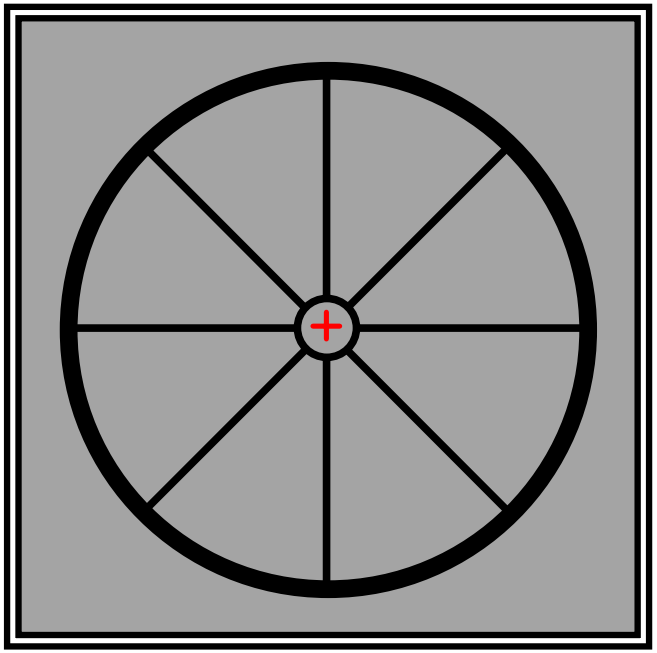
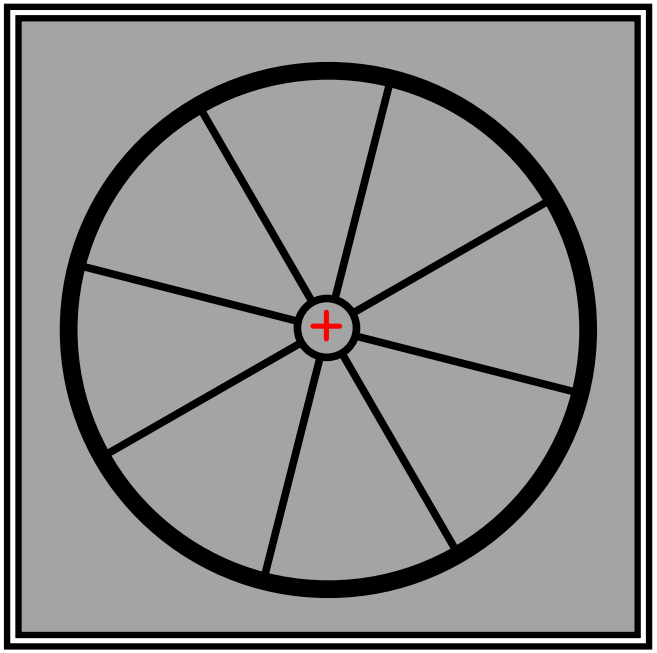
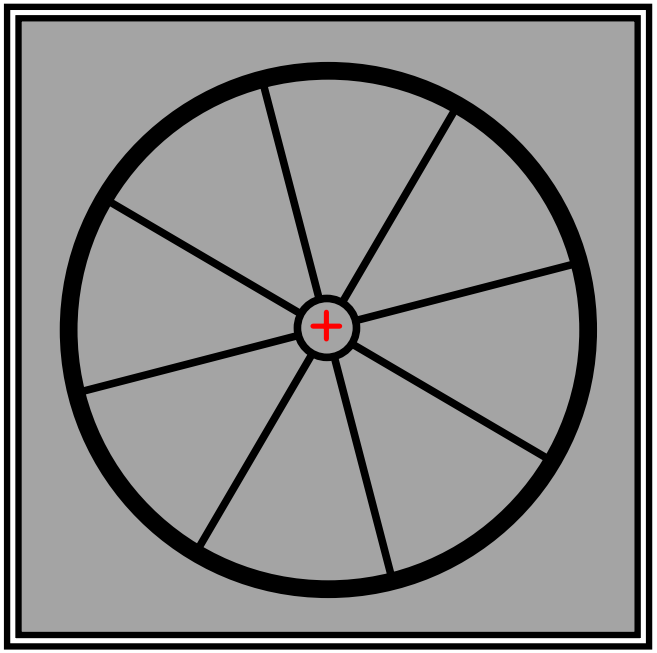
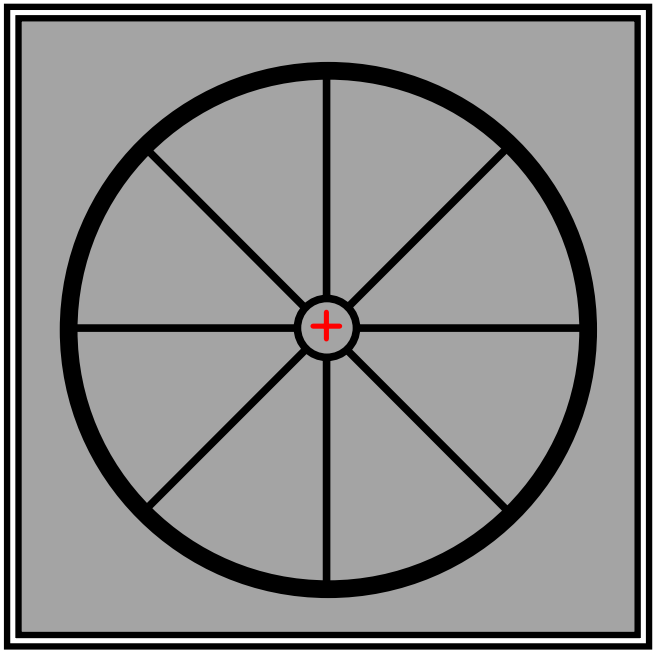
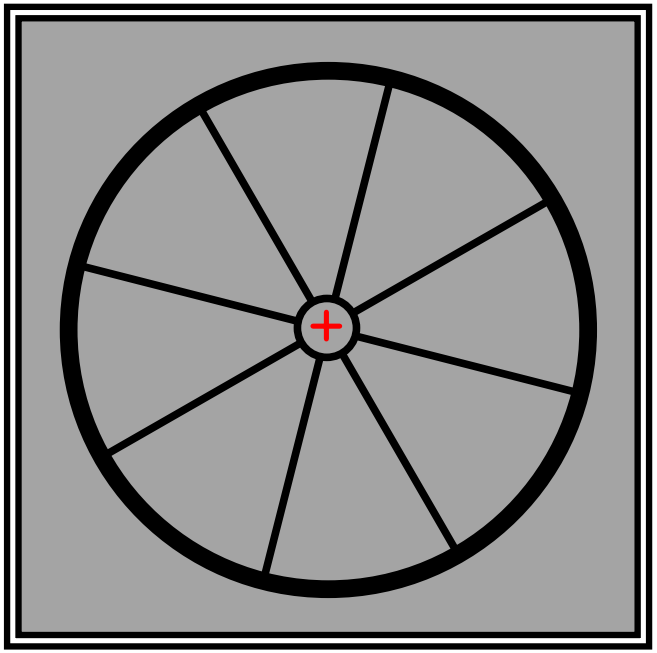
2
3

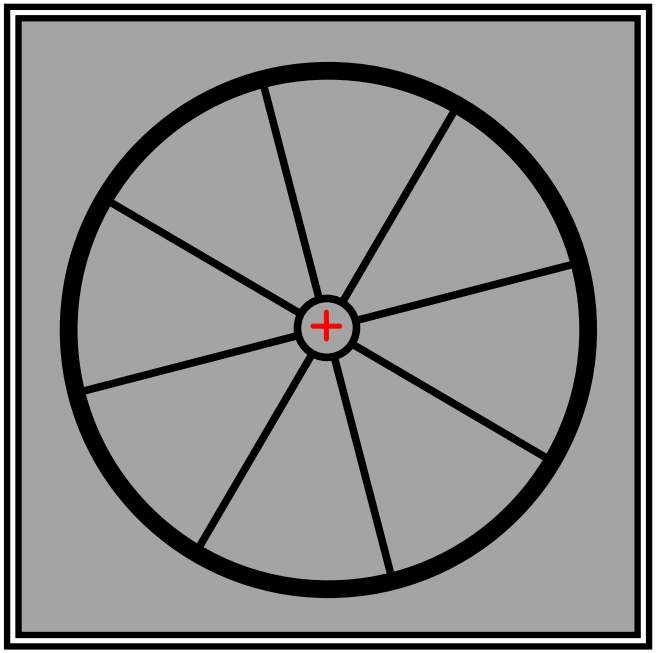


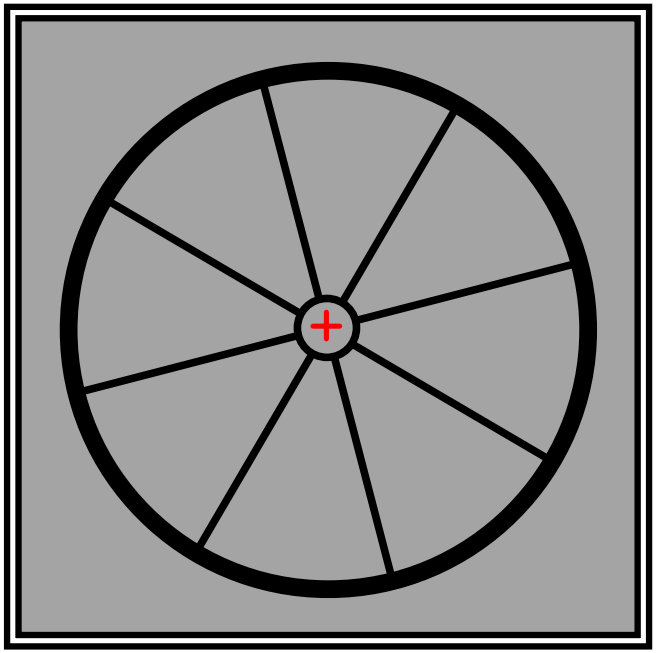


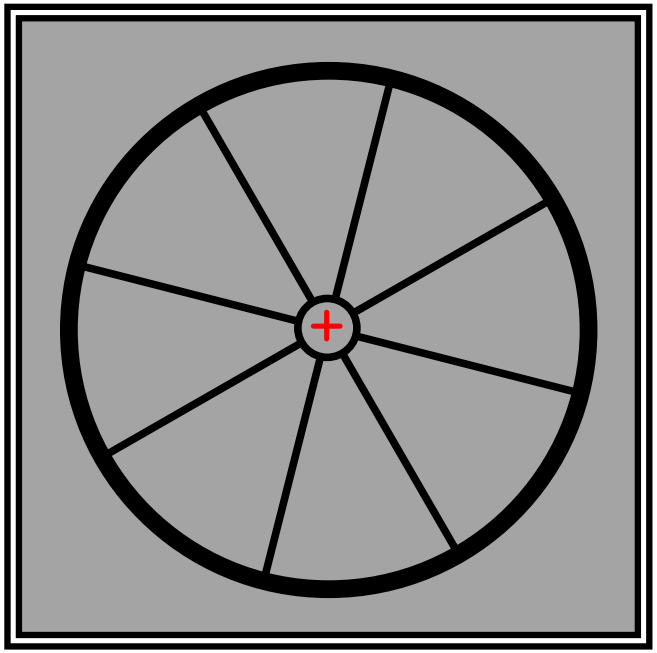






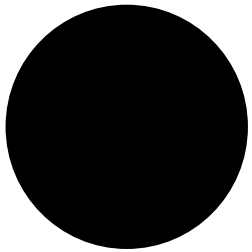


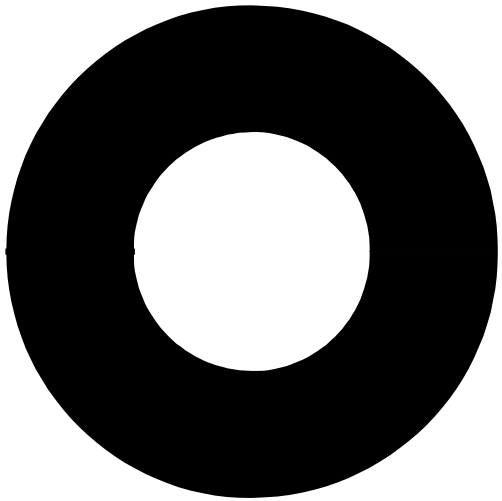




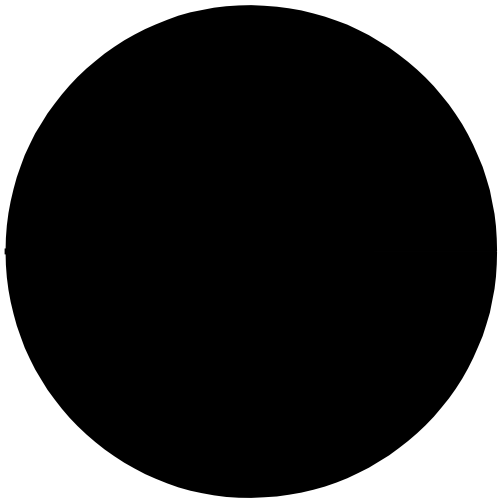
Metacontrast

Disk-ring sequence

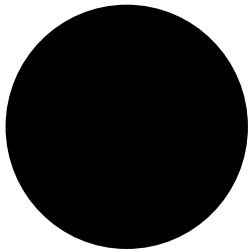


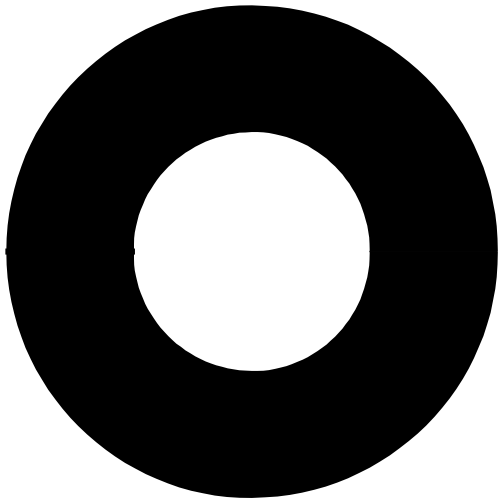


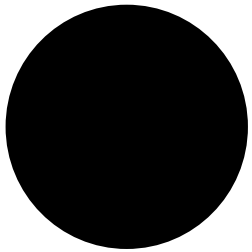
Simultaneous presentation

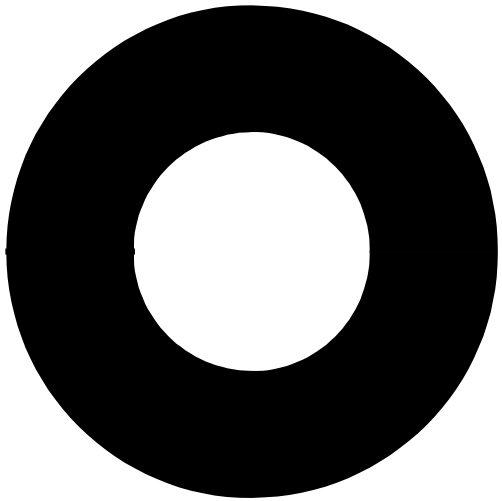


Sequential presentation

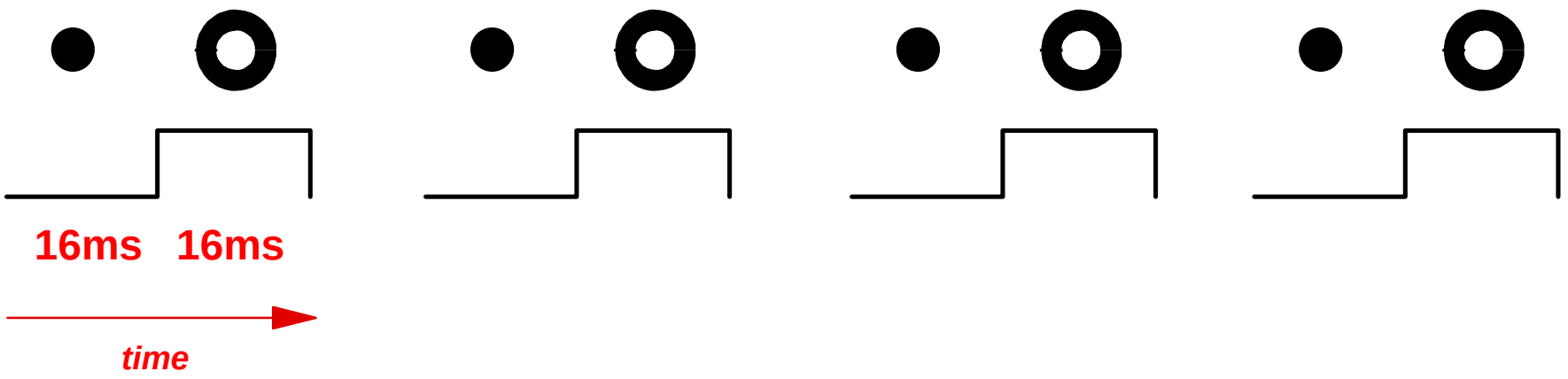






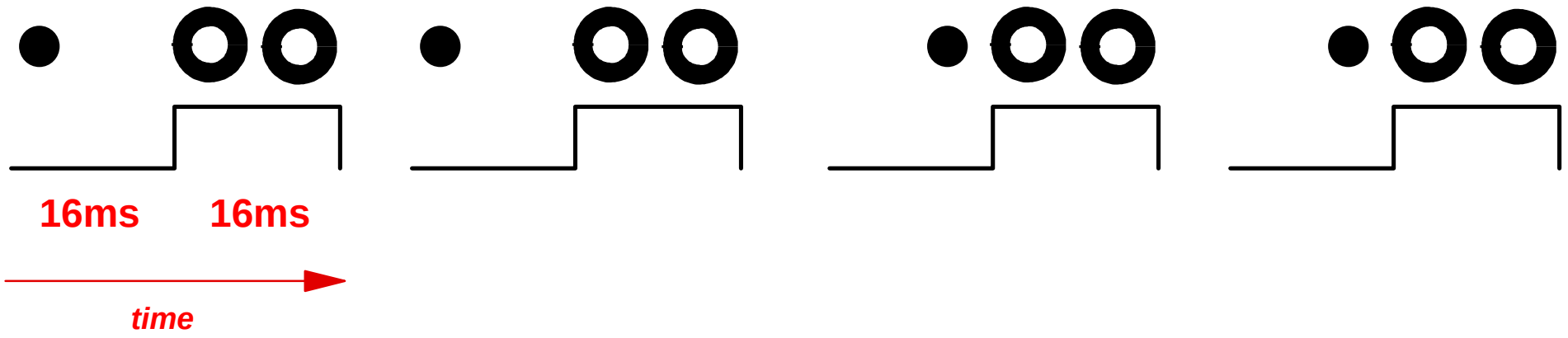


Four sequences with 16ms offsets between disk and ring



Disk and ring and disk alone side

by side shown four times



Fixate red cross

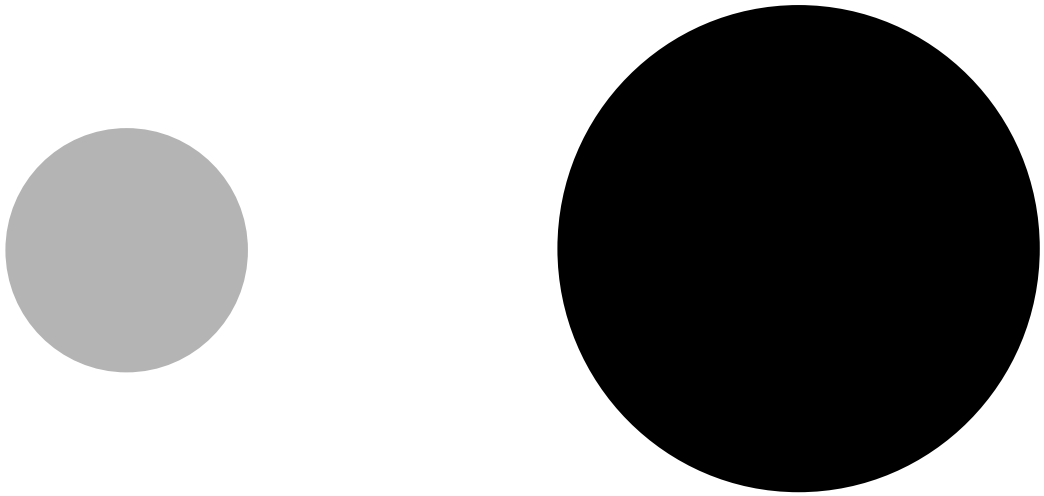
cycling disk and ring with
equal cycle times

cycle

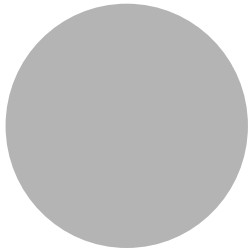
cycle

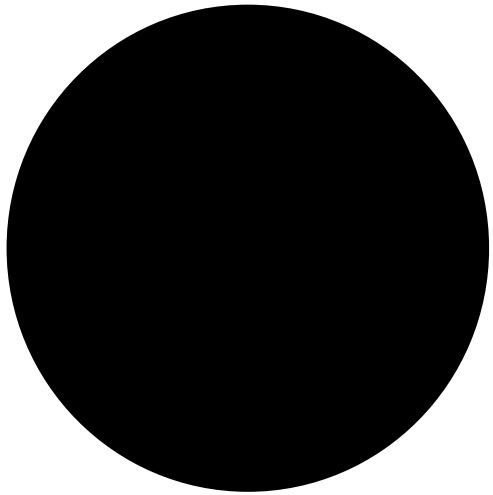
Brightness masking

Brightness masking



1 2





Long sequence

Short sequence

+

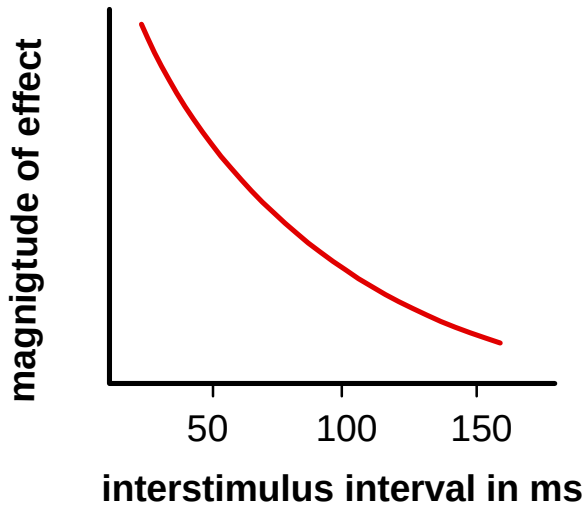
Two disks, one of which is preceded by the target

The target was always on the left

Brightness masking and metacontrast

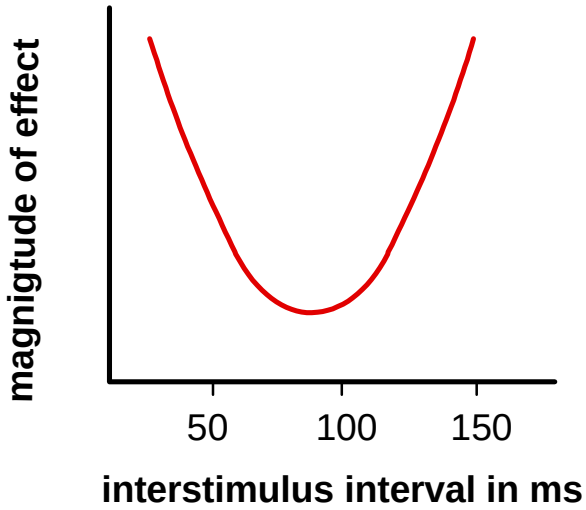
Brightness masking

1. Effect declines with increasing interstimulus interval
2. Does not occur interocularly
3. Mostly due to differential conduction velocity in retina

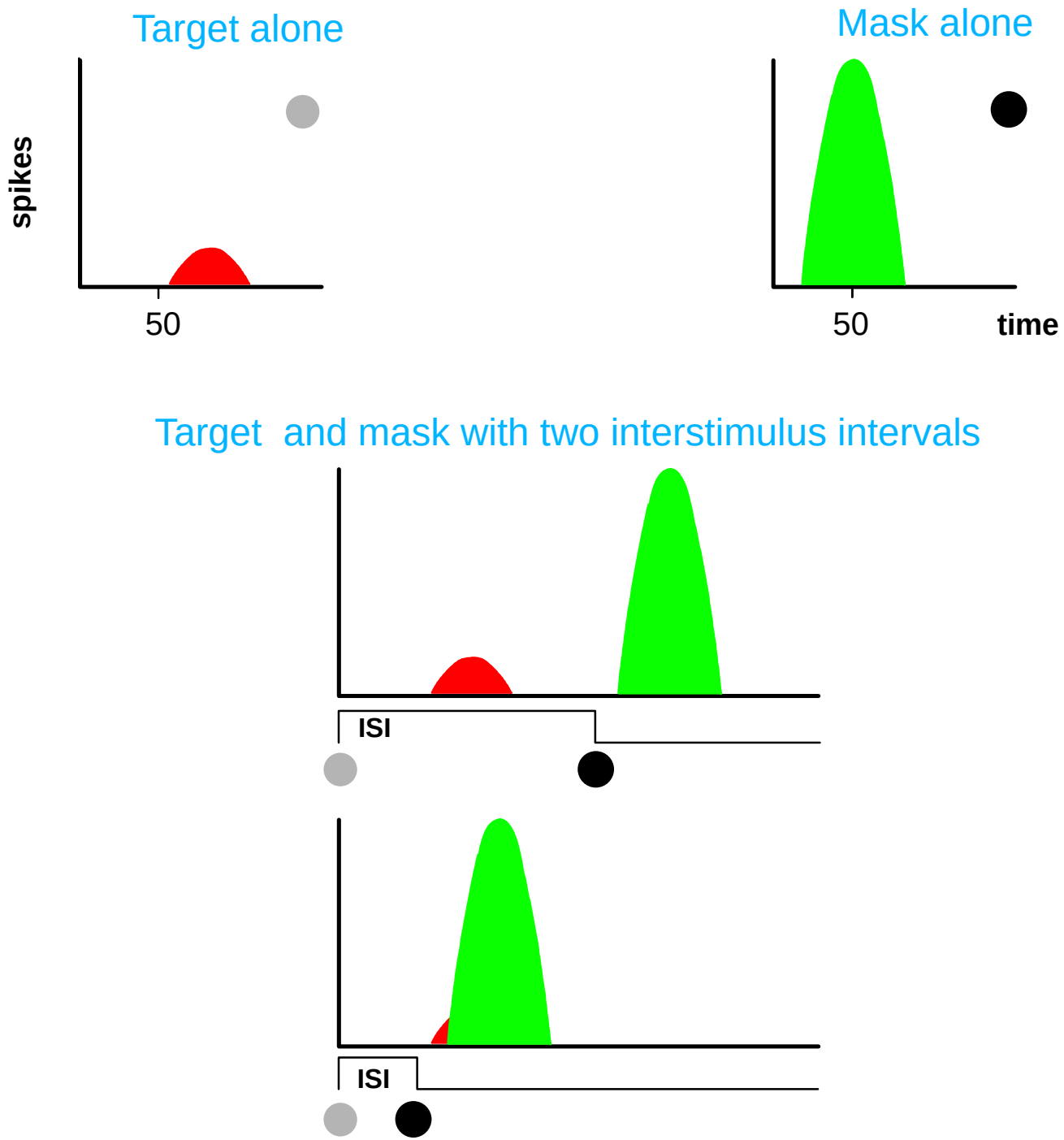


Metacontrast

1. U shaped function
2. Contiunes to occur interocularly
3. Physiology unclear but linked to motion perception

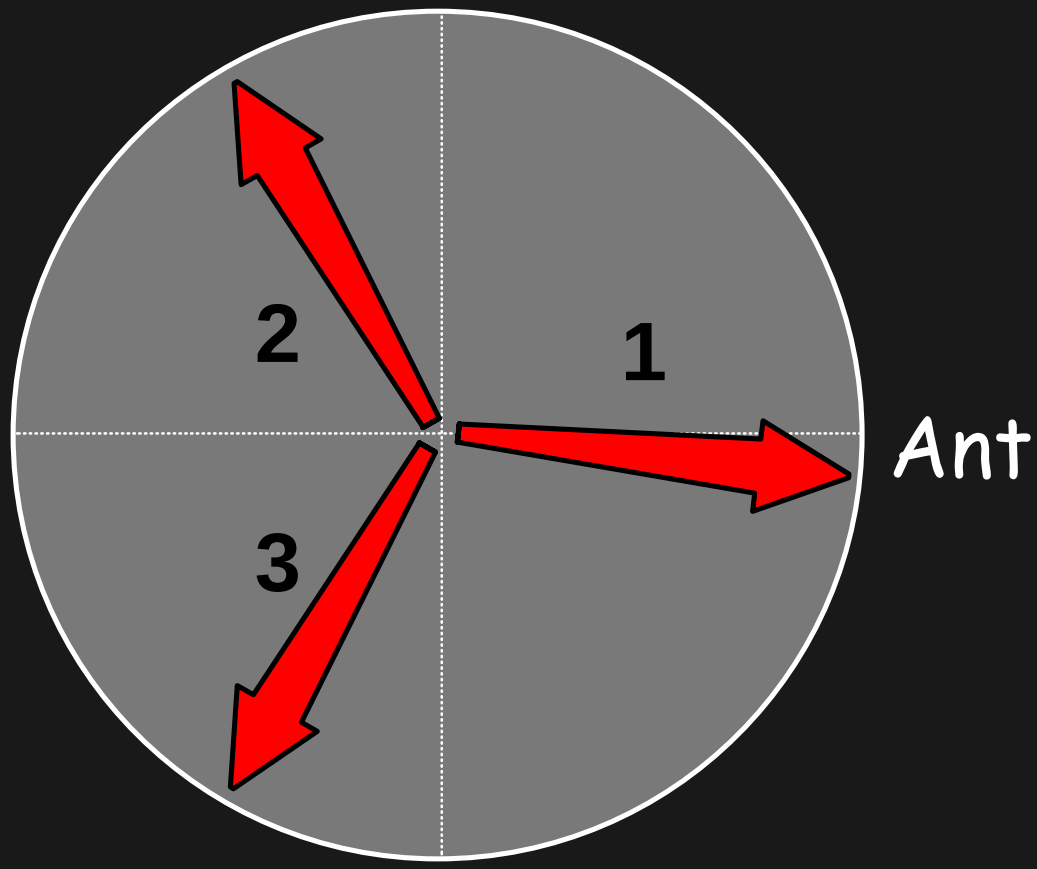


Schematized RGC cell response to brightness masking



Motion analysis in the accessory optic system

Prime axes of the retinal ganglion cells of Dogiel
that feed into the accessory optic system

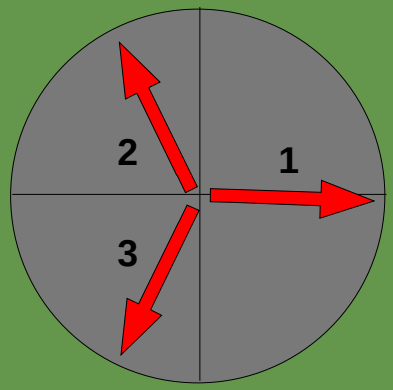


The axons of the cells of Dogiel
project to the terminal nuclei

Major Pathways of the Accessory Optic System (AOS)

Velocity response of AOS neurons = 0.1-1.0 degree/sec

Number of AOS RGCs in rabbit = 7K out of 350K



Prime axes of the cells of Dogiel

Cortex

Cerebellum

climbing fibers

NOT

Inferior Olive

D 1

M 2,3

L 2,3

Terminal Nuclei

rate code

BS

Semicircular canals

Vestibular Nucleus

vestibulo-ocular reflex

Summary:

1. Motion has been classified into several different types that includes planar, circular, radial as well as differential for parallax.
2. The majority of V1 cells and most MT cells are directional and velocity selective. Some V1 cells respond to different directions of movement for light and dark edges. Some cells are sensitive to differential velocities of movement.
3. The AOS, that begins with RGCs that form three axes of direction selectivity that correspond to the three axes of the semicircular canals, is involved in generating pursuit eye movements for image stabililization.
4. One of the most important tasks of motion analysis is motion parallax as it serves to provide vital information about depth.
5. Motion cues can provide important information for object recognition often referred to as "structure from motion."
6. Stationary stimuli that flicker with various temporal asynchronies induce apparent motion.
7. Metacontrast masking occurs when stimuli with shared contours appear in succession. The masking occurs centrally as it is not eliminated by intraocular presentation.
8. Brightness masking that arises with overlapping stimuli appearing in rapid succession does not occur with intraocular presentation and arises in the retina due to differential conduction velocities for low and high contrast stimuli.

Optokinetic nystagmus

Optokinetic nystagmus