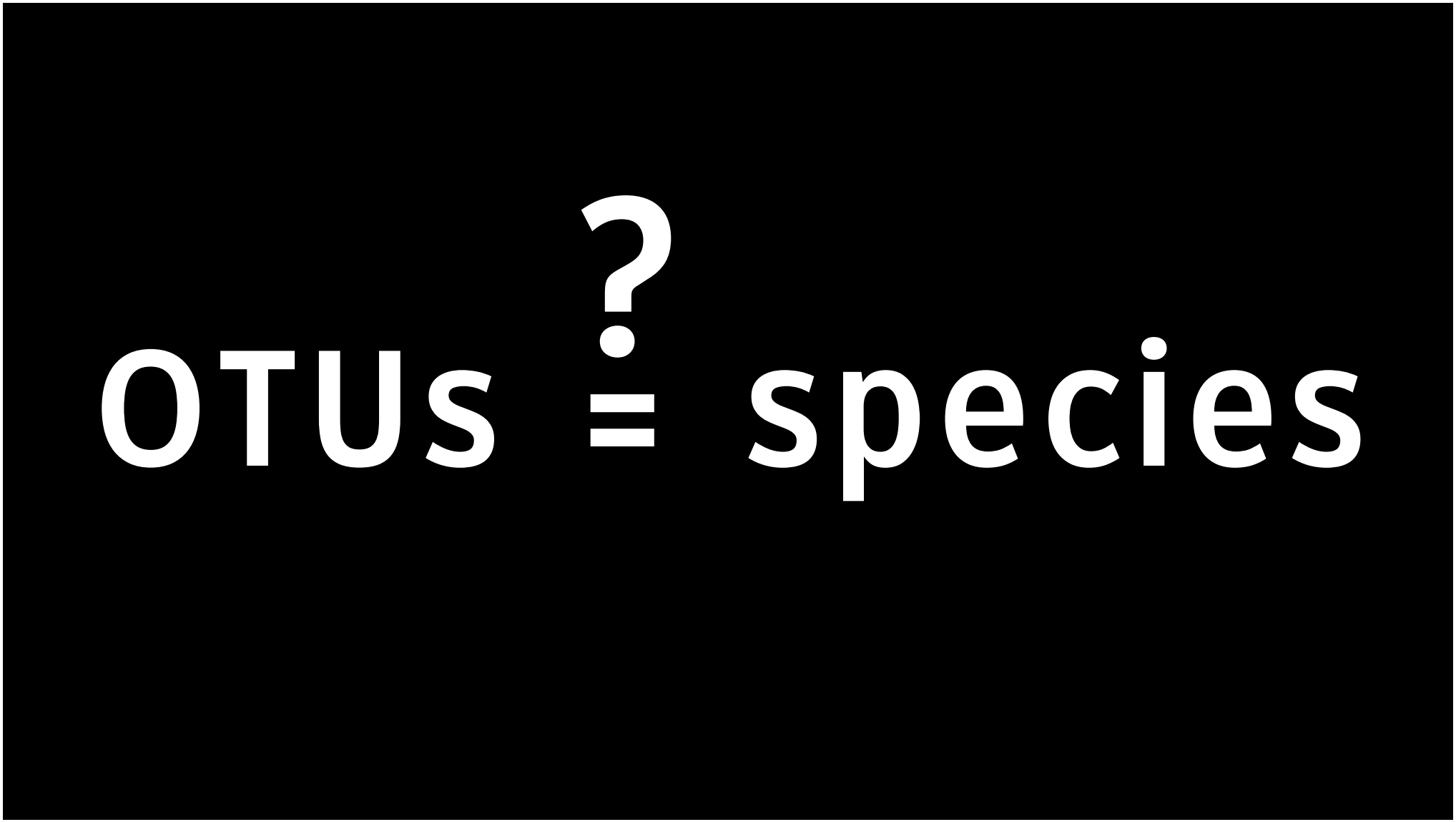
Equating OTUs With Species

Micah Dunthorn

OTUs

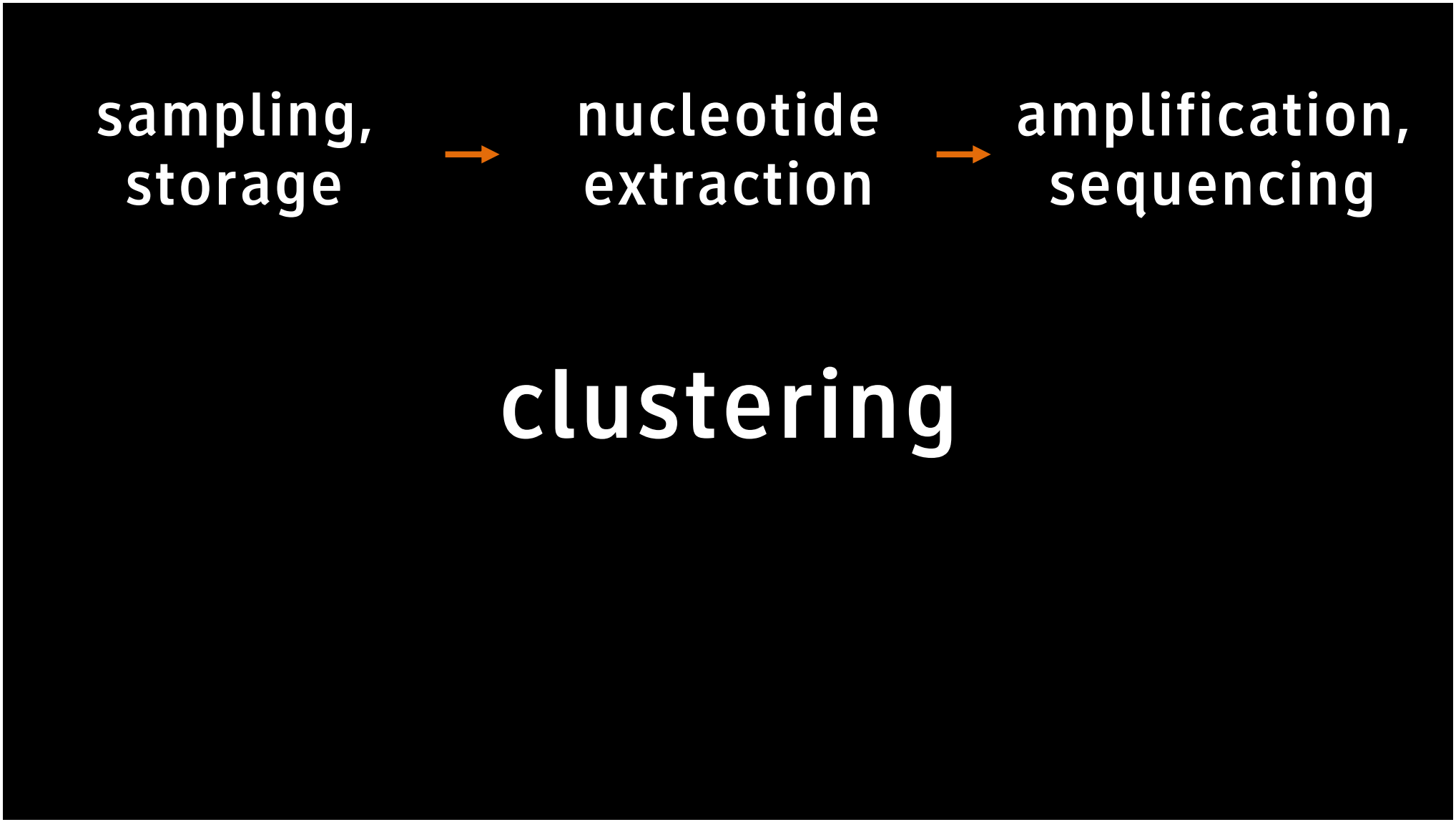

OTUs ≟ species

clustering as a step

clustering

= grouping of similar sequences

clustering


sampling, storage
nucleotide extraction
amplification, sequencing
clustering

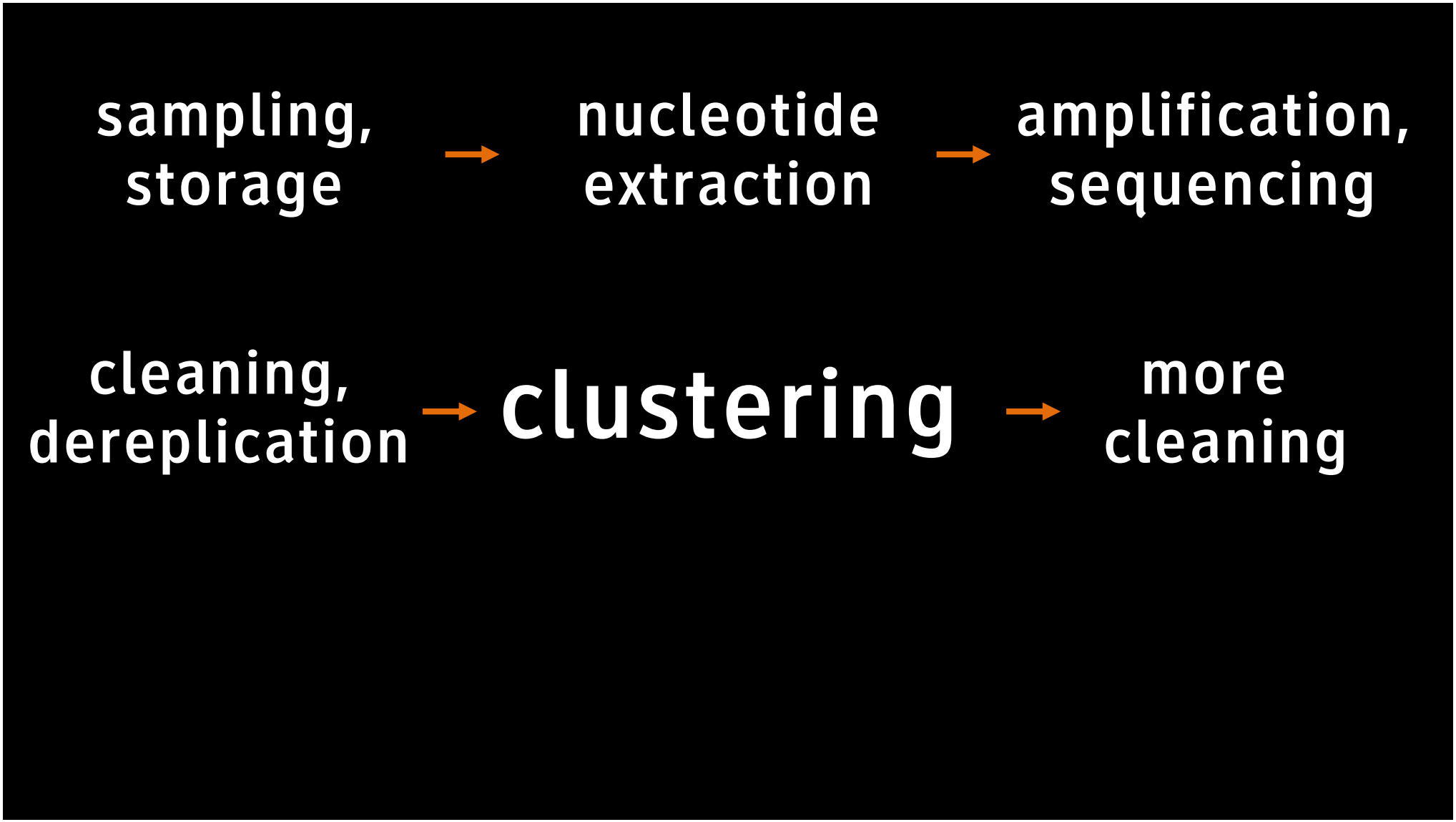
environmental microbiology

Environmental Microbiology (2010) **12**(7), 1806–1810 doi:10.1111/j.1462-2920.2010.02201.x

Opinion

Replicate or lie

James I. Prosser*
Institute of Biological and Environmental Sciences, University of Aberdeen, Cruickshank Building, St. Machar Drive, Aberdeen, AB24 3UU, UK.


sampling, storage
nucleotide extraction
amplification, sequencing
cleaning, dereplication
clustering
more cleaning

nature COMMUNICATIONS

2017 8:1188

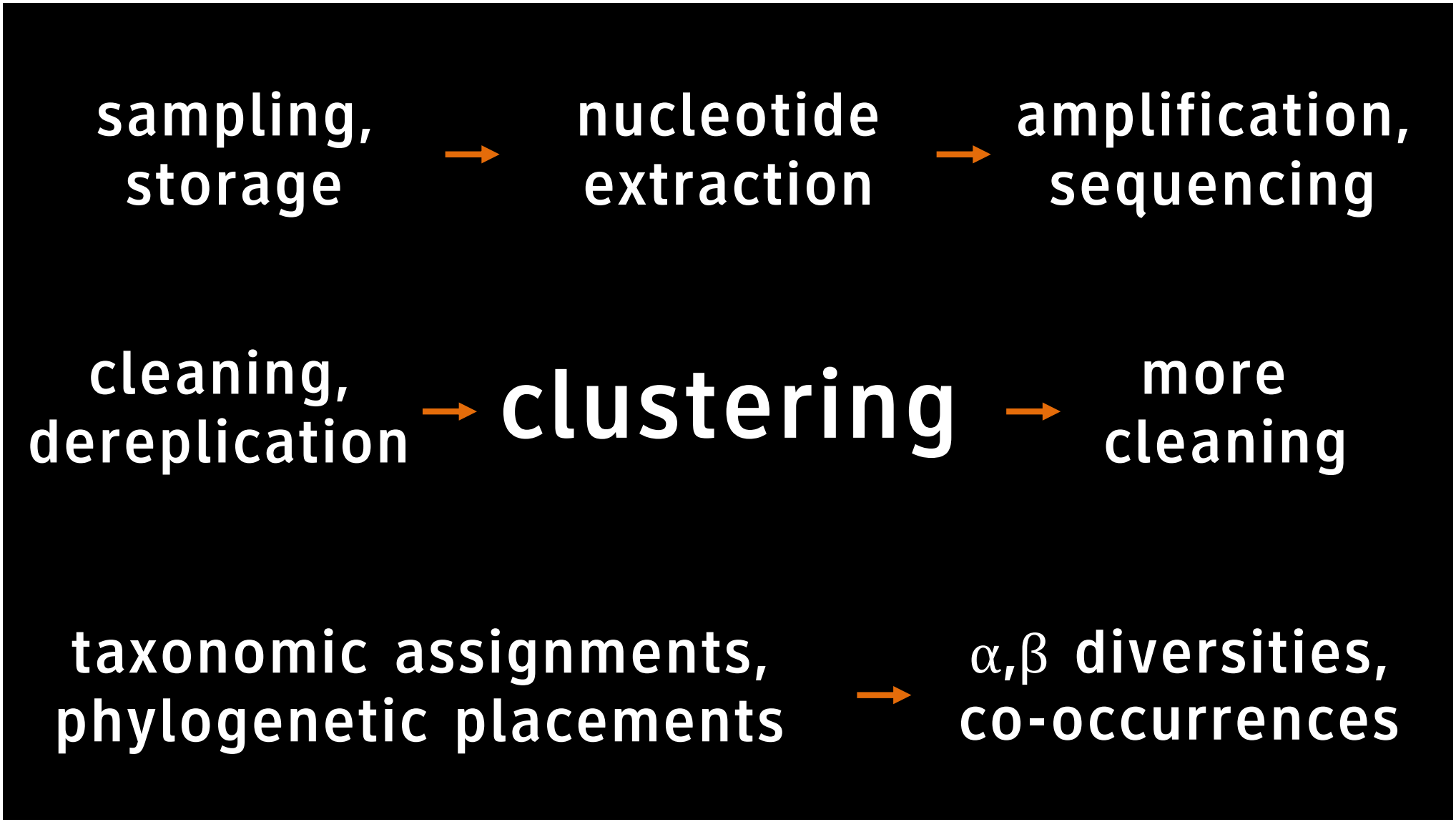
ARTICLE

DOI: 10.1038/s41467-017-01312-x OPEN

program: LULU

Algorithm for post-clustering curation of DNA amplicon data yields reliable biodiversity estimates

Tobias Guldberg Frøslev[1,2], Rasmus Kjøller[1], Hans Henrik Bruun[1], Rasmus Ejrnæs[3], Ane Kirstine Brunbjerg[3], Carlotta Pietroni[2] & Anders Johannes Hansen[2]


sampling, storage
nucleotide extraction
amplification, sequencing
cleaning, dereplication
clustering
more cleaning
taxonomic assignments, phylogenetic placements
α,β diversities, co-occurrences

what is a species

1997 in "Species: The units of biodiversity"

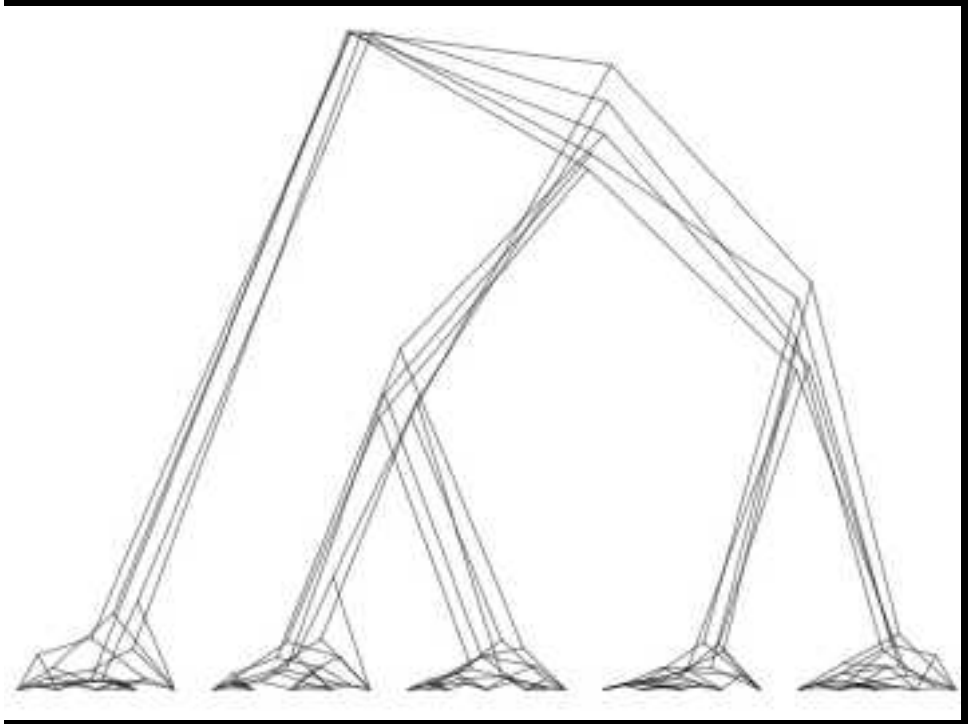
A hierarchy of species concepts: the denouement in the saga of the species problem

R. L. Mayden

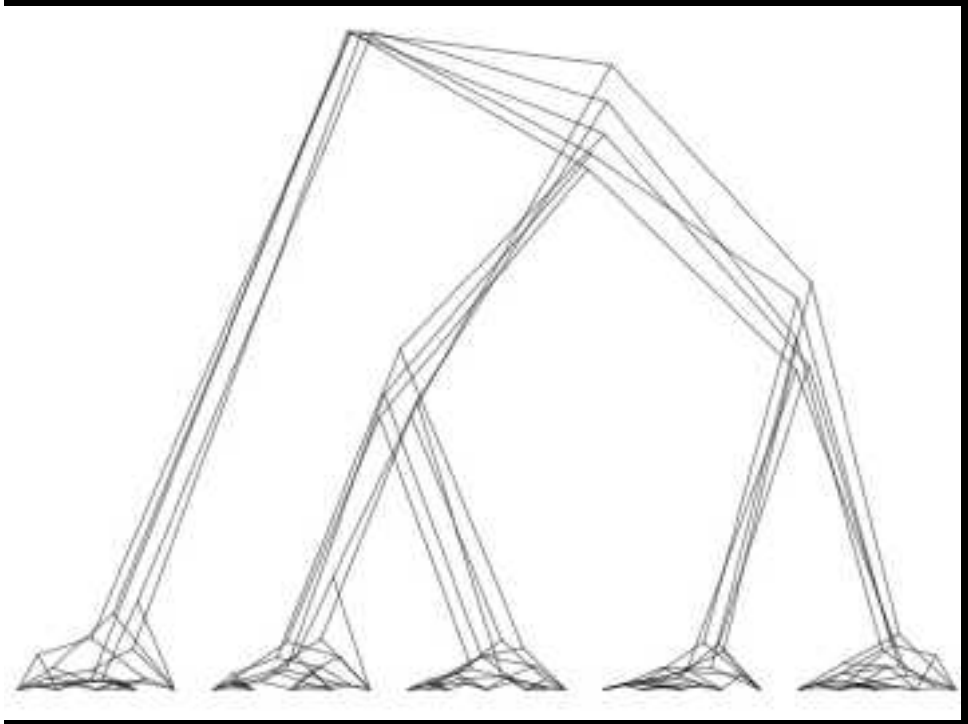
Contacting address: Department of Biological Sciences, P.O. Box 0344, University of Alabama, Tuscaloosa, AL 35487, USA

eukaryote
vs.
bacteria and archaea

sexual
vs.
asexual

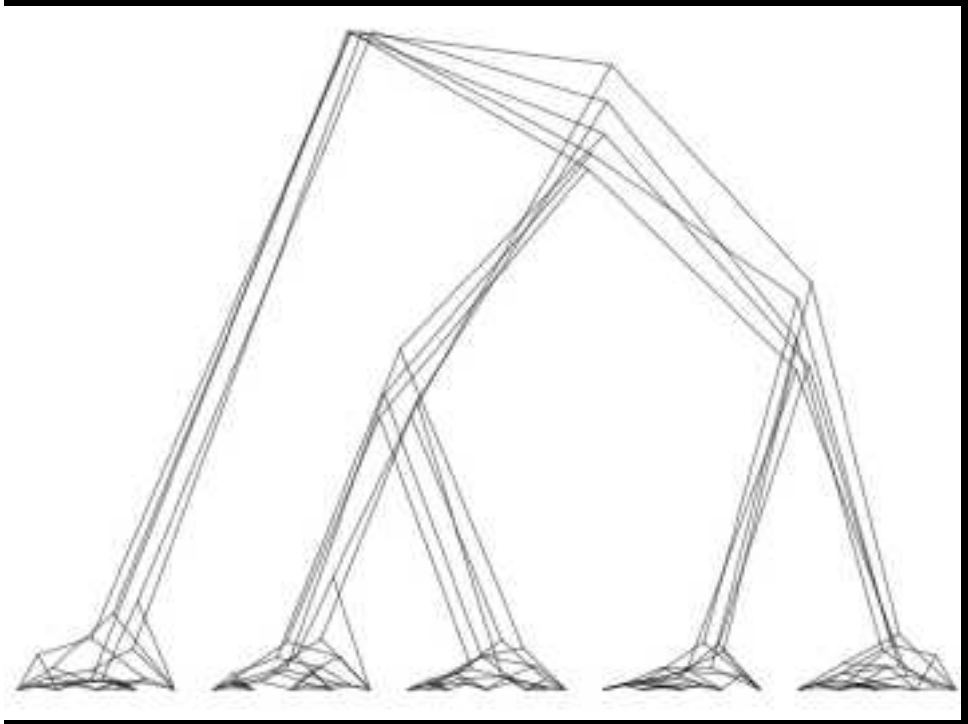


Barraclough (2019) The Evolutionary Biology of Species



macro-evolutionary processes of phylogeny

Barraclough (2019) The Evolutionary Biology of Species



macro-evolutionary processes of phylogeny

micro-evolutionary processes of population genetics

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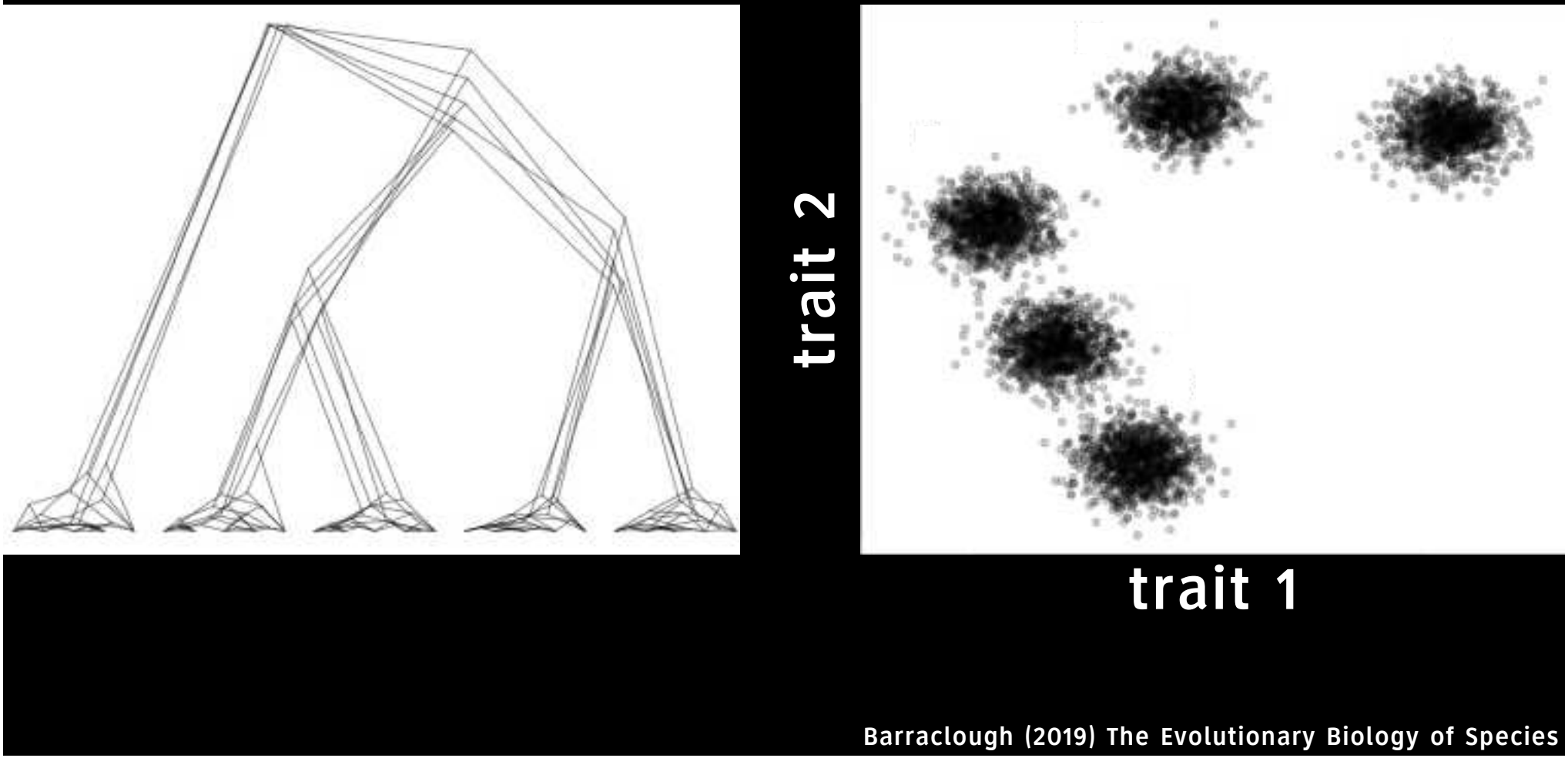


Barraclough (2019) The Evolutionary Biology of Species

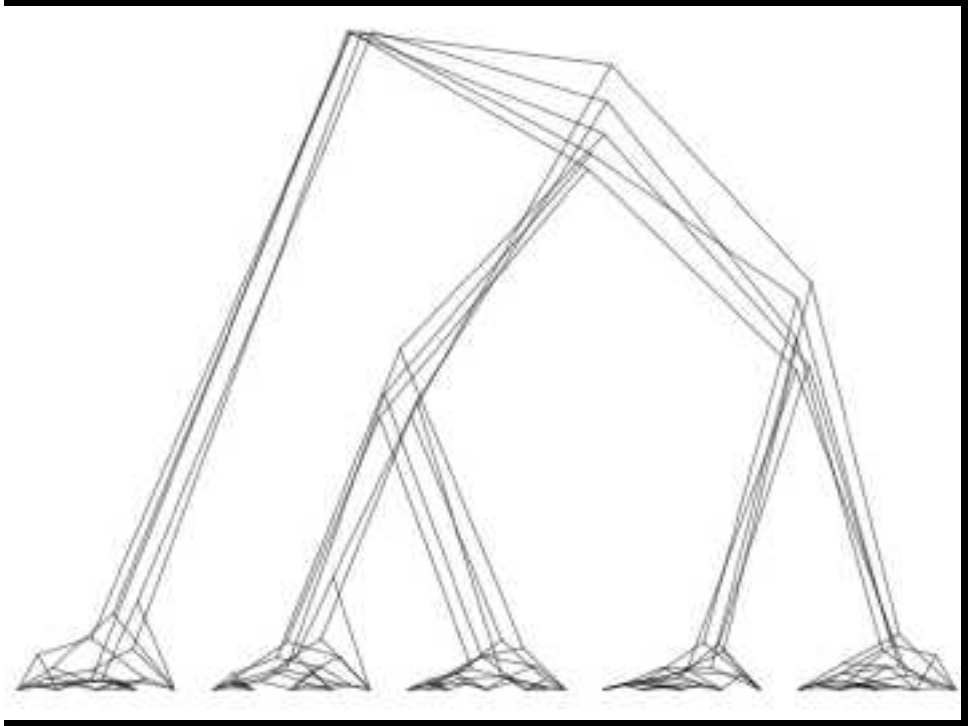
biological species

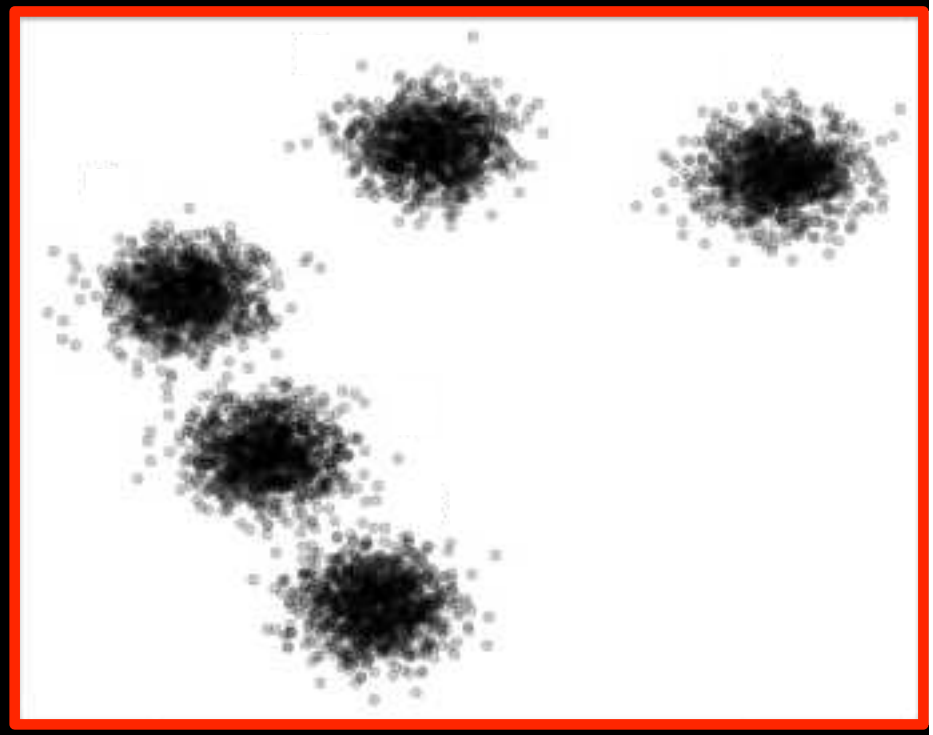
= actually or potentially inter-breeding natural populations, which are reproductively isolated

- Mayr 1942

ciliate sex

Symbiodinium





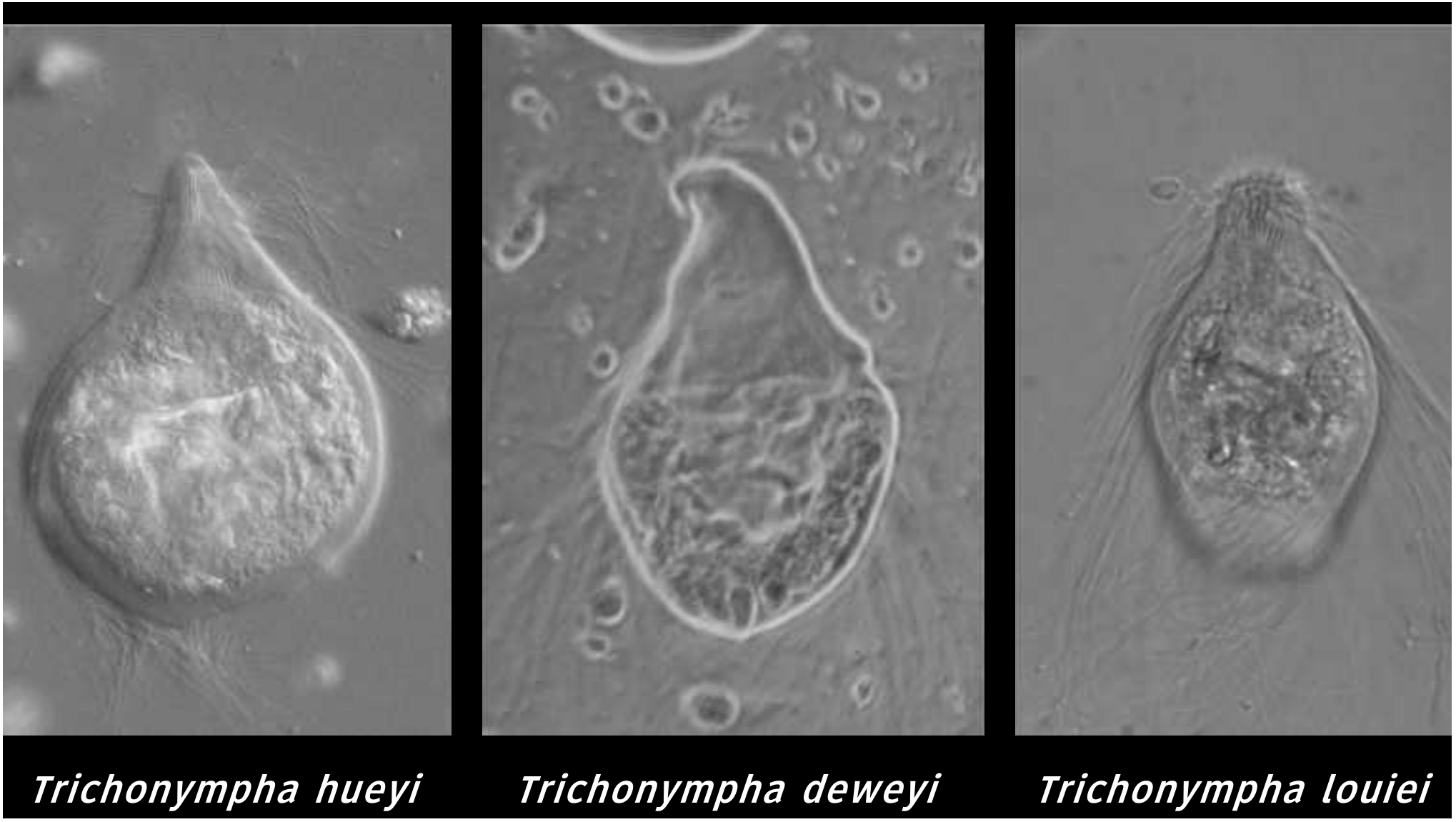
Barraclough (2019) The Evolutionary Biology of Species

morphological species

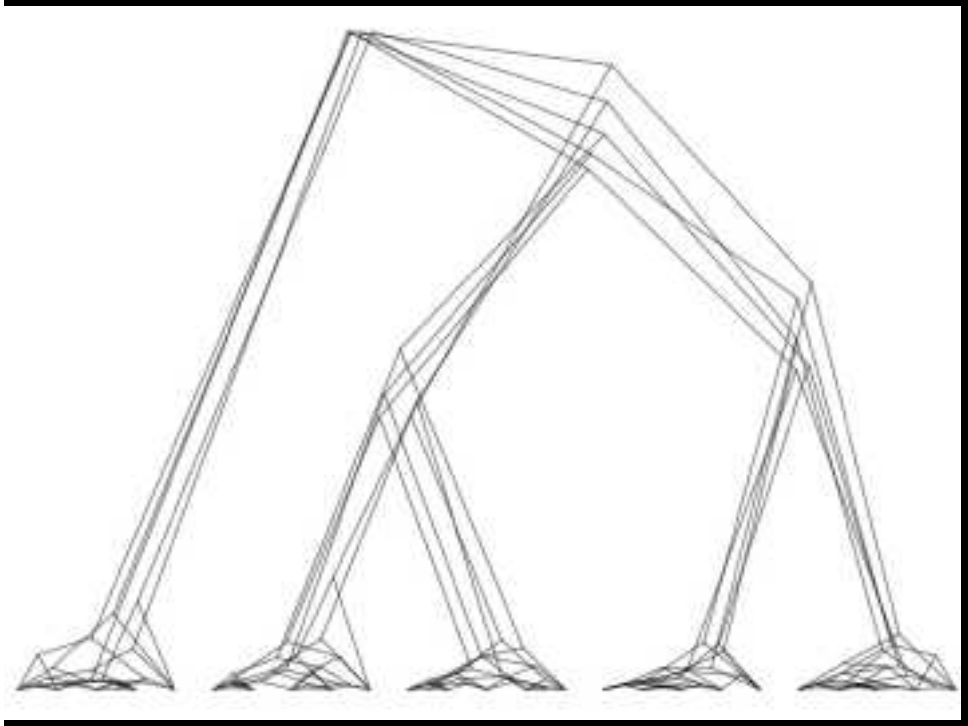
= the smallest groups that are consistently and persistently distinct

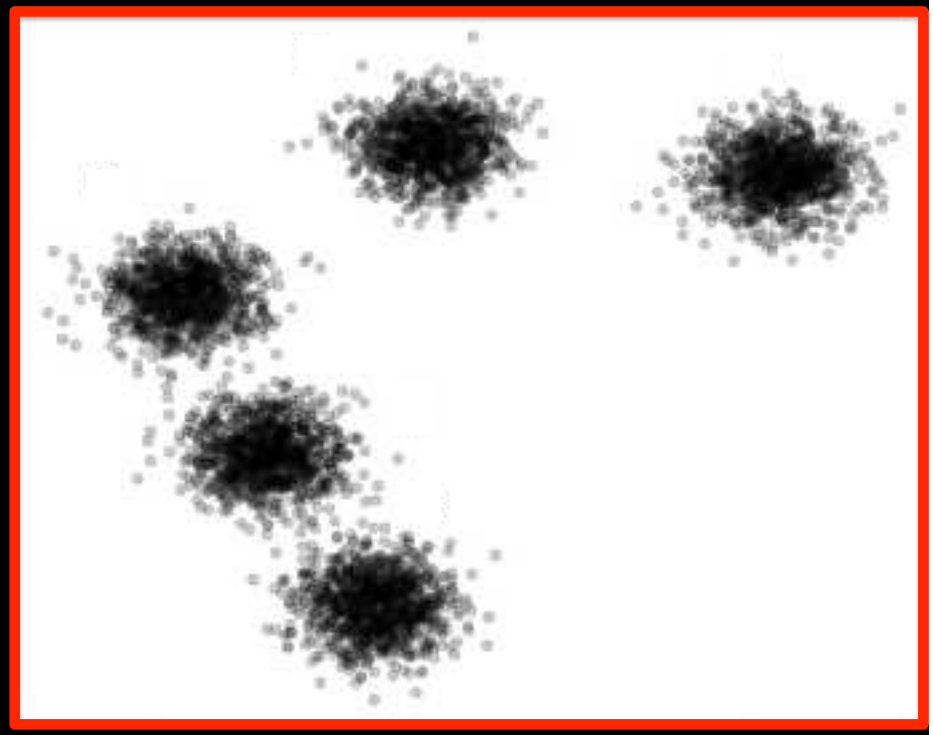
- Cronquist 1978

ciliates



Trichonympha hueyi *Trichonympha deweyi* *Trichonympha louiei*



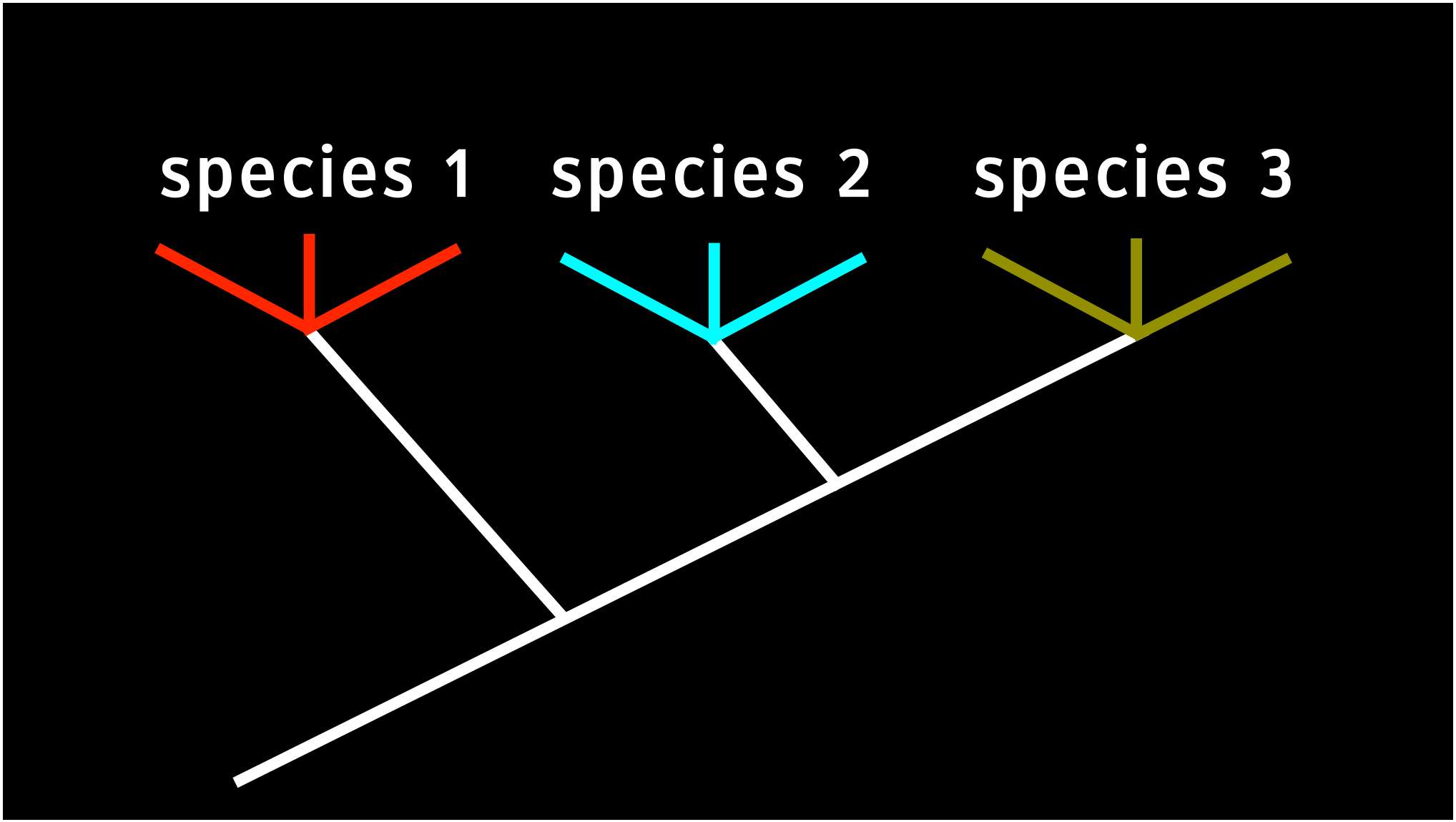


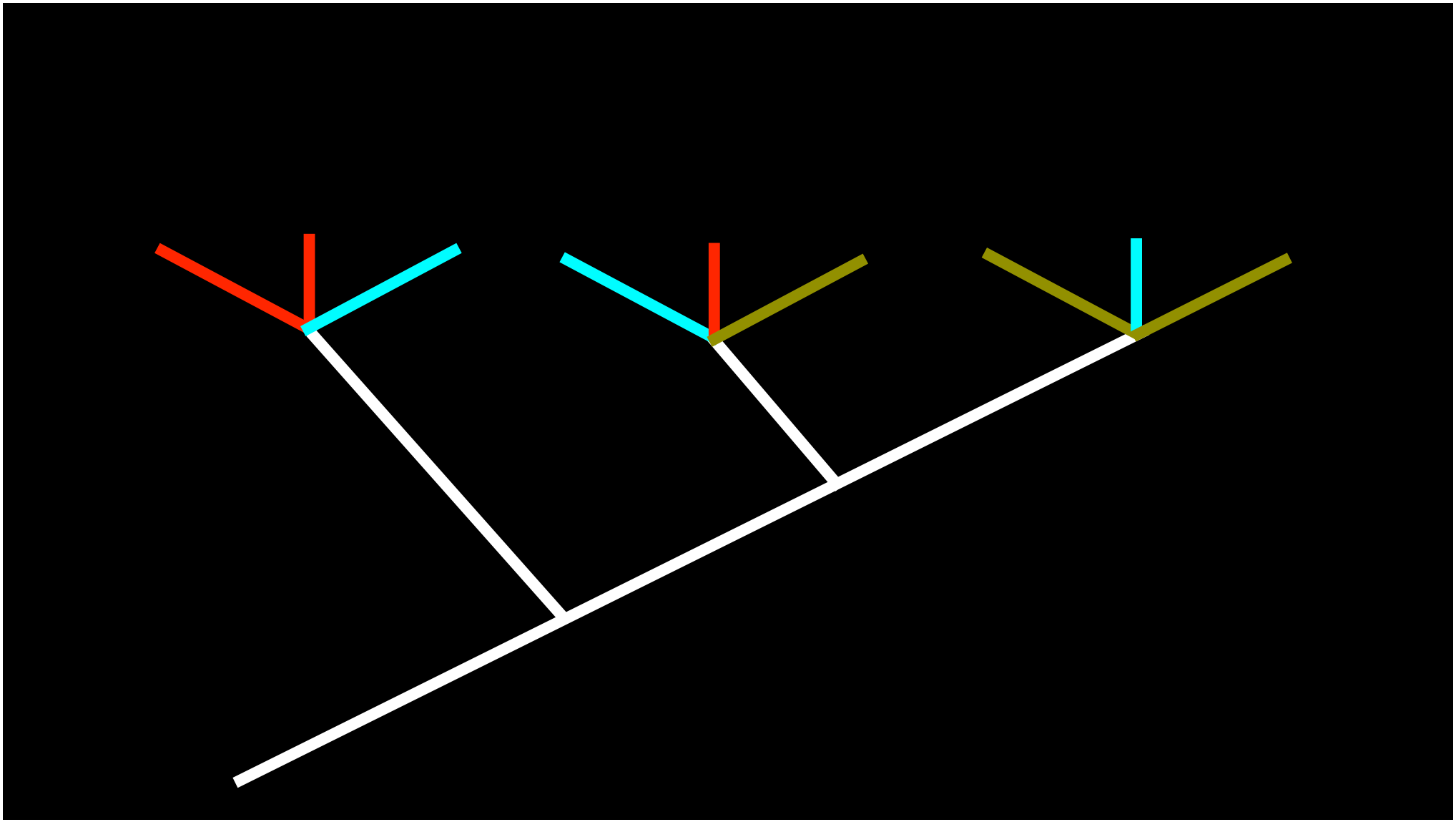
Barraclough (2019) The Evolutionary Biology of Species

phylogenetic species

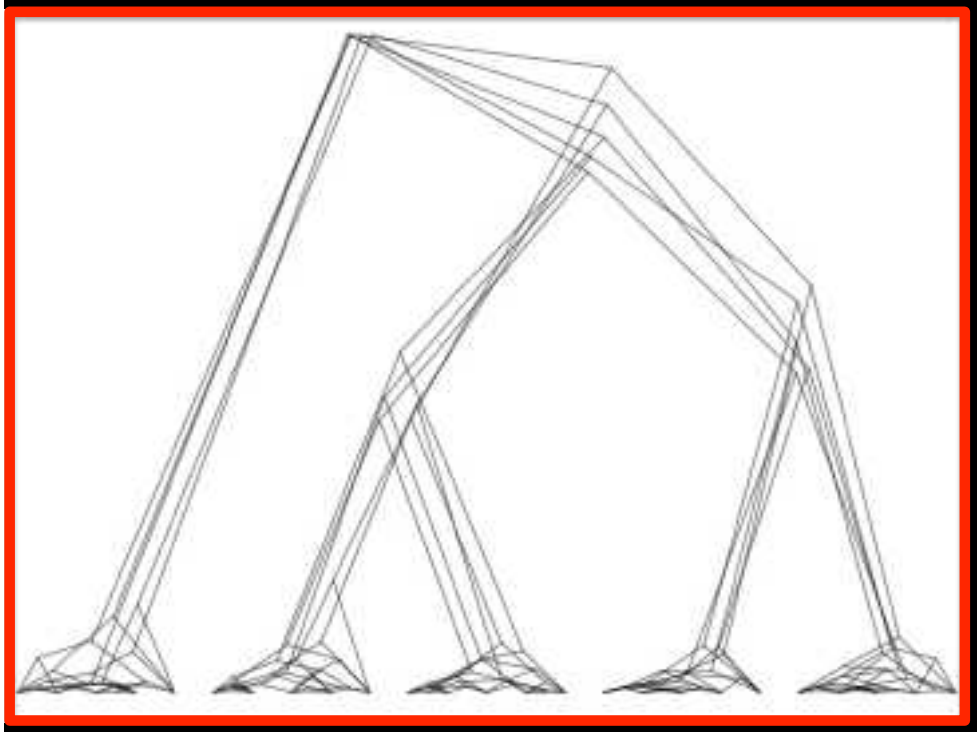
= the smallest biological entities that are diagnosable and/or monophyletic

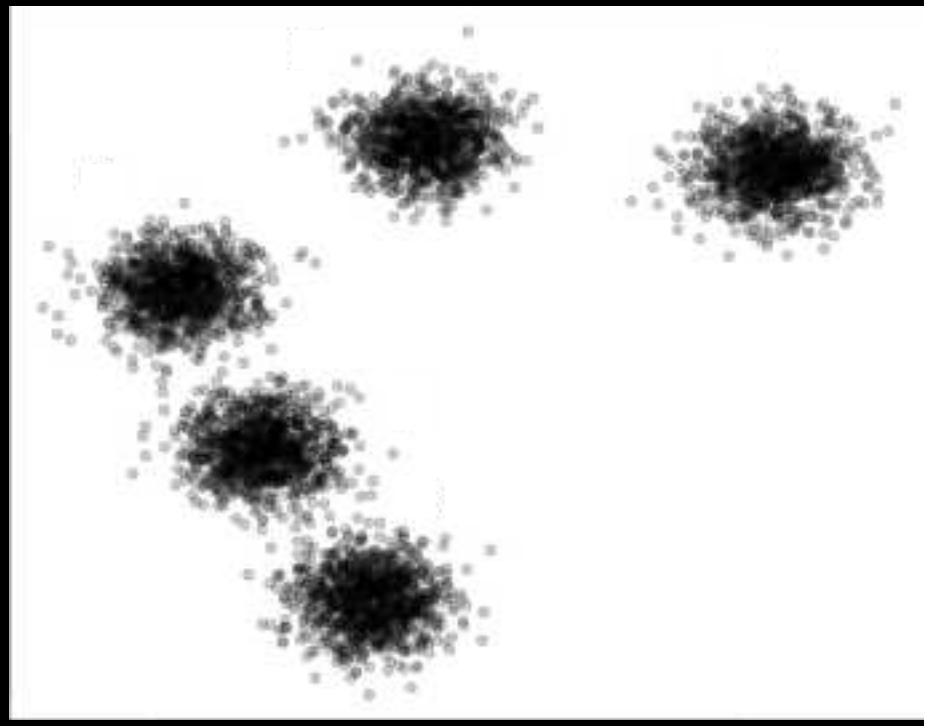
- Mayden 1997


species 1
species 2
species 3



Paramecium





Barraclough (2019) The Evolutionary Biology of Species

Syst. Biol. 56(6):879–886, 2007
Copyright © Society of Systematic Biologists
ISSN: 1063-5157 print / 1076-836X online
DOI: 10.1080/10635150701701083

Species Concepts and Species Delimitation

KEVIN DE QUEIROZ

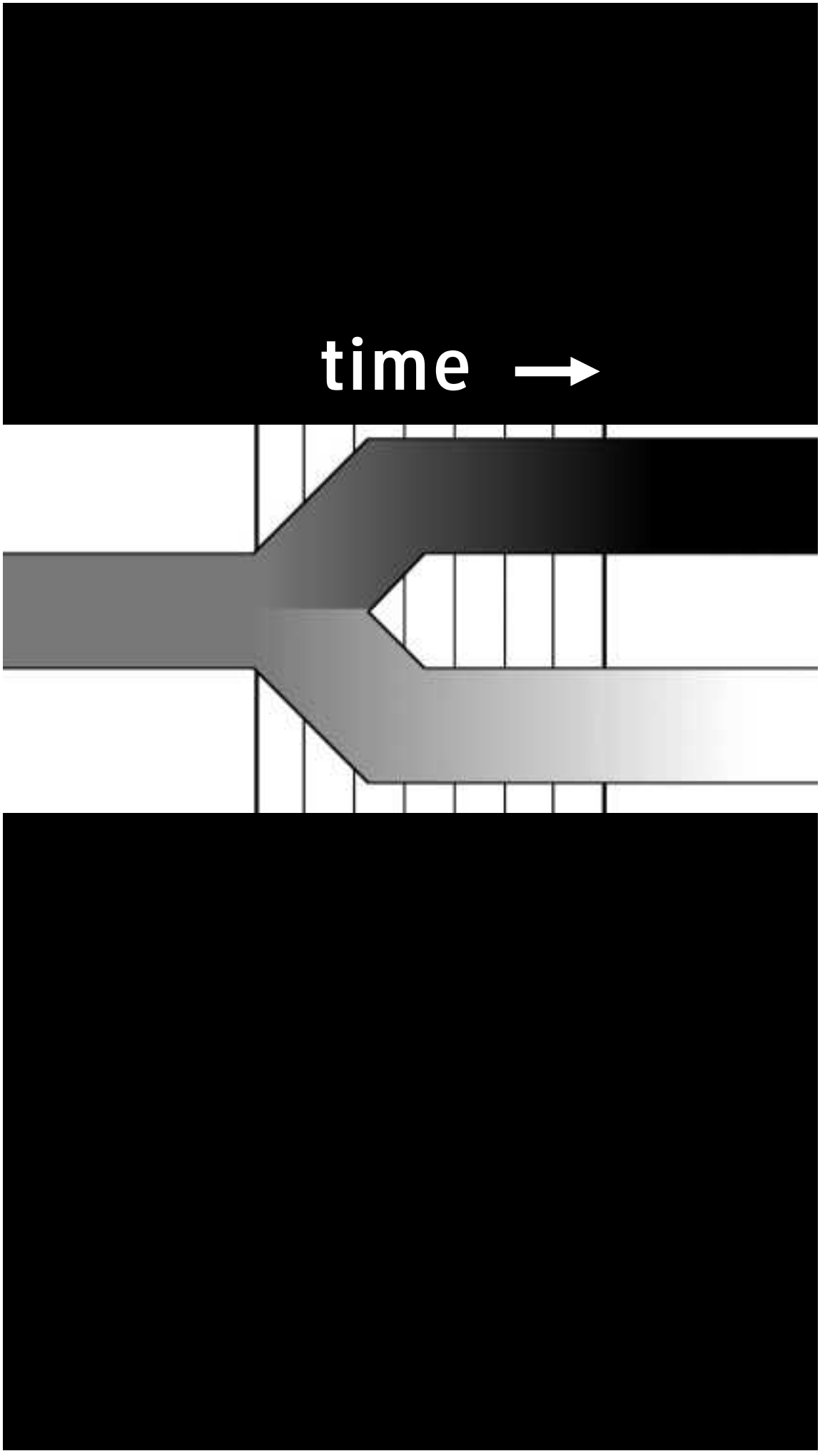
Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20560-0162, USA; E-mail: dequeirozk@si.edu

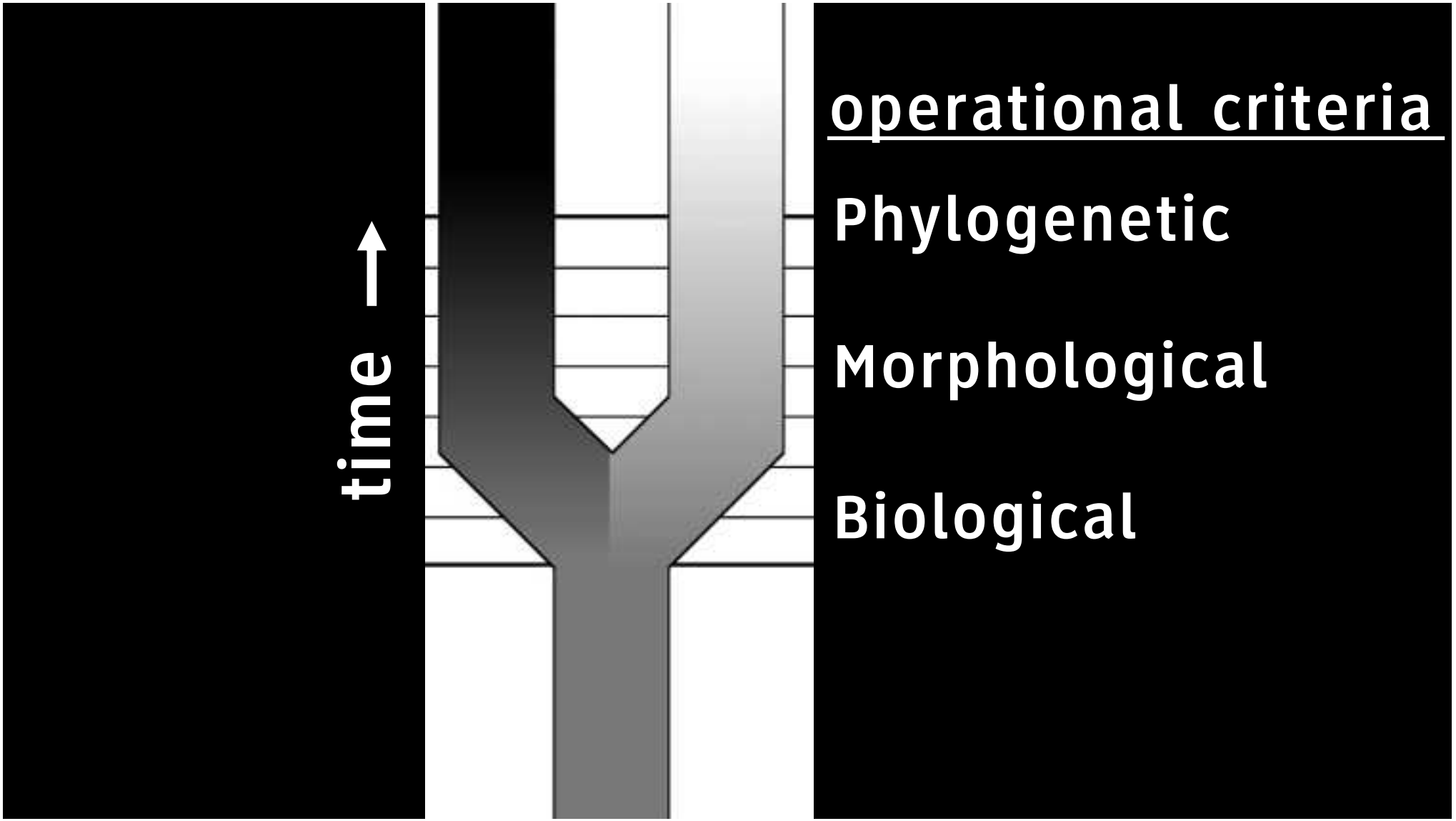
concept of a species

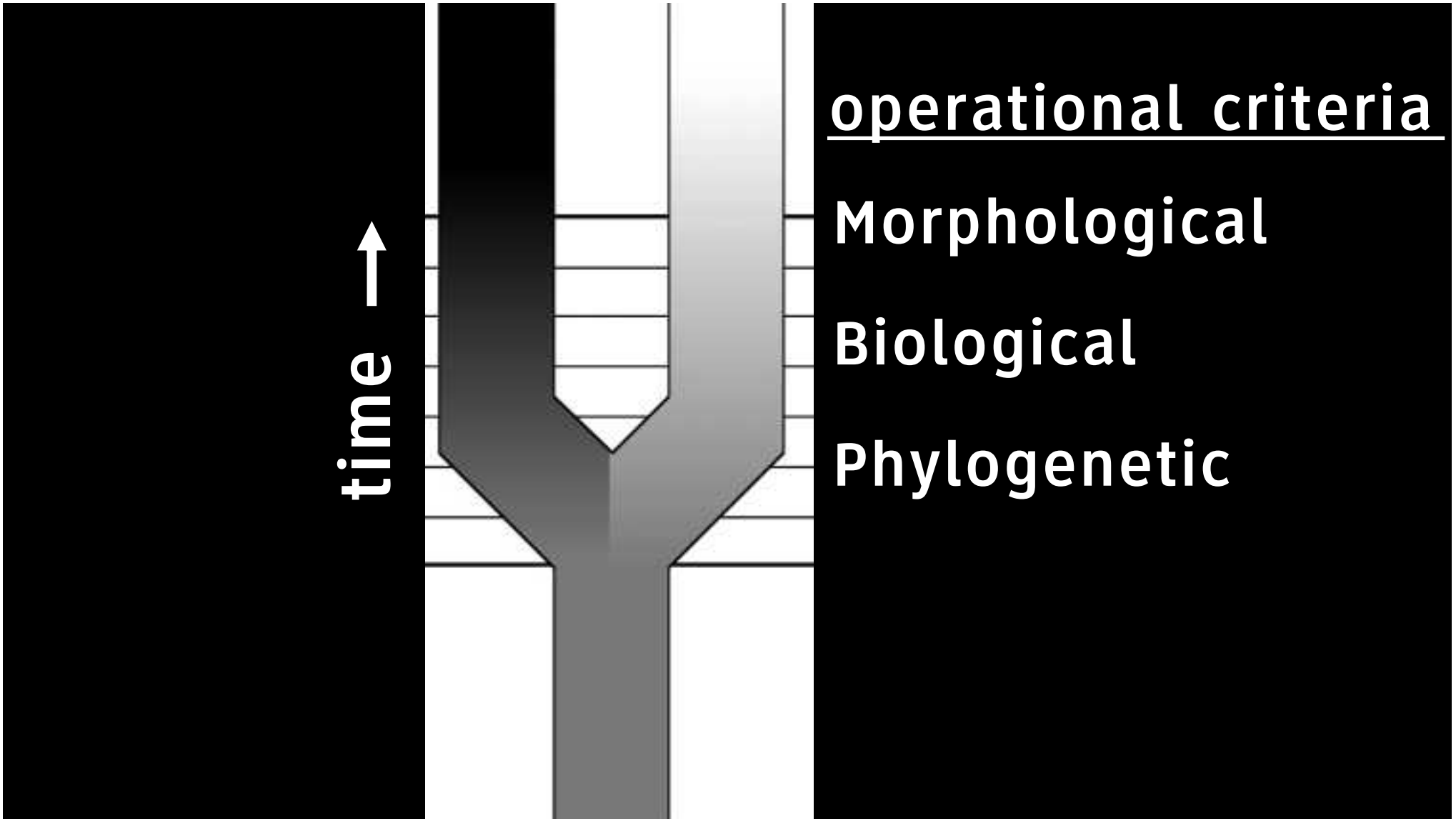
= separately evolving metapopulation lineages

concept of a species
= separately evolving metapopulation lineages

operational criteria for delimitation
= Biological Species, Morphological Species, Phylogenetic Species, etc.


time →


time
operational criteria
Phylogenetic
Morphological
Biological


time
operational criteria
Morphological
Biological
Phylogenetic

clustering methods

just clustering
vs.
clustering and cleaning

de novo clustering
vs.
closed-reference clustering

metabarcoding data
vs.
metagenomic/ metatranscriptomic

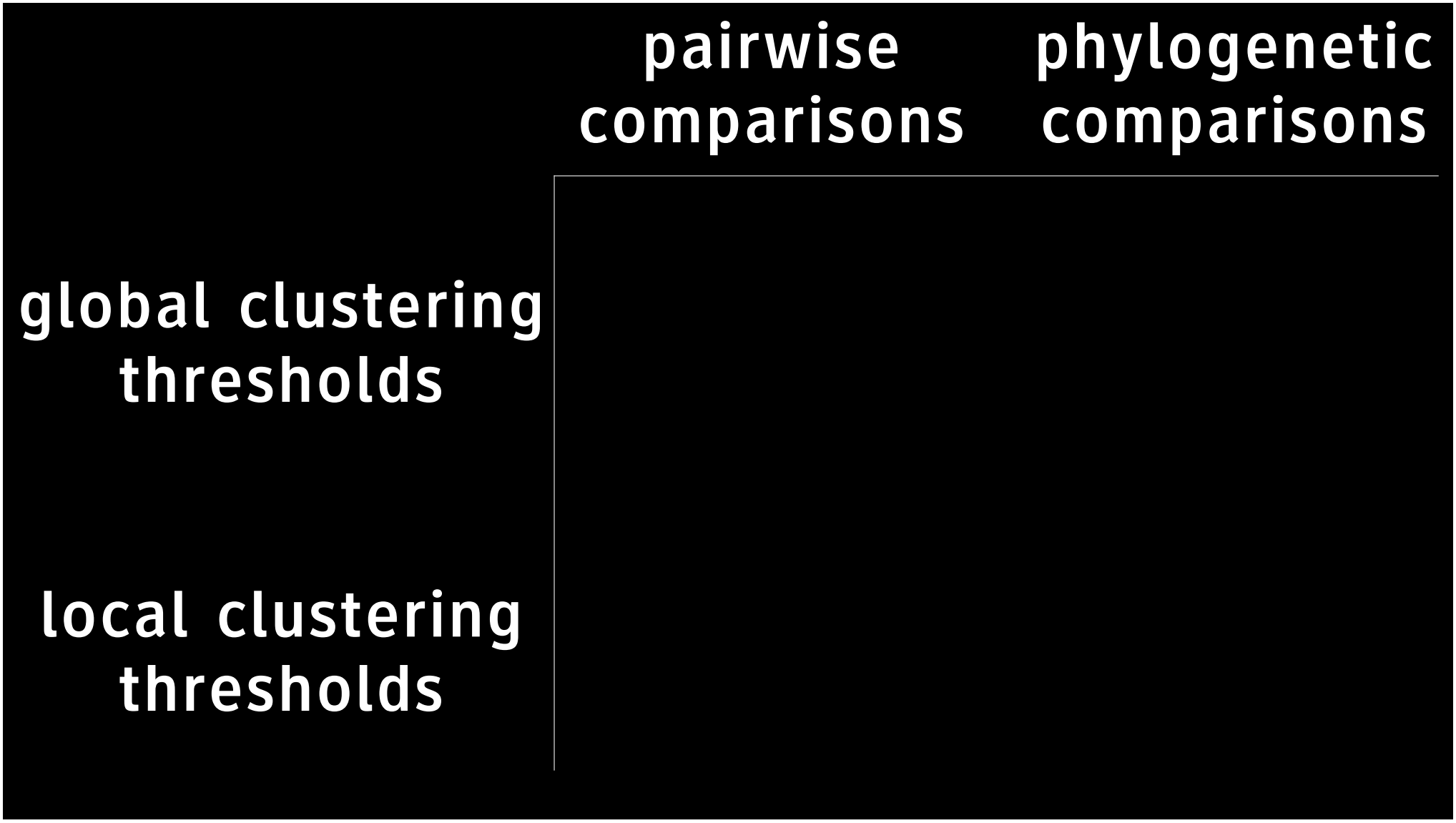
2002 75:509-516 Biol. J. Linn. Soc.

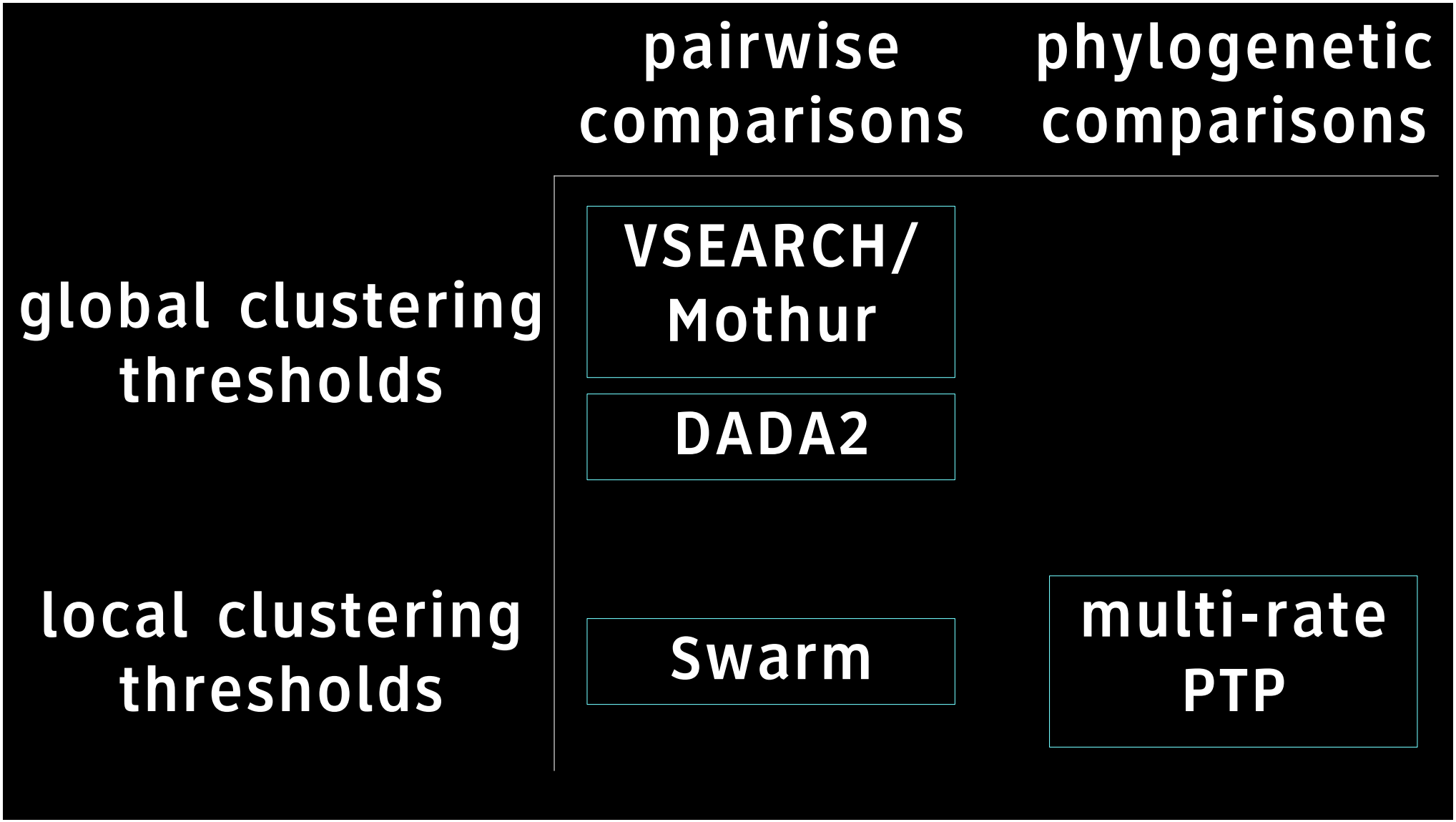
On the use of genetic divergence for identifying species

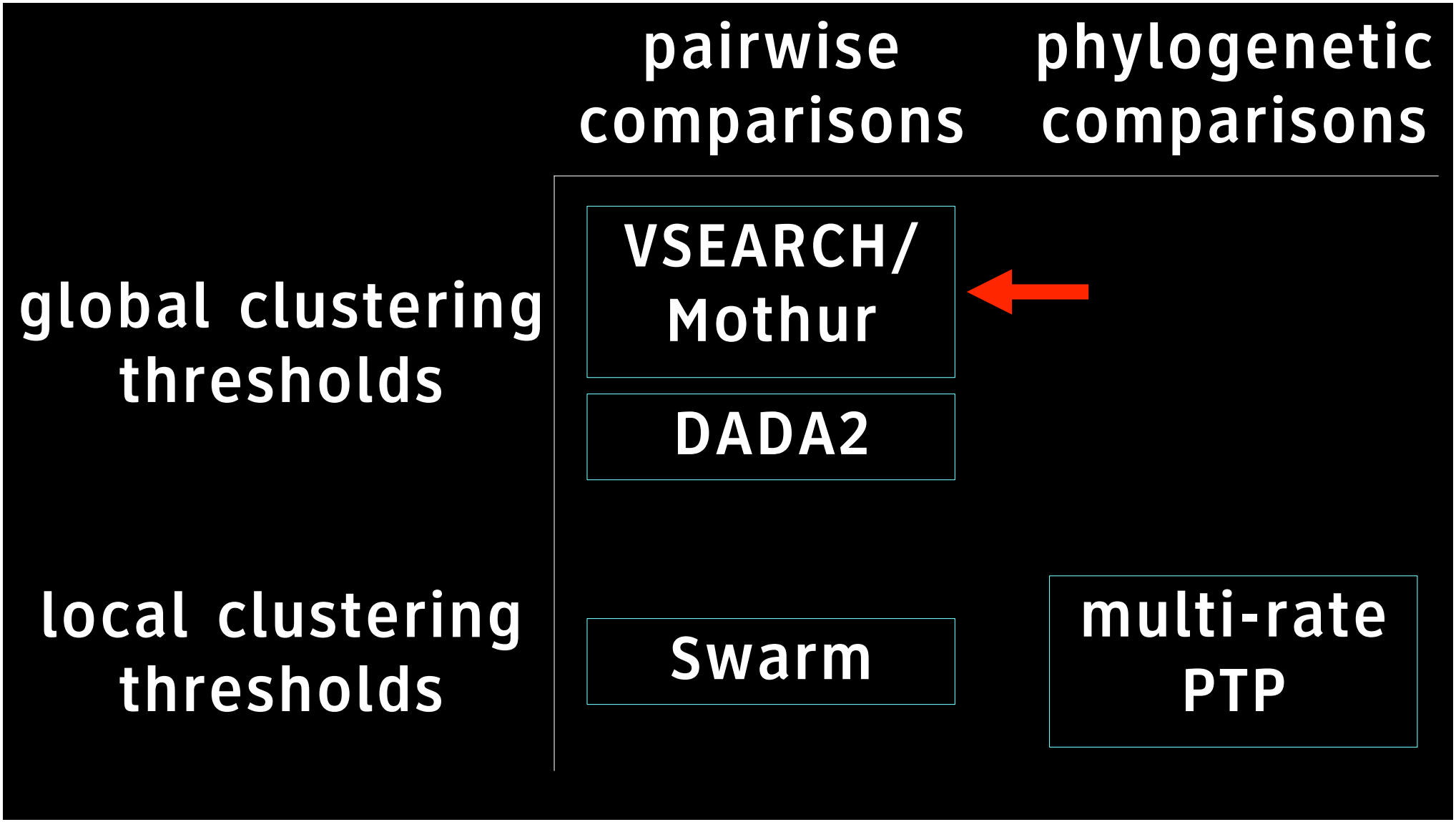
J. WILLEM H. FERGUSON*

Department Zoology and Entomology, University of Pretoria, 0002 Pretoria, South Africa

global clustering thresholds
local clustering thresholds


pairwise comparisons
phylogenetic comparisons
global clustering thresholds
local clustering thresholds


pairwise comparisons
phylogenetic comparisons
global clustering thresholds
VSEARCH/ Mothur
DADA2
local clustering thresholds
Swarm
multi-rate PTP


pairwise comparisons
phylogenetic comparisons
global clustering thresholds
VSEARCH/ Mothur
DADA2
local clustering thresholds
Swarm
multi-rate PTP

2016 4:e2584

PeerJ

VSEARCH: a versatile open source tool for metagenomics

Torbjørn Rognes[1,2], Tomáš Flouri[3,4], Ben Nichols[5], Christopher Quince[5,6] and Frédéric Mahé[7,8]

APPLIED AND ENVIRONMENTAL MICROBIOLOGY, Dec. 2009, p. 7537–7541 Vol. 75, No. 23
0099-2240/09/$12.00 doi:10.1128/AEM.01541-09
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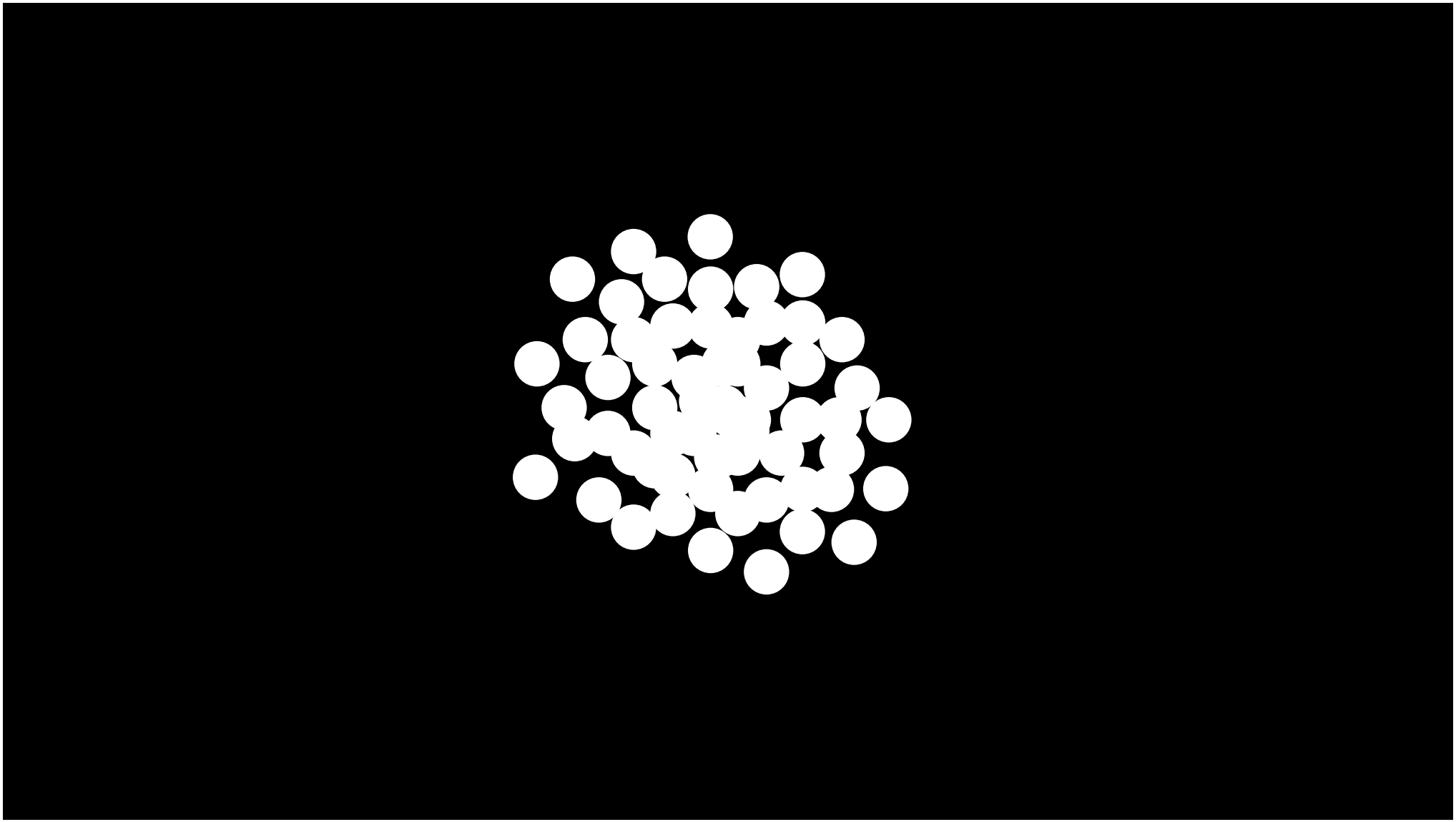
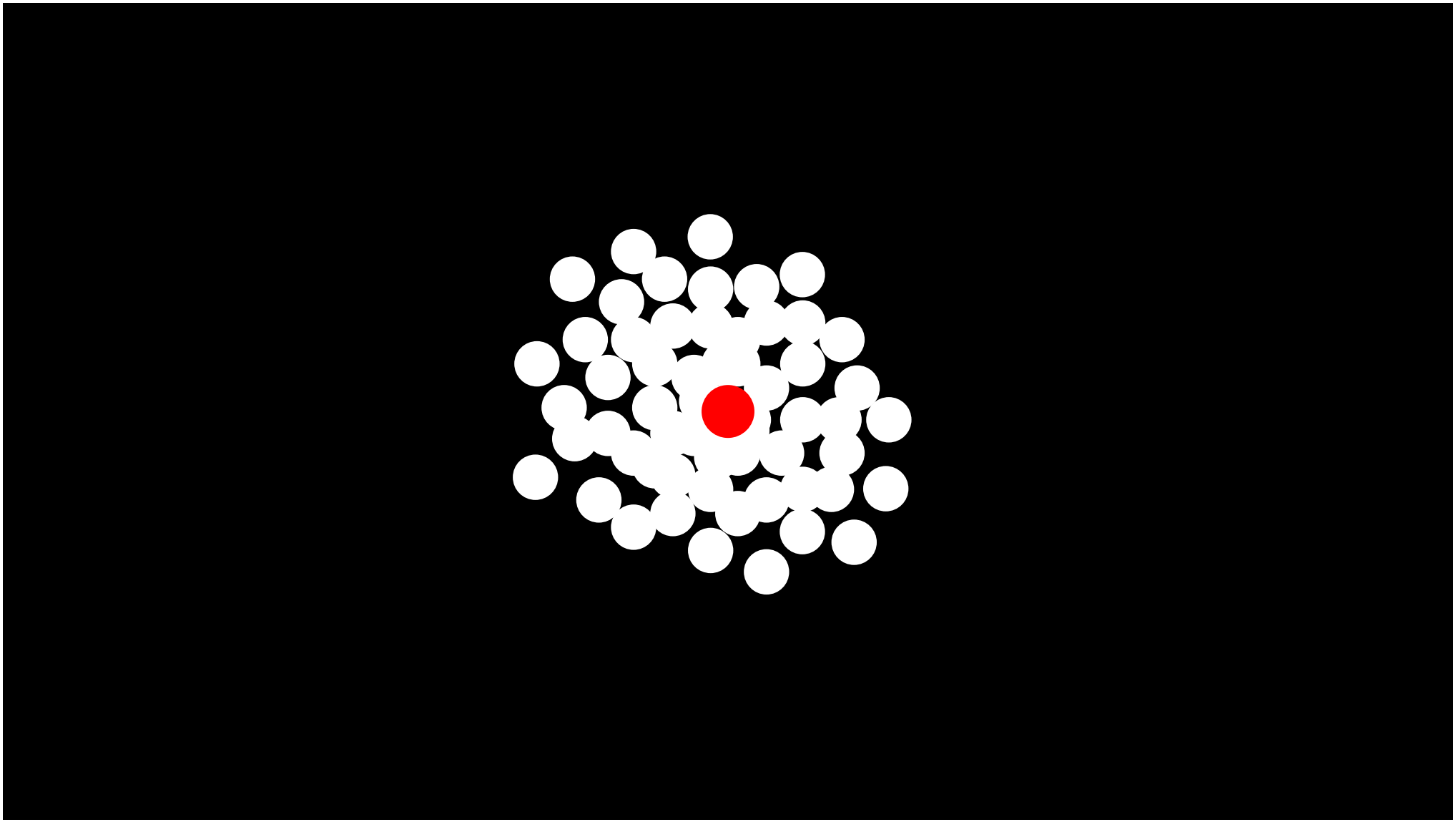
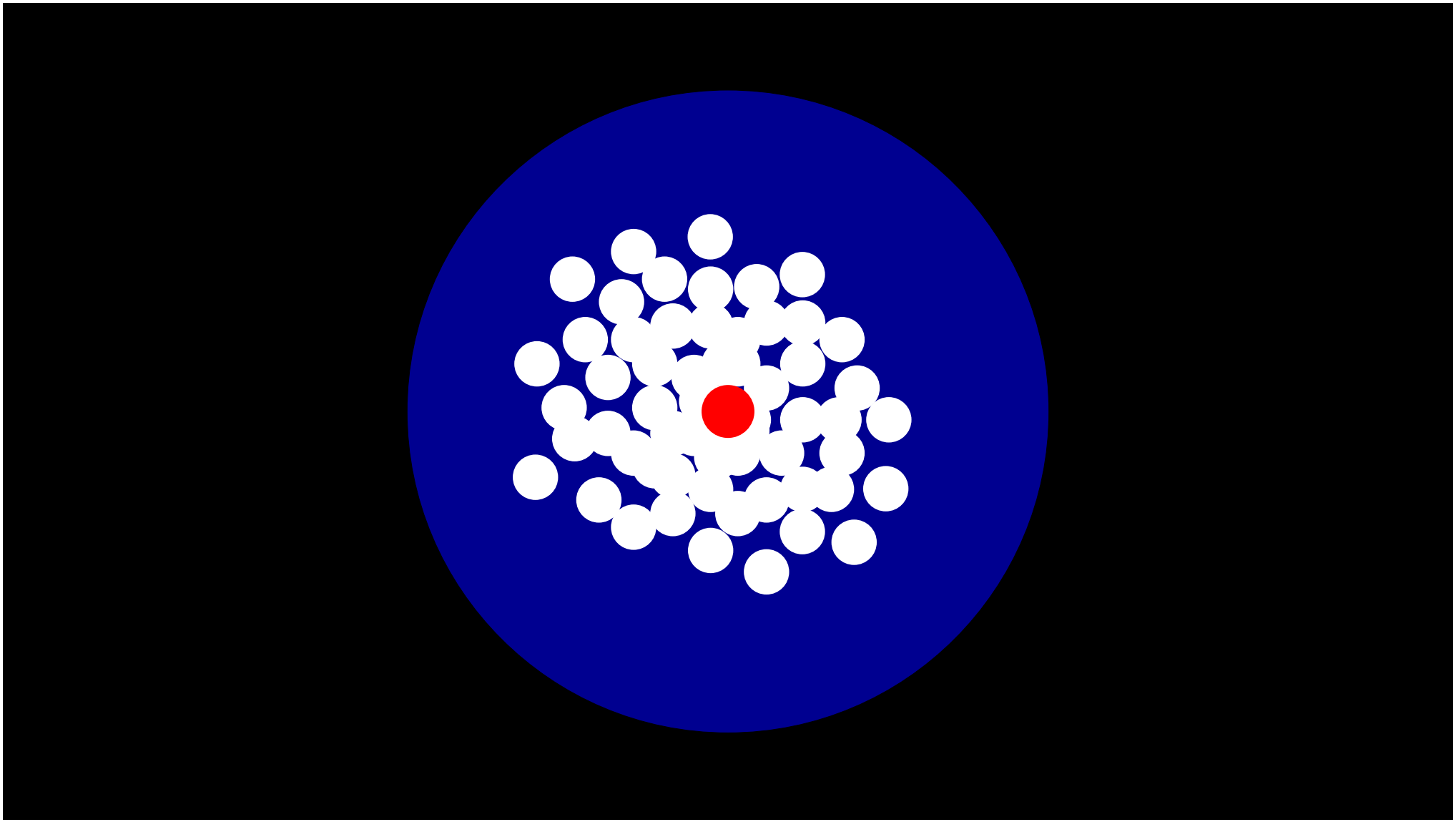
Introducing mothur: Open-Source, Platform-Independent, Community-Supported Software for Describing and Comparing Microbial Communities▽

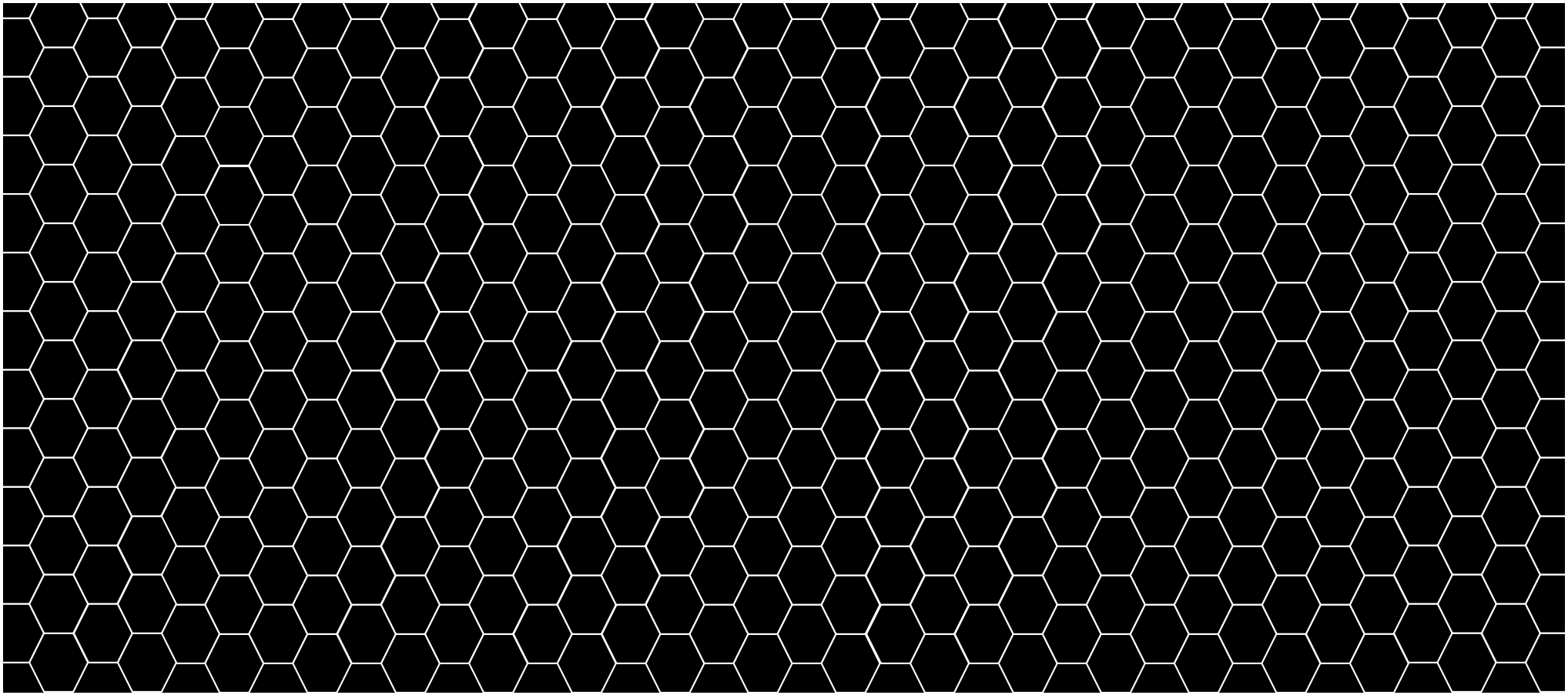
Patrick D. Schloss,[1,2]* Sarah L. Westcott,[1,2] Thomas Ryabin,[1] Justine R. Hall,[3] Martin Hartmann,[4] Emily B. Hollister,[5] Ryan A. Lesniewski,[6] Brian B. Oakley,[7] Donovan H. Parks,[8] Courtney J. Robinson,[2] Jason W. Sahl,[9] Blaz Stres,[10] Gerhard G. Thallinger,[11] David J. Van Horn,[2] and Carolyn F. Weber[12]

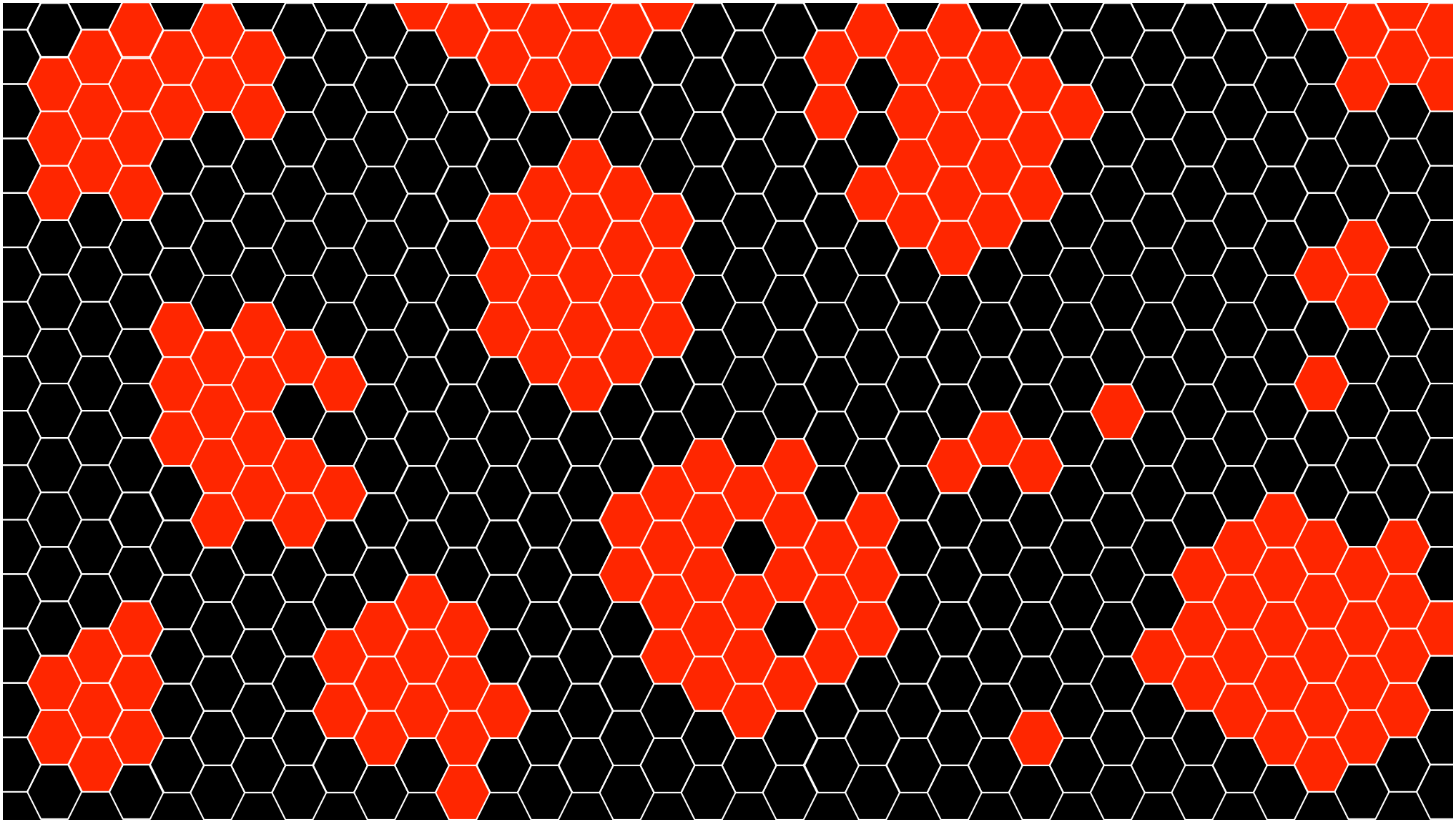


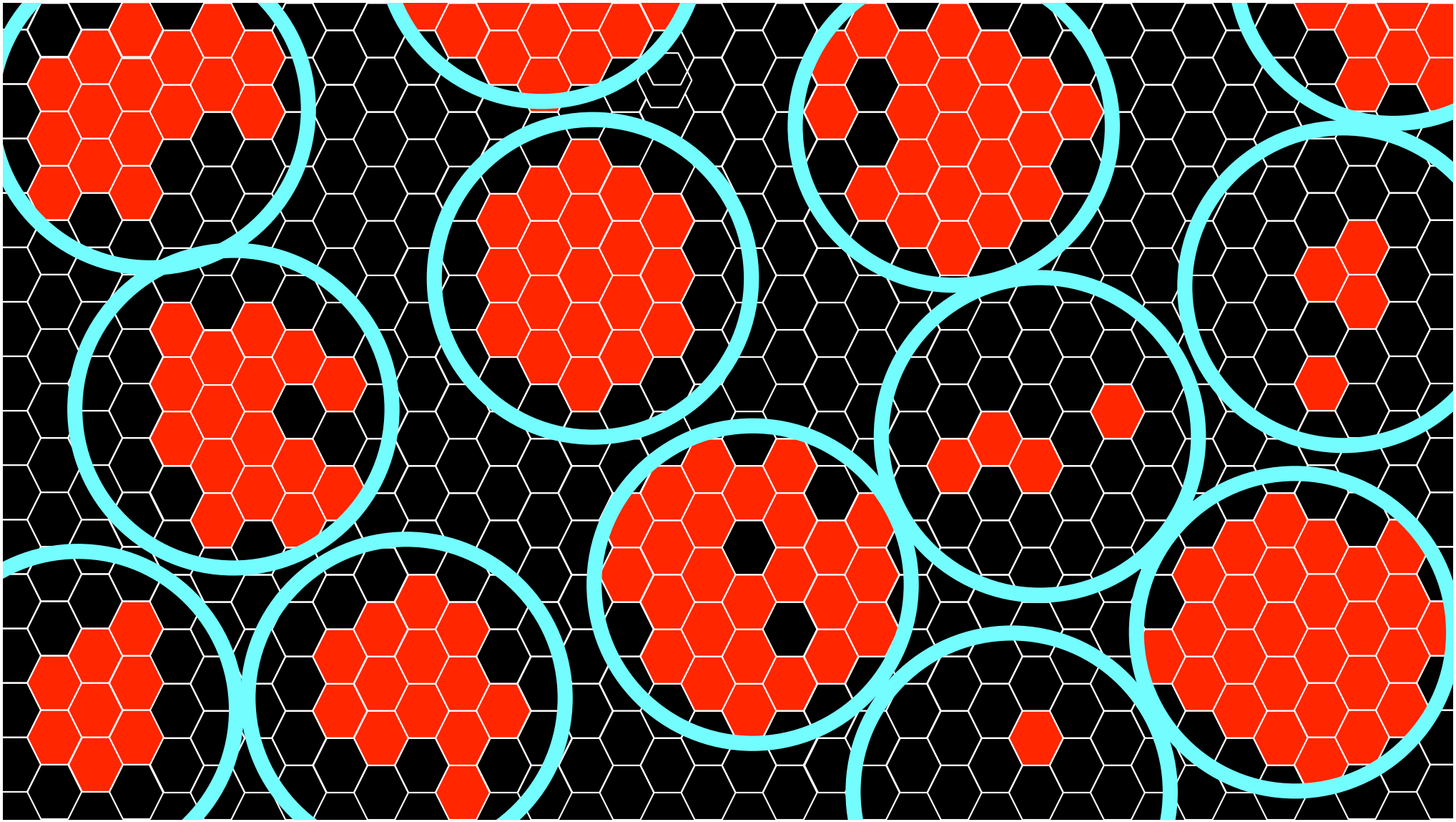


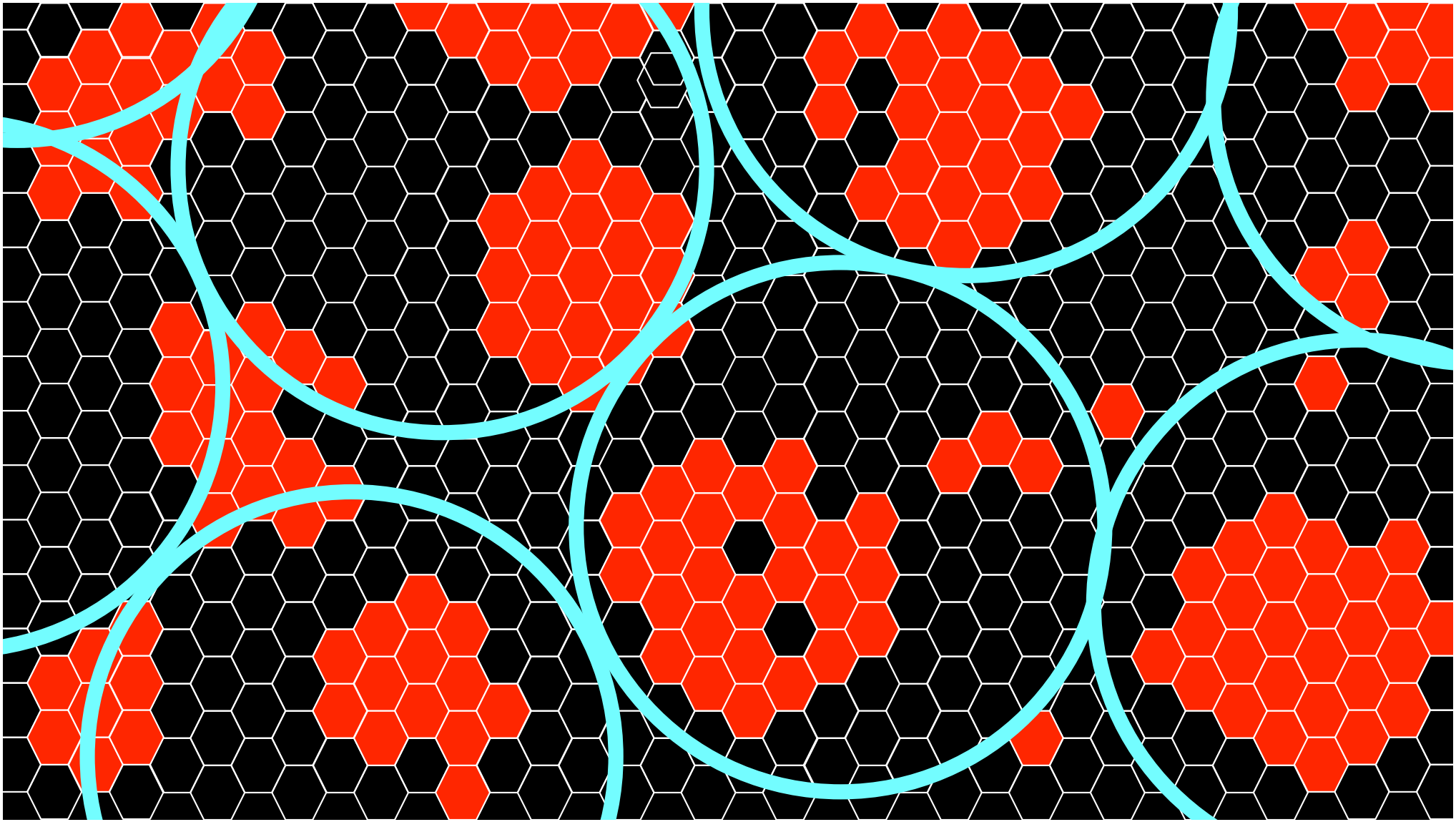


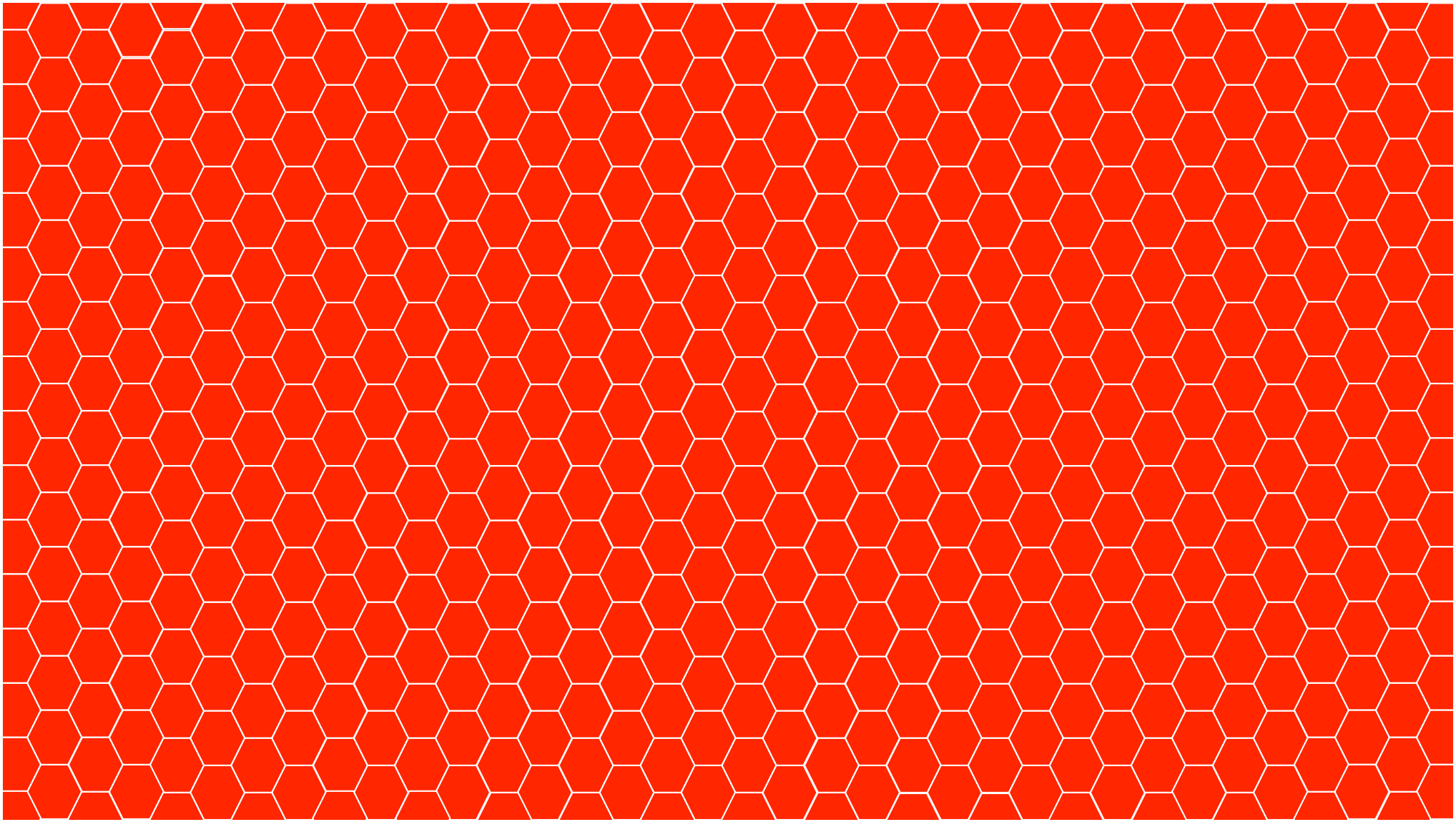
each hexagon is a unique sequence,
neighboring hexagons differ by one base pair

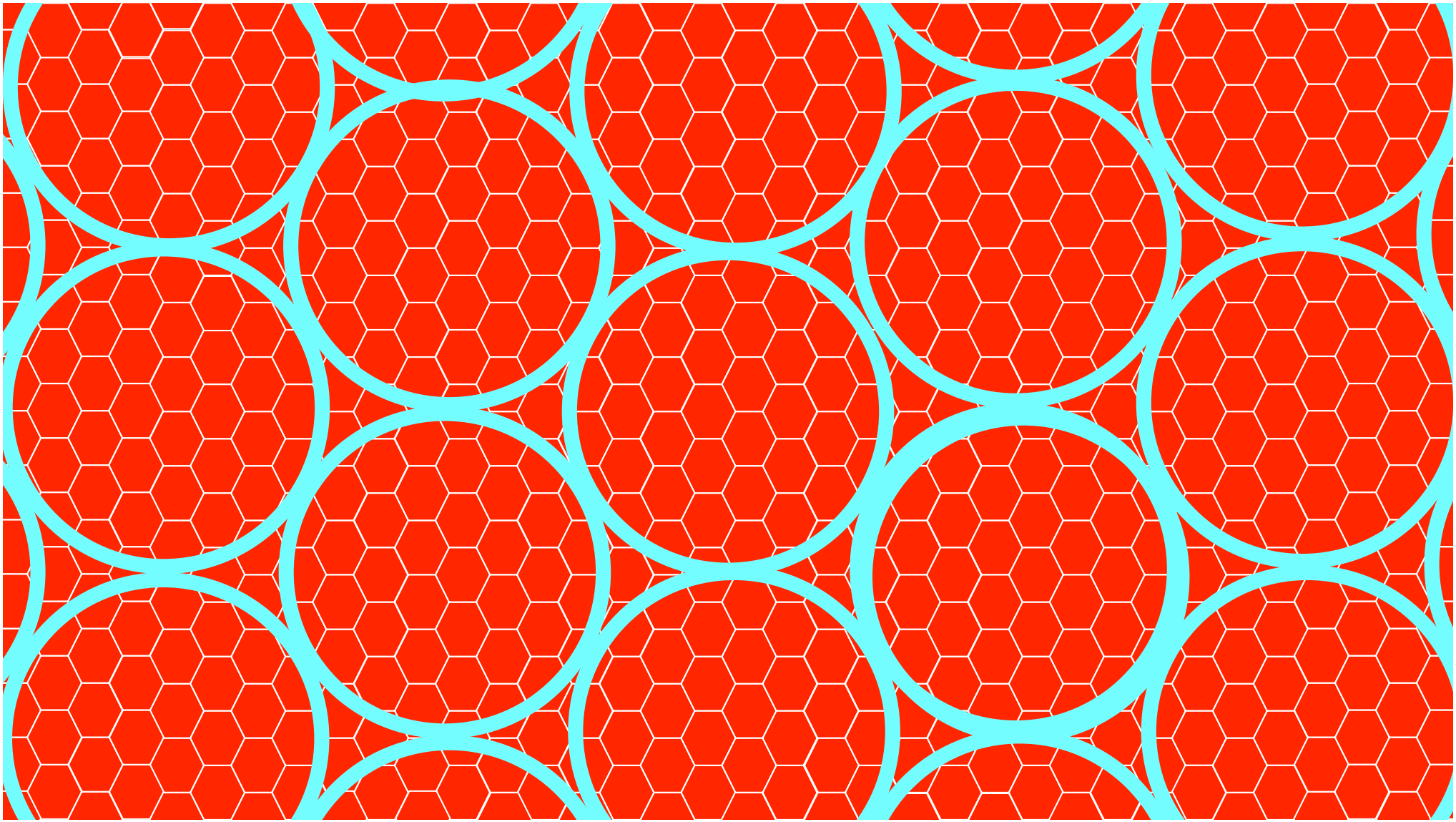


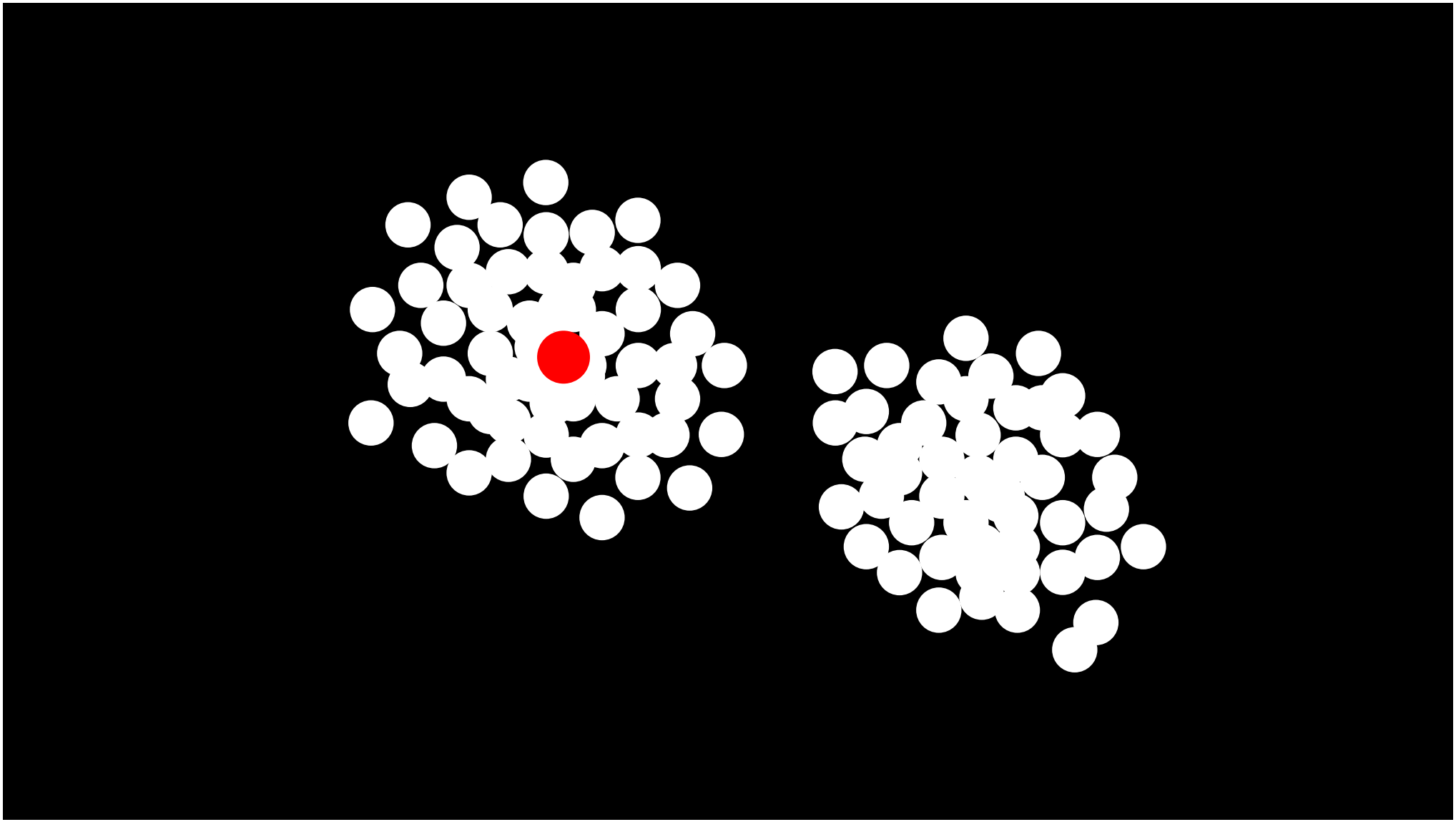


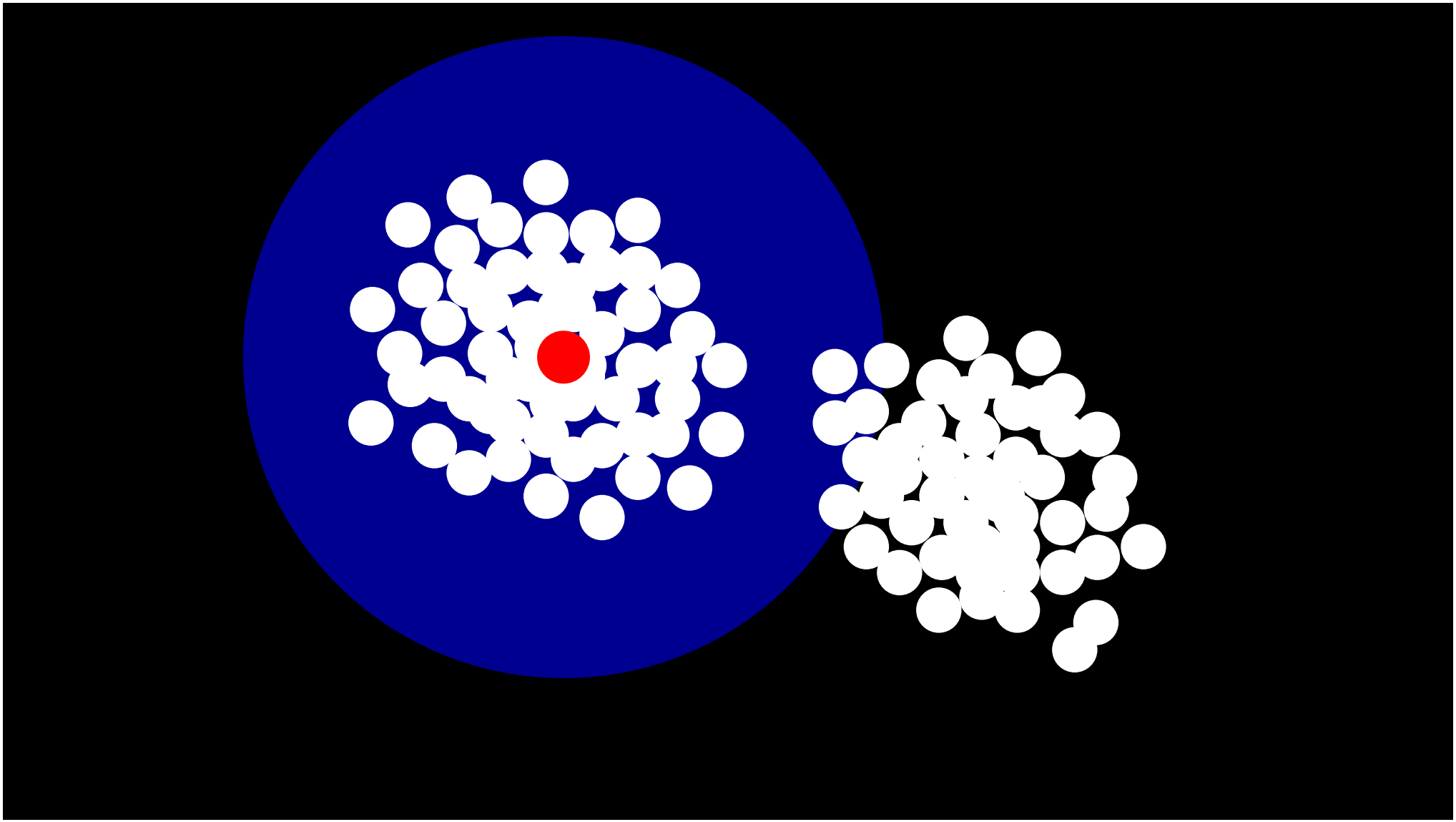


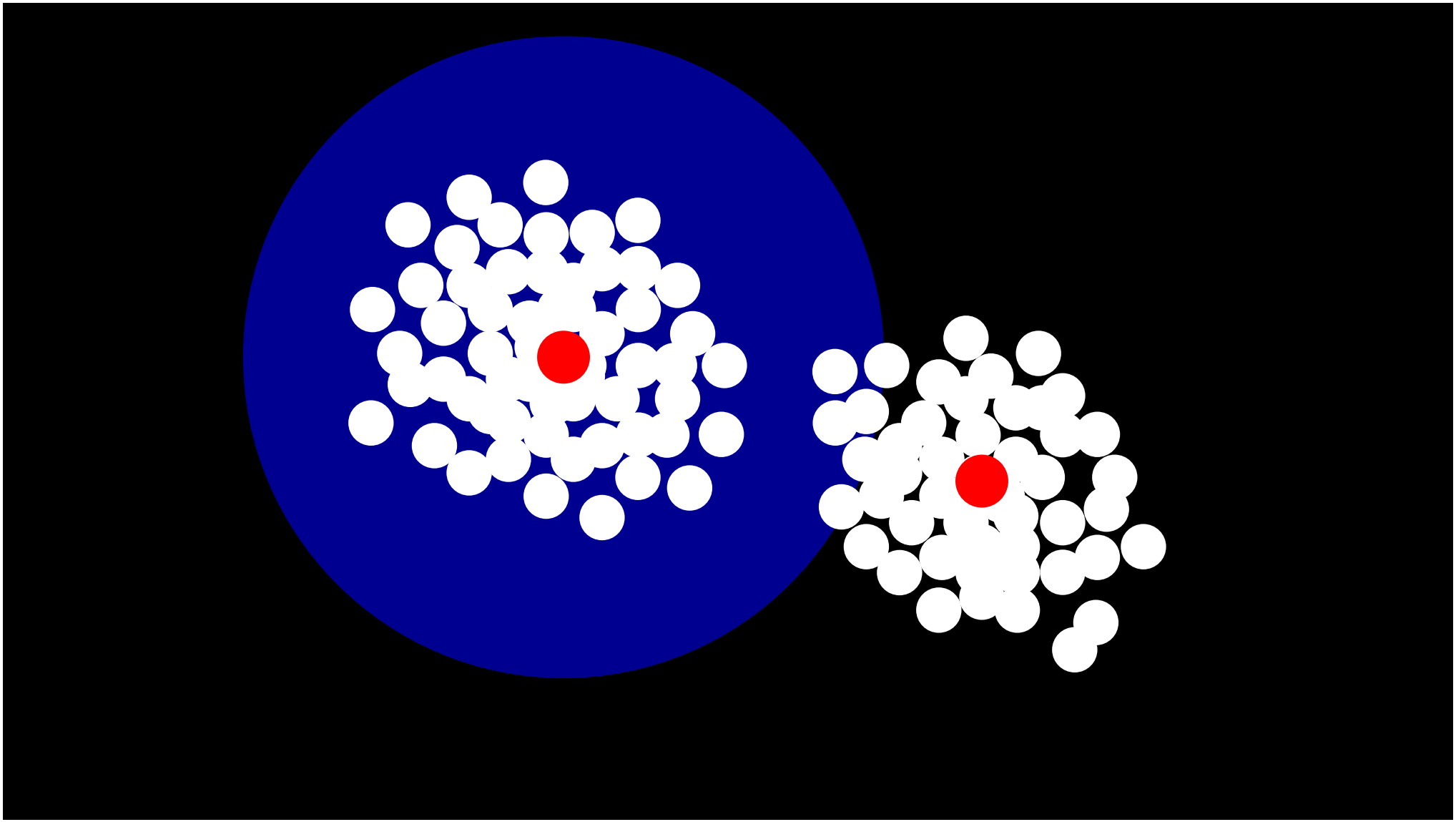


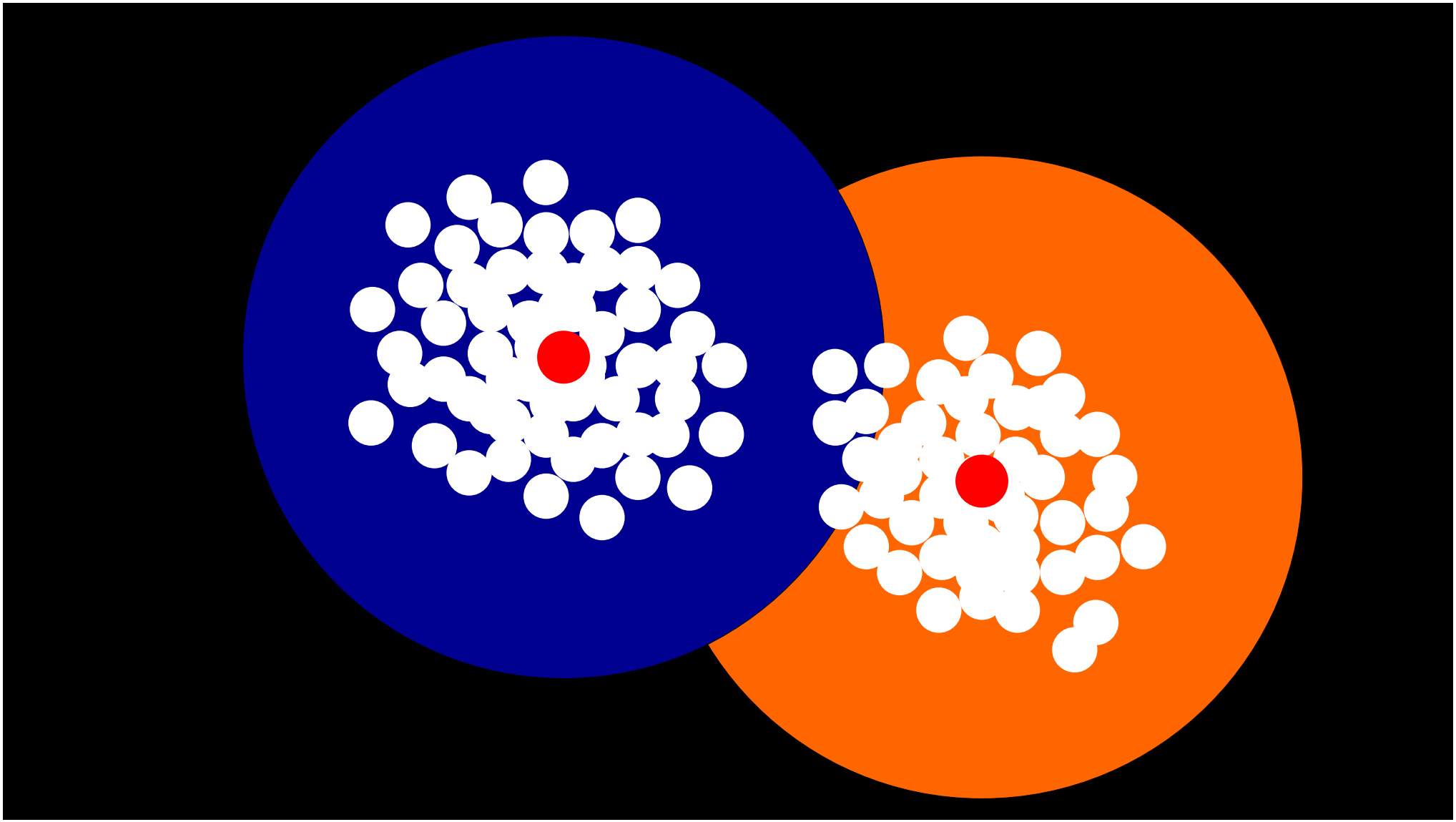


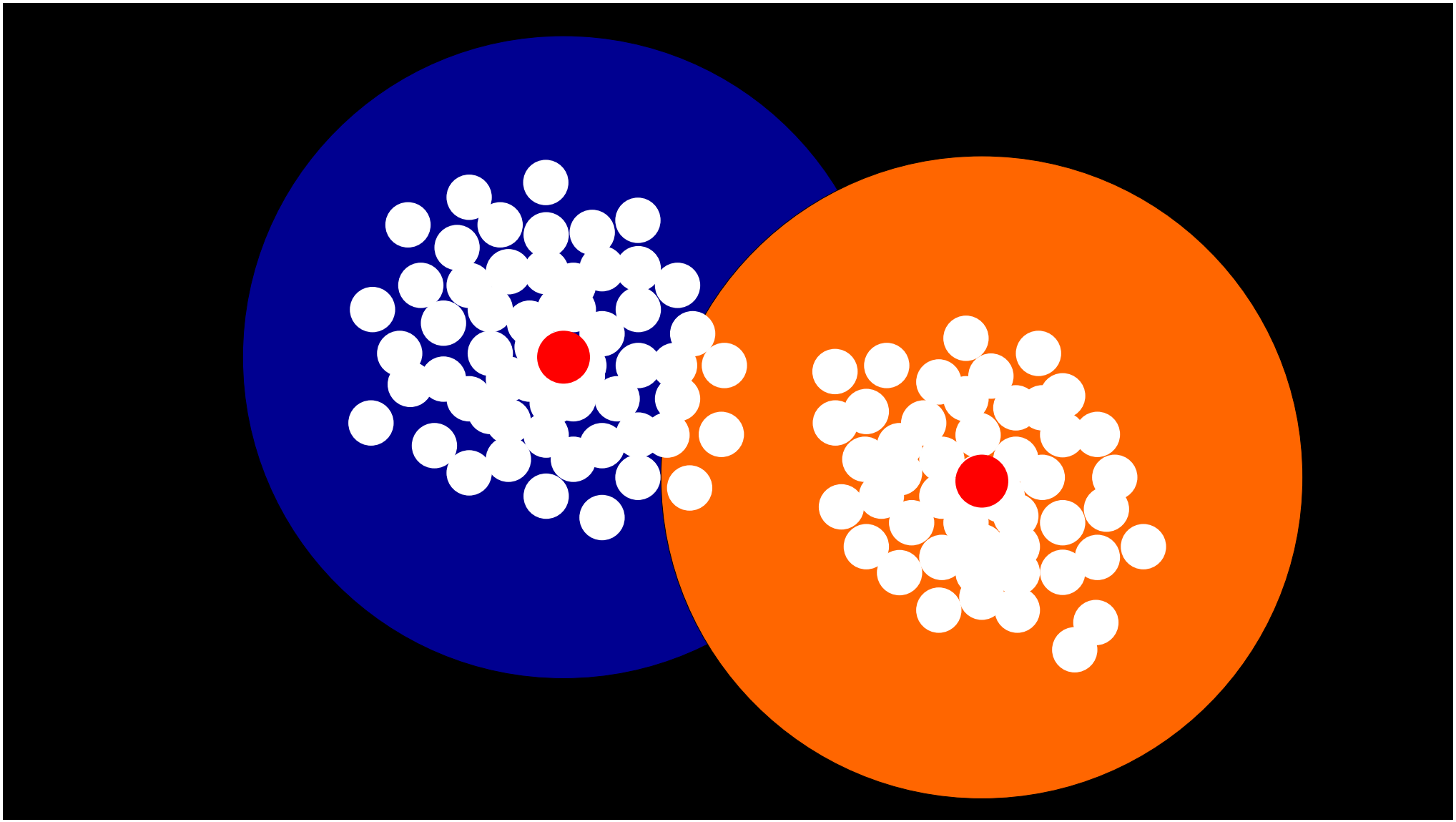












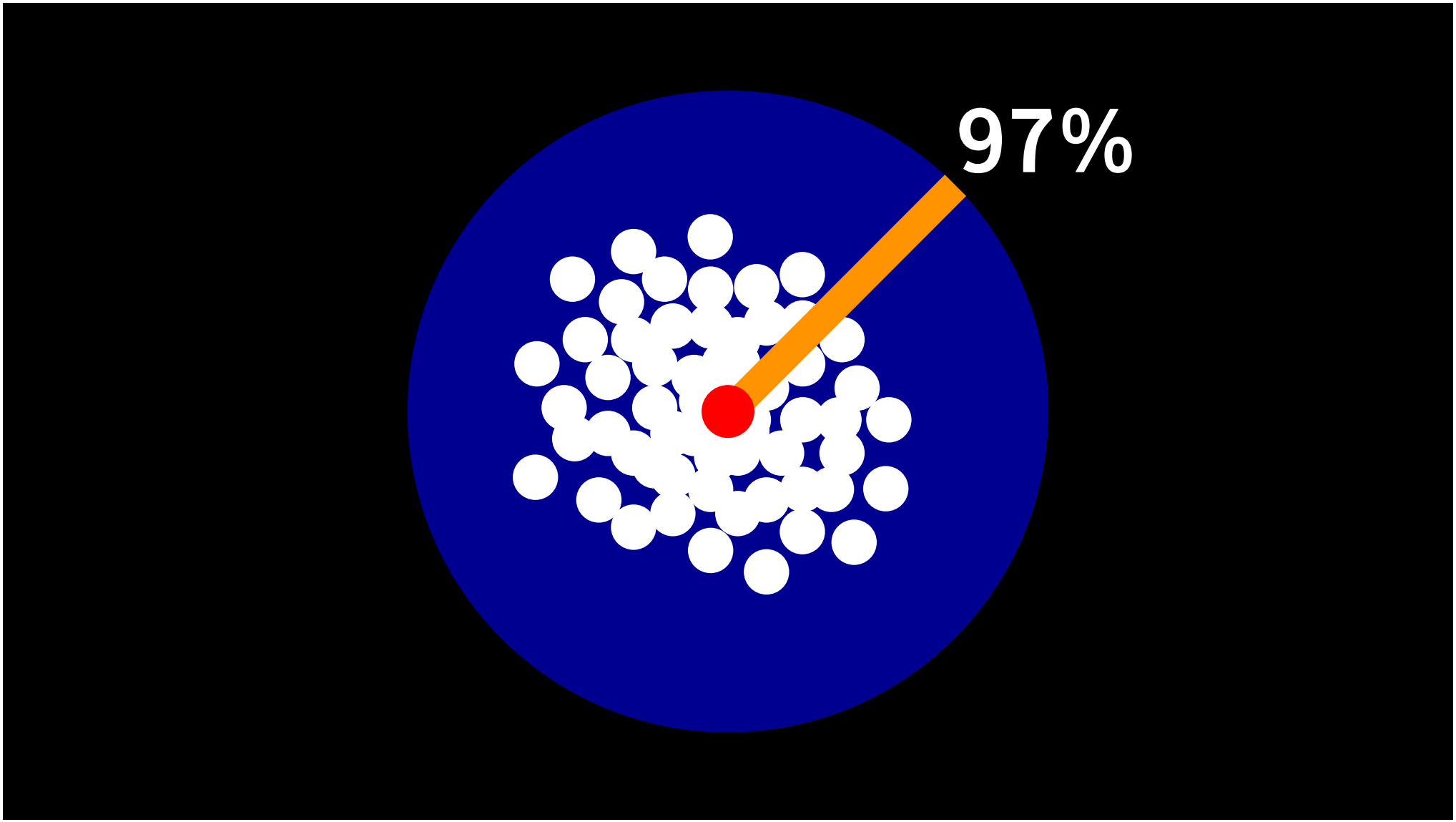
97%

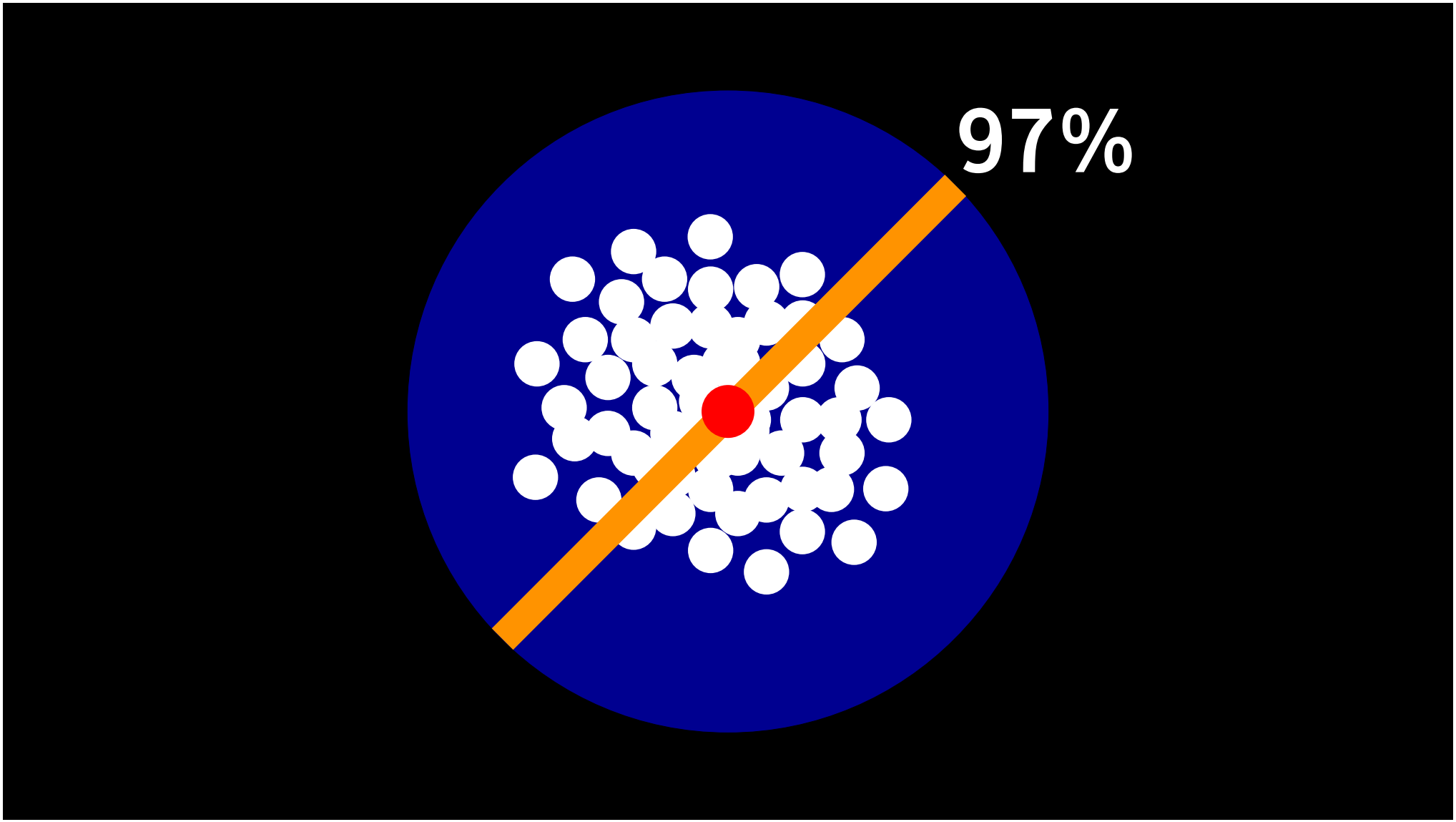
Ian Marshall
@ianpgm.bsky.social

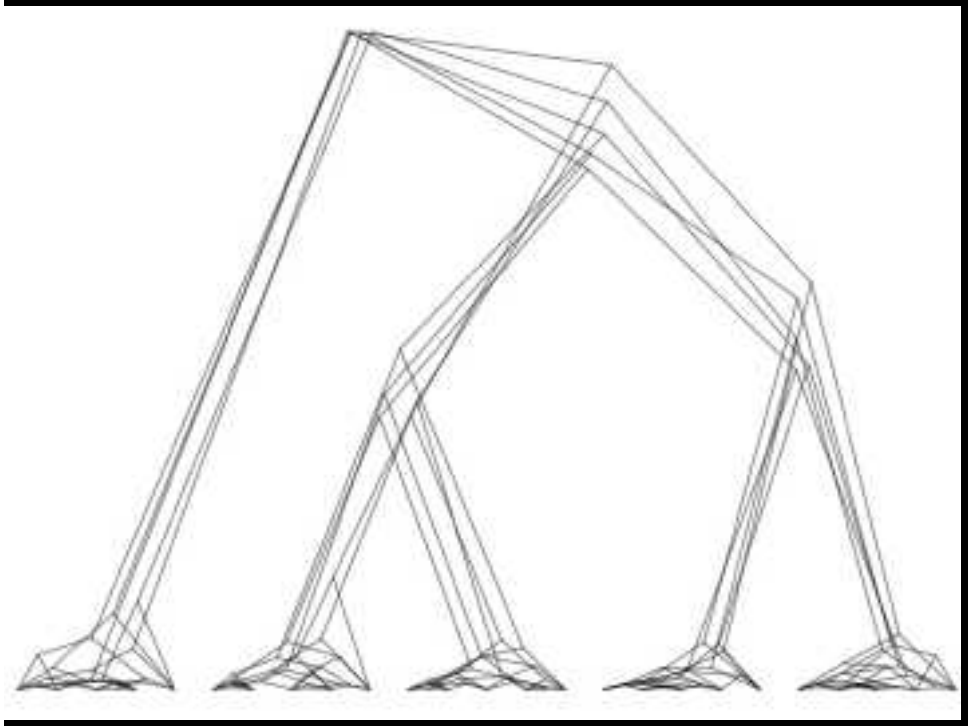
I know people teaching with old slides that never updated the 97% species threshold to 98.7%... looks like they've waited long enough that now those slides are almost accurate again :-)

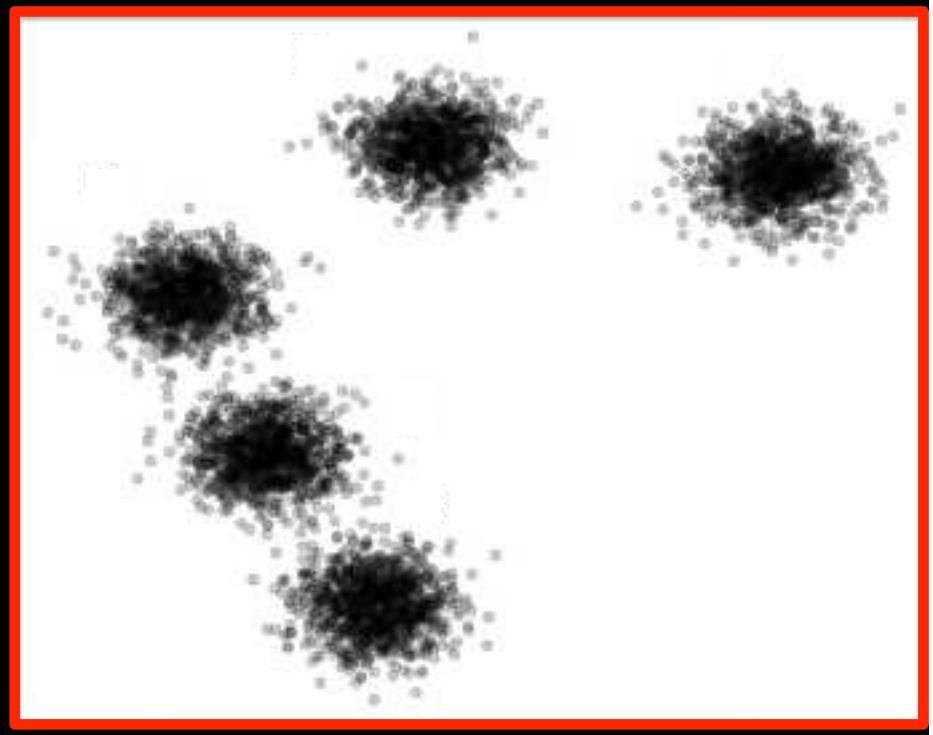
> **Cameron Thrash** @jcamthrash.bsky.s... · 5h
> Setting new boundaries of 16S rRNA gene identity for prokaryotic taxonomy
> www.microbiologyresearch.org/content/jour...
> #jcampubs

April 9, 2025 at 7:22 PM Everybody can reply

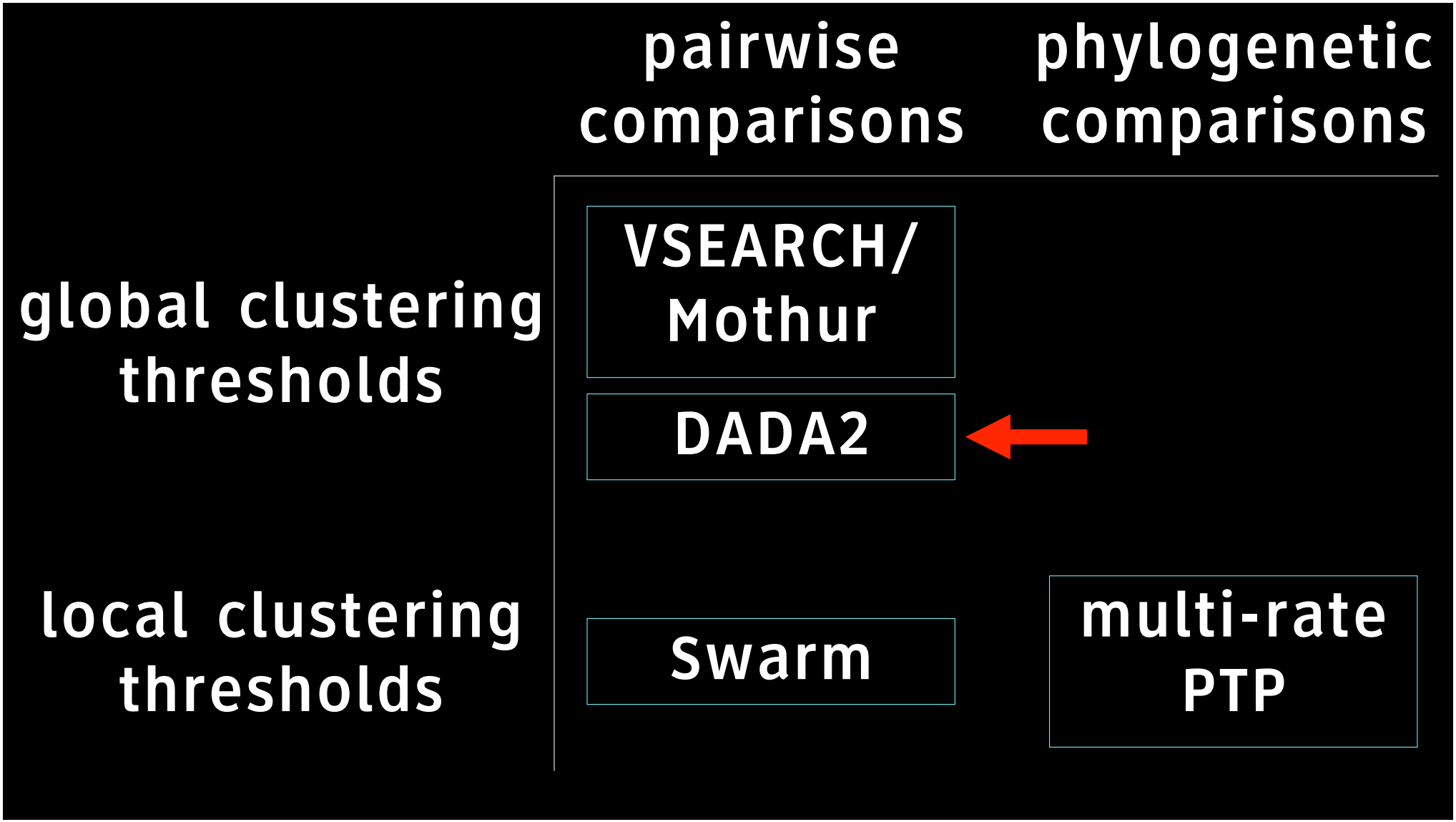

97%


97%





Barraclough (2019) The Evolutionary Biology of Species


pairwise comparisons
phylogenetic comparisons
global clustering thresholds
VSEARCH/ Mothur
DADA2
local clustering thresholds
Swarm
multi-rate PTP

BRIEF COMMUNICATIONS

2016 13:581-583

Nature Methods

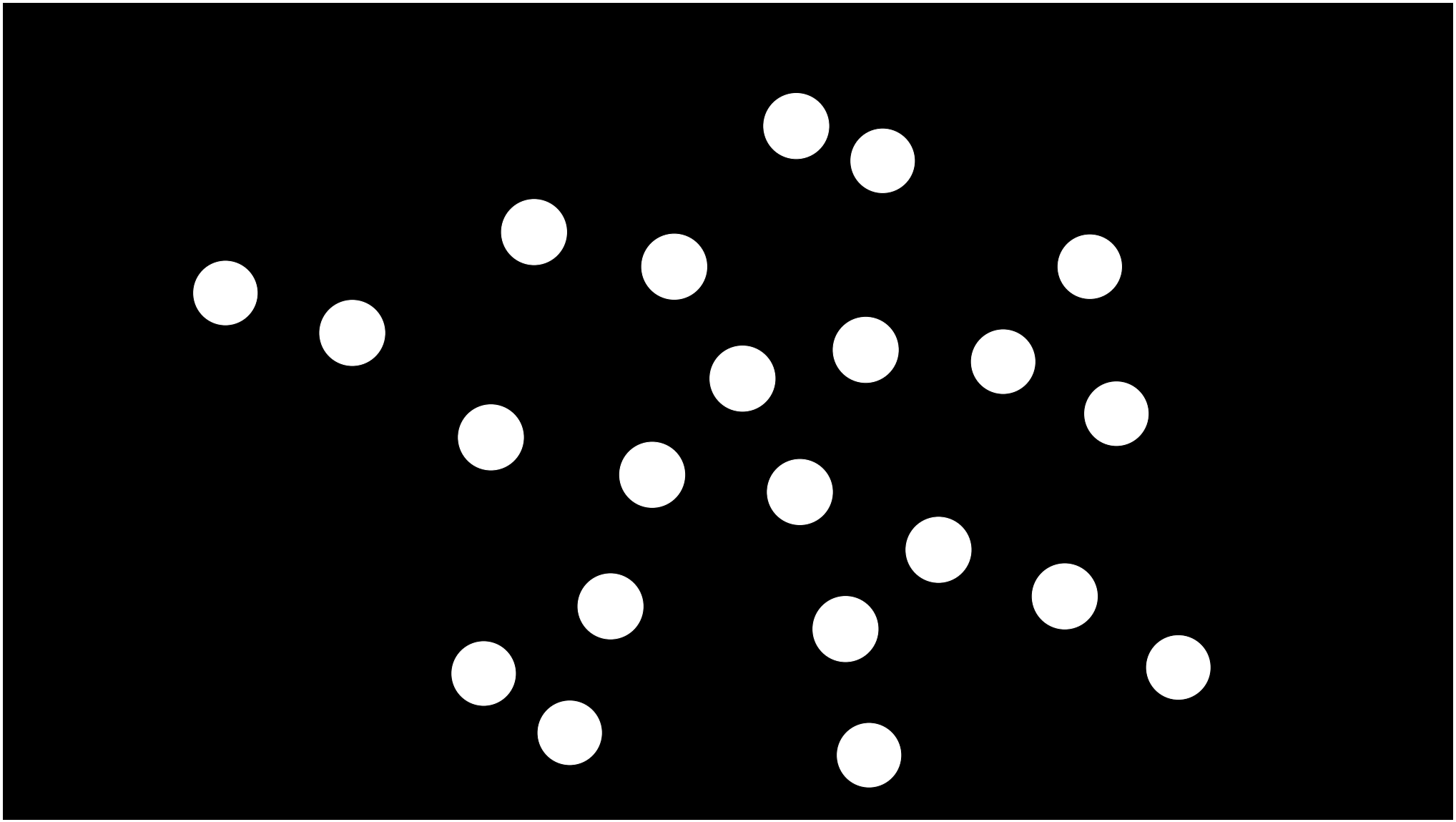
DADA2: High-resolution sample inference from Illumina amplicon data

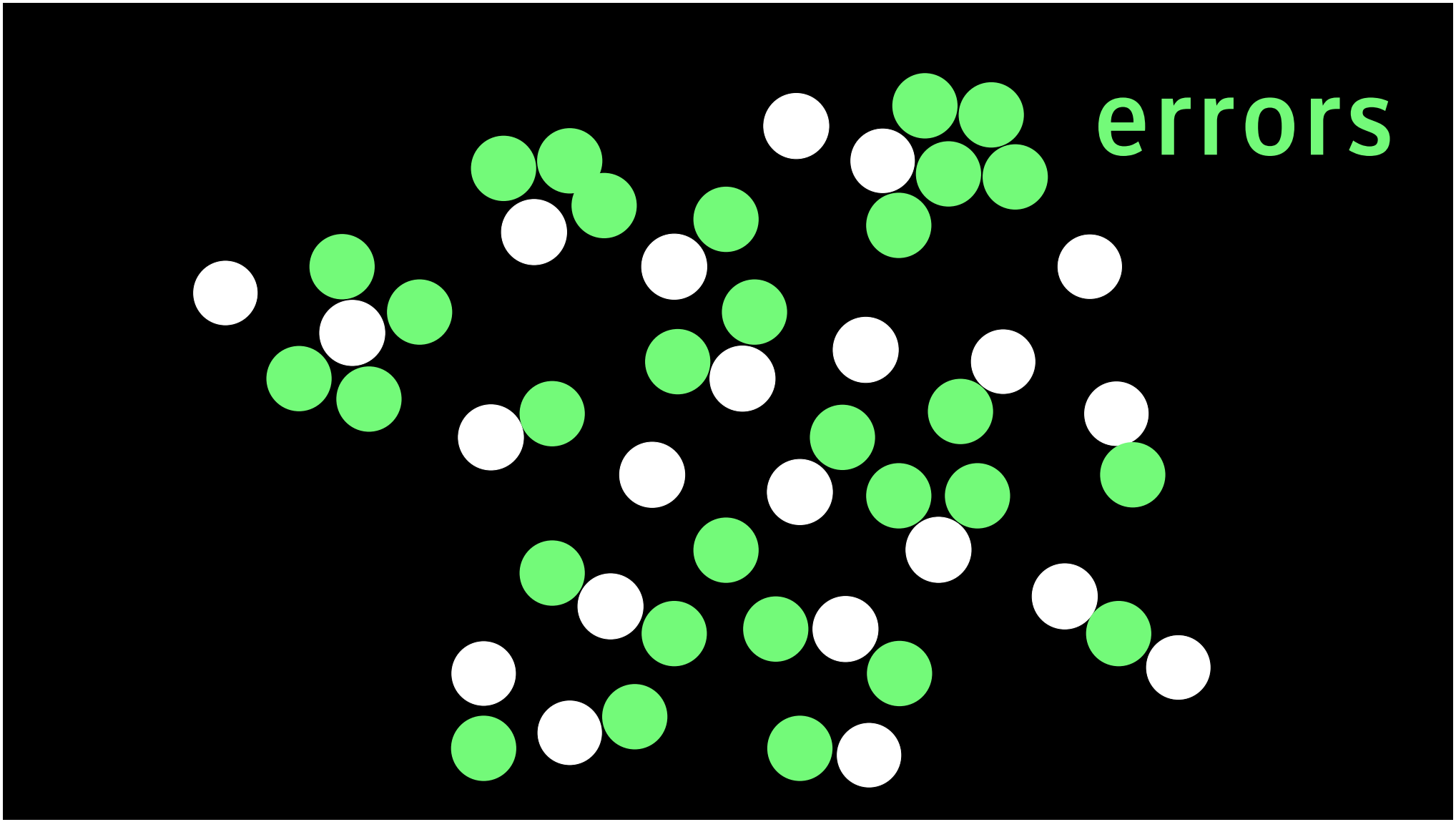
Benjamin J Callahan[1], Paul J McMurdie[2], Michael J Rosen[3], Andrew W Han[2], Amy Jo A Johnson[2] & Susan P Holmes[1]

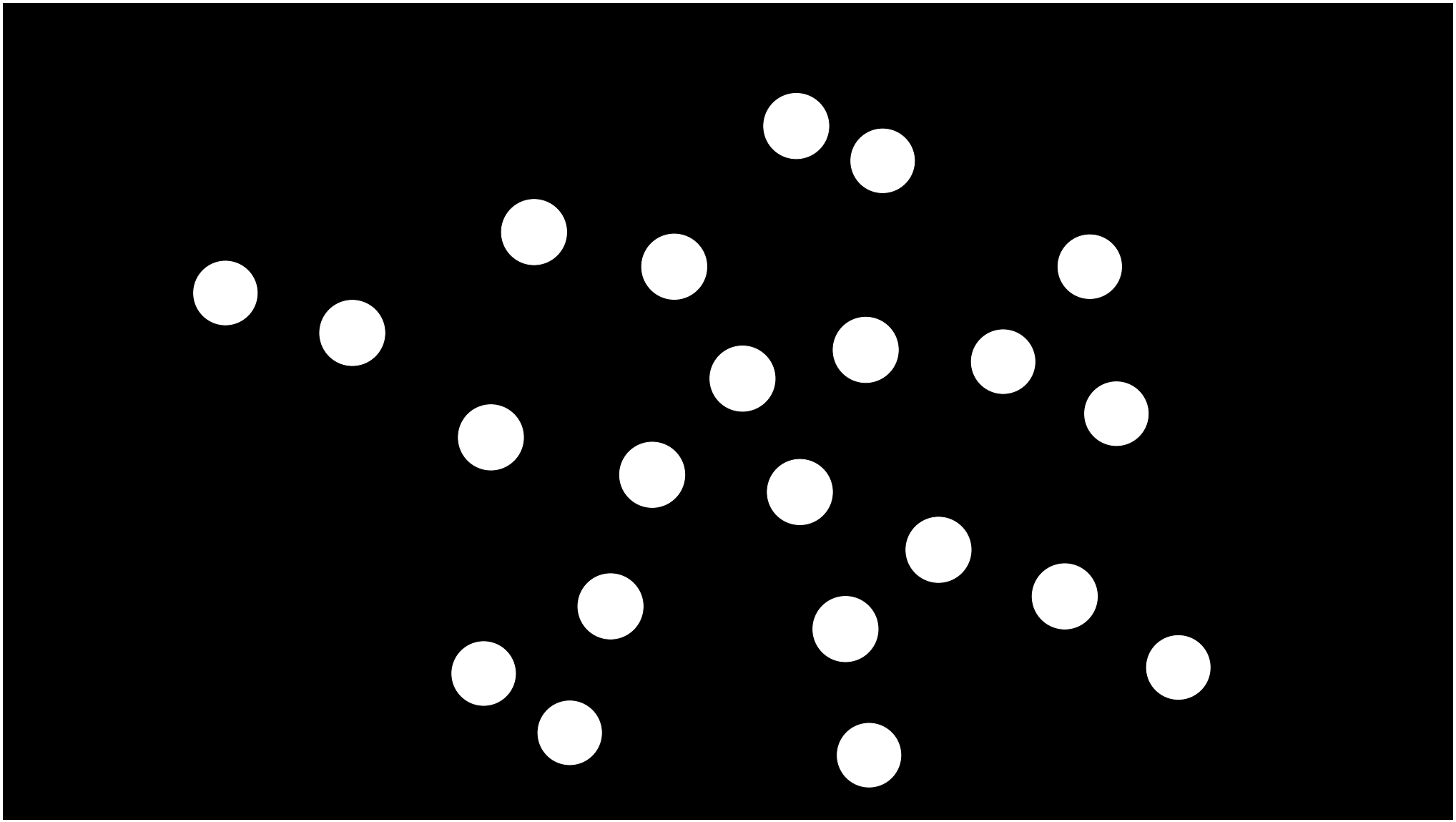
amplicon sequence variants (ASVs)

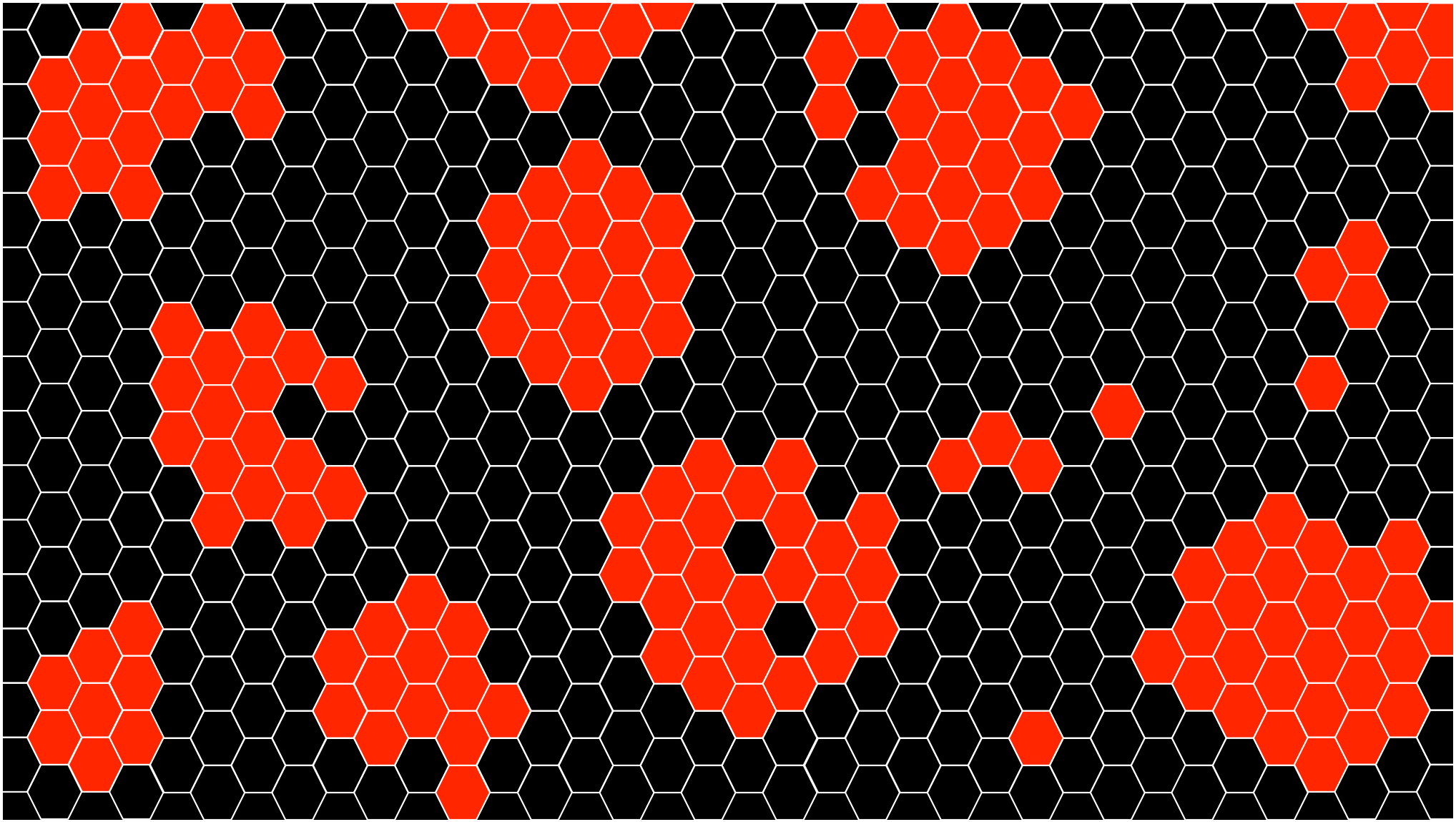
amplicon sequence variants (ASVs)

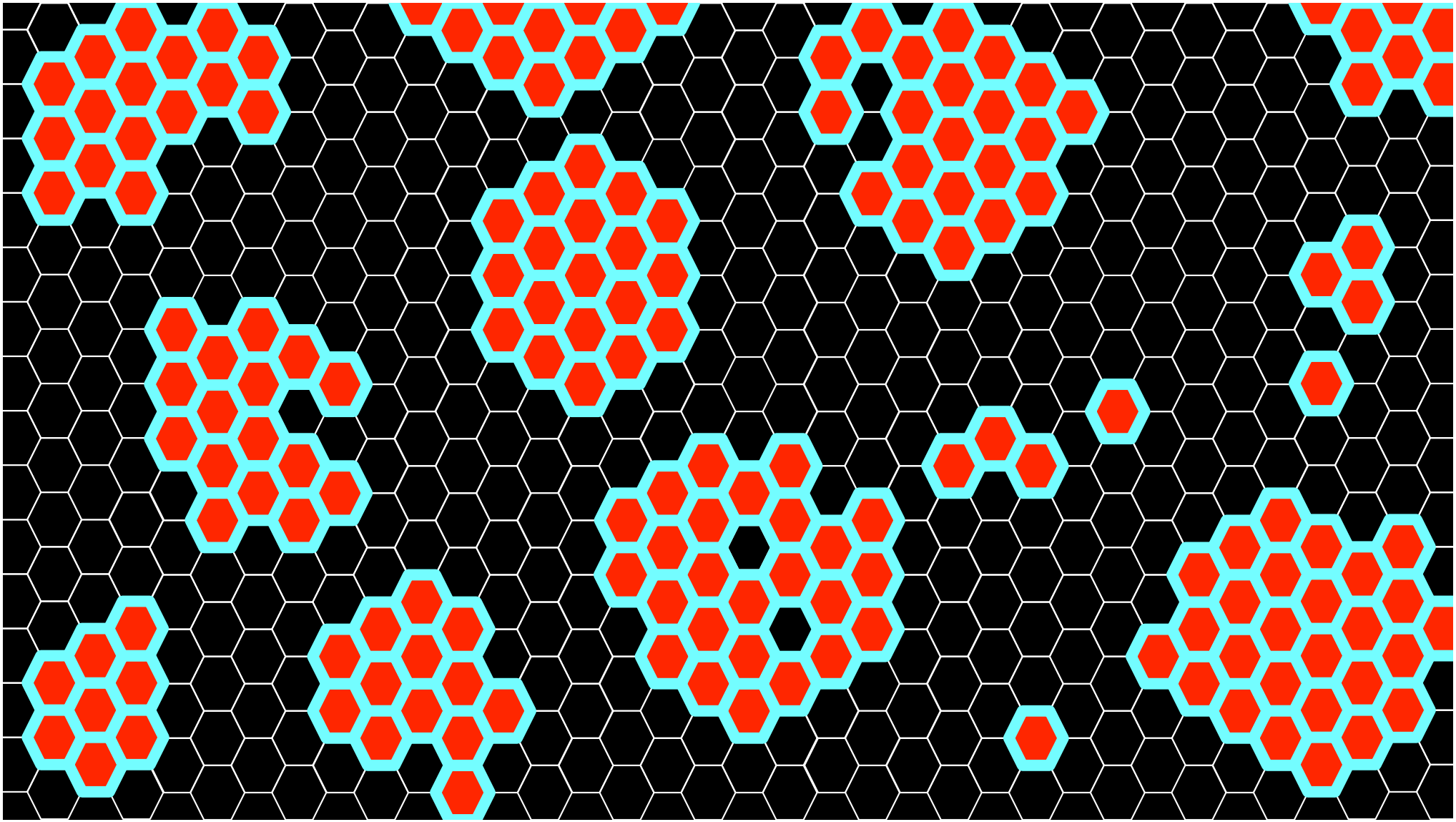
clustering by another name

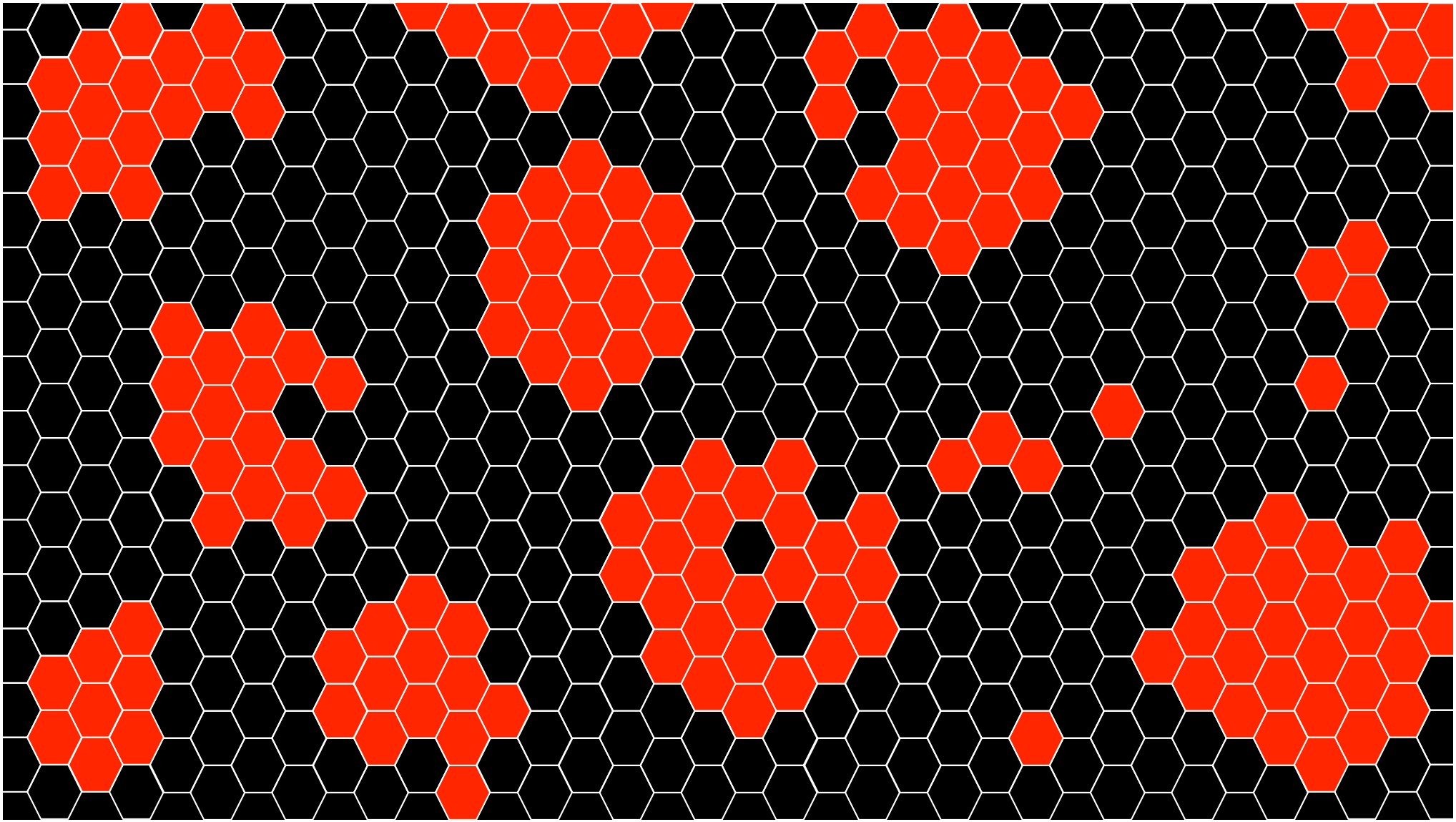


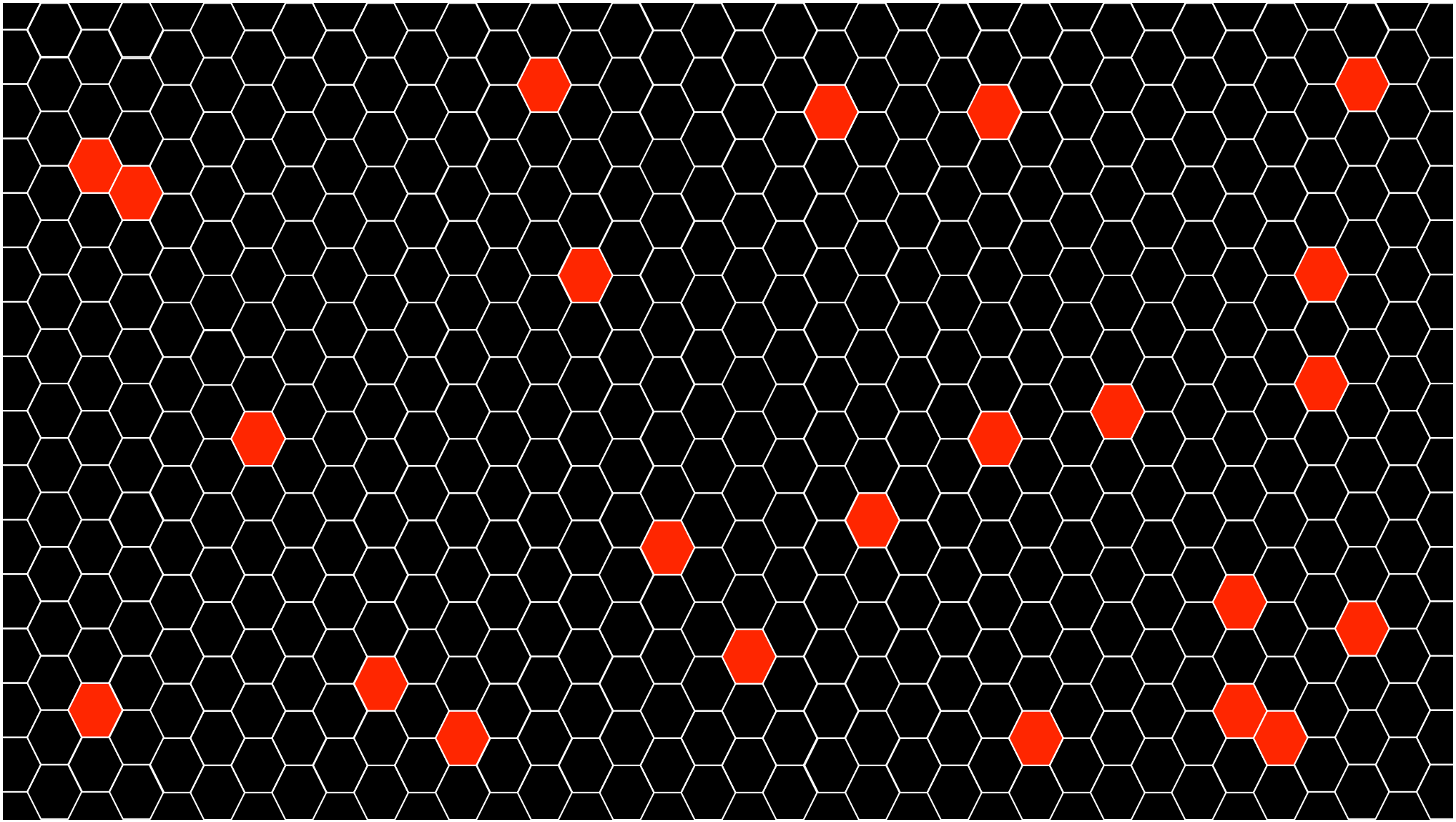

errors

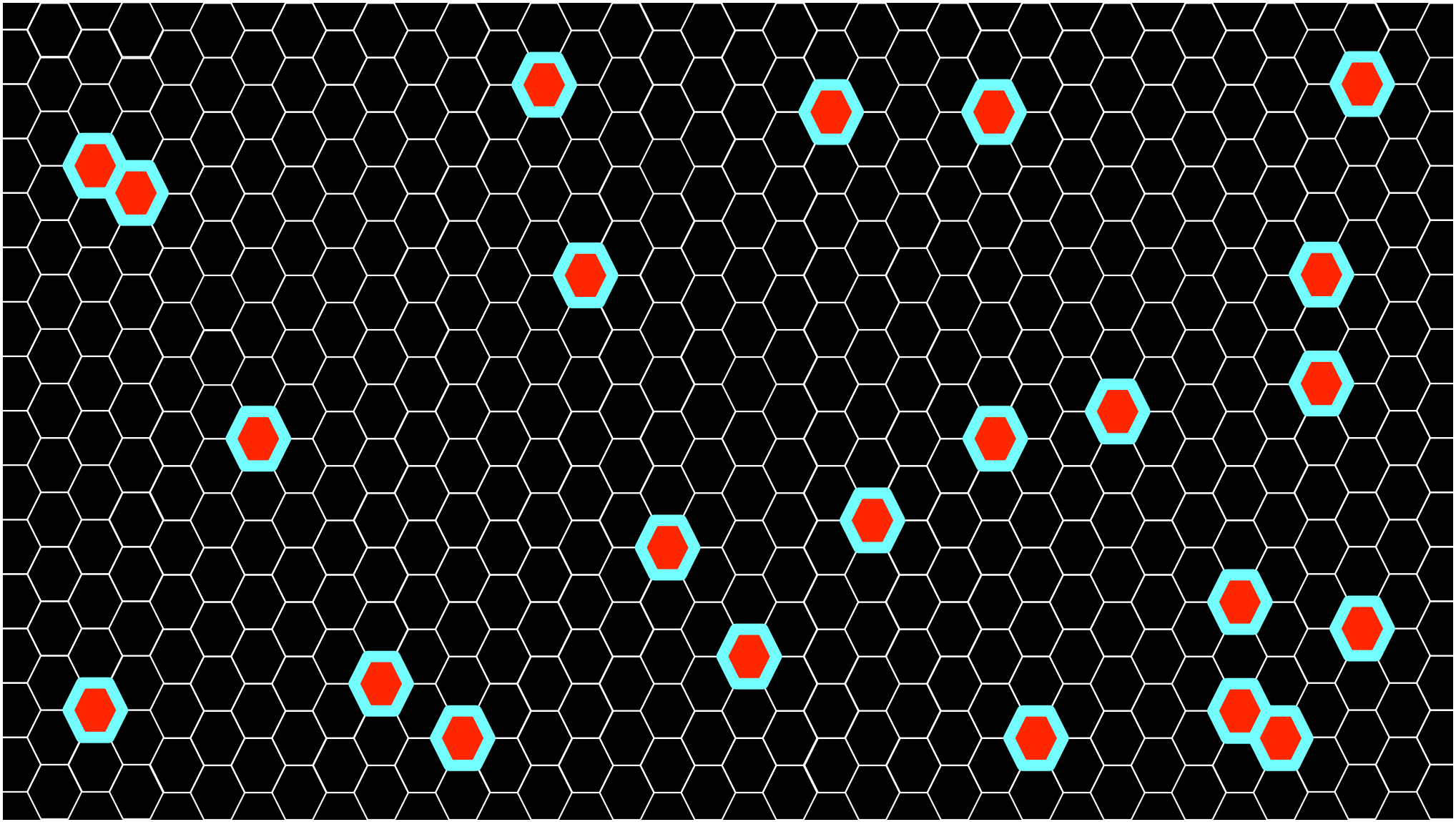


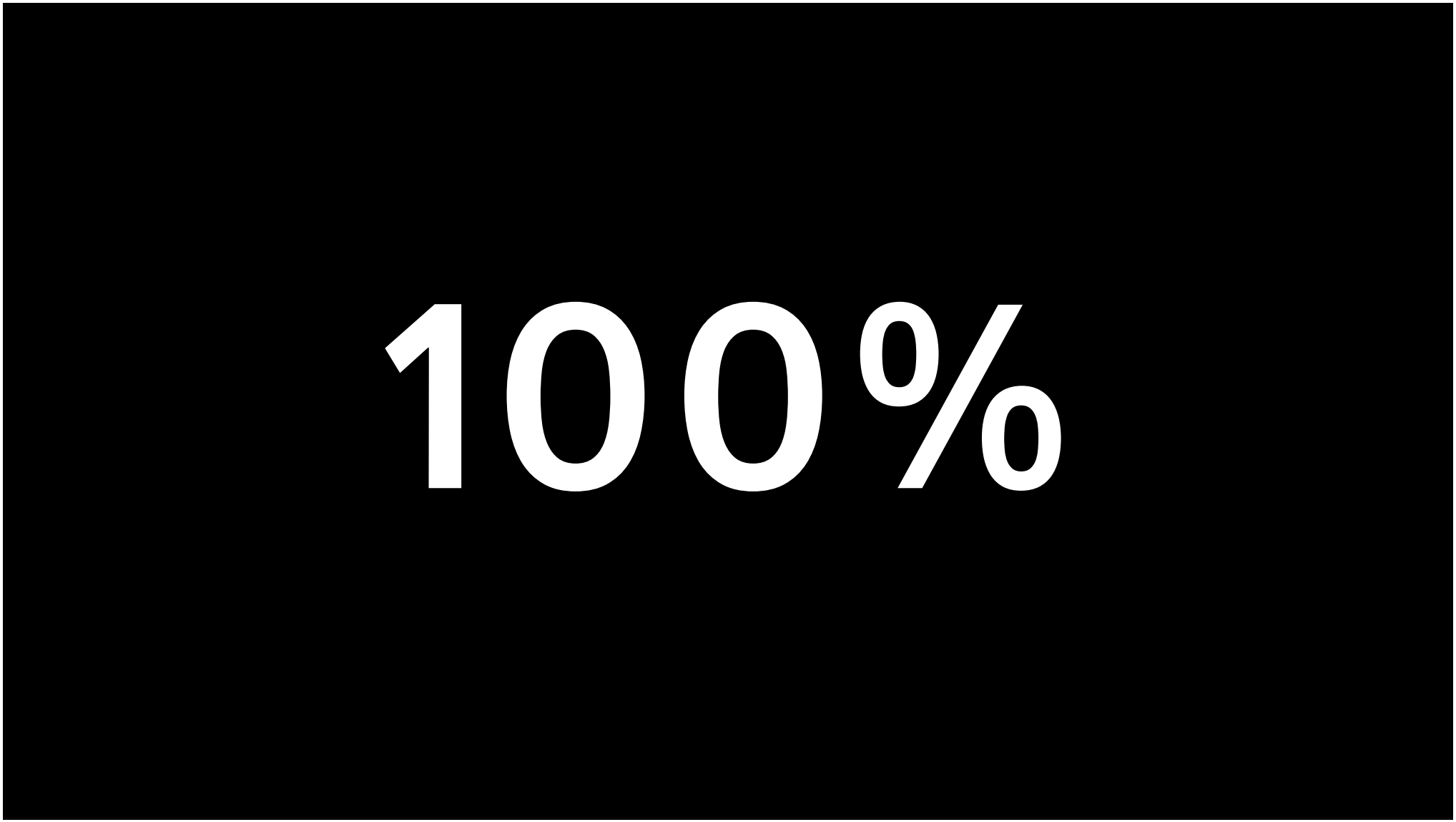











100%

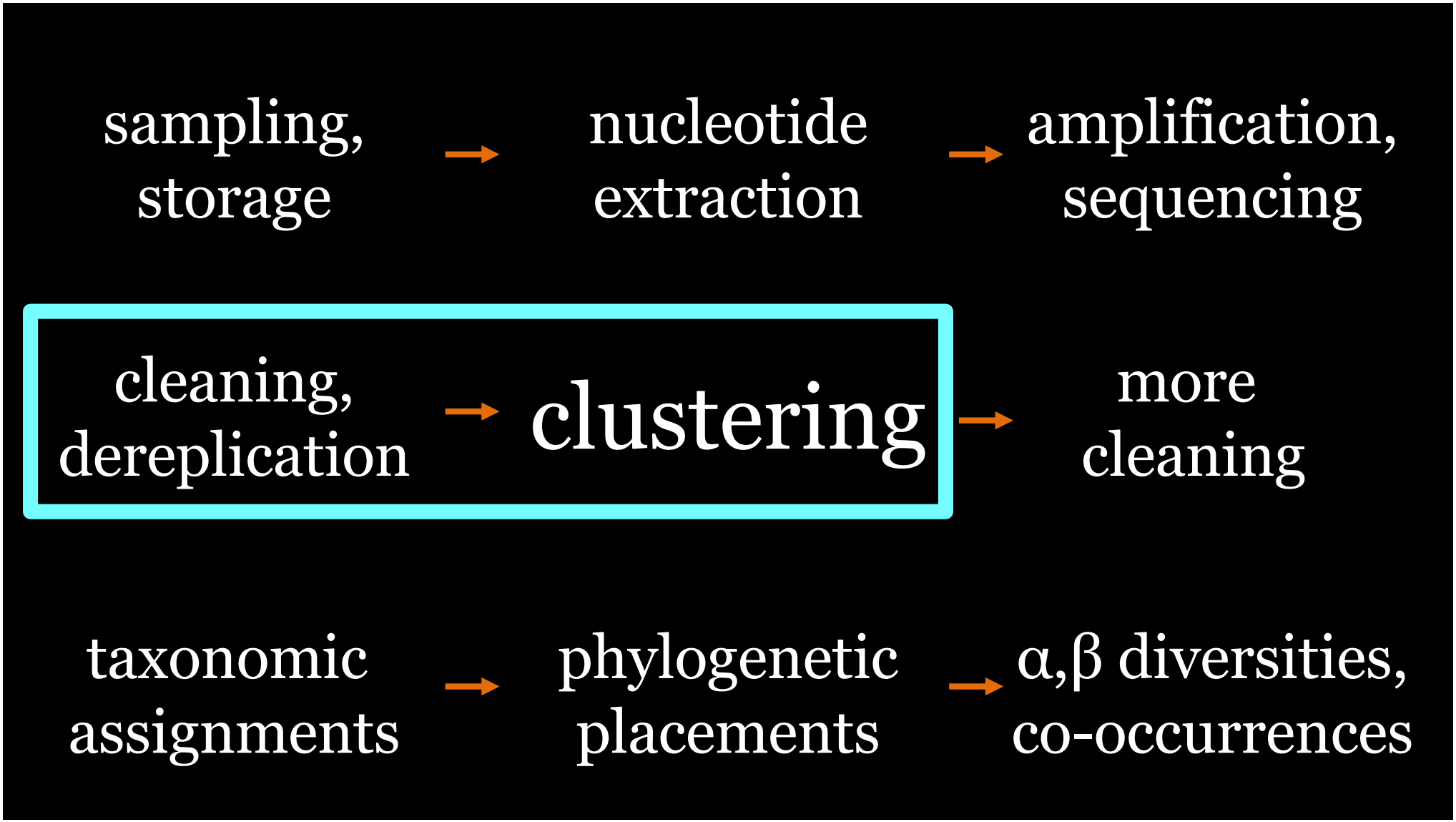
population genetics doesn’t matter

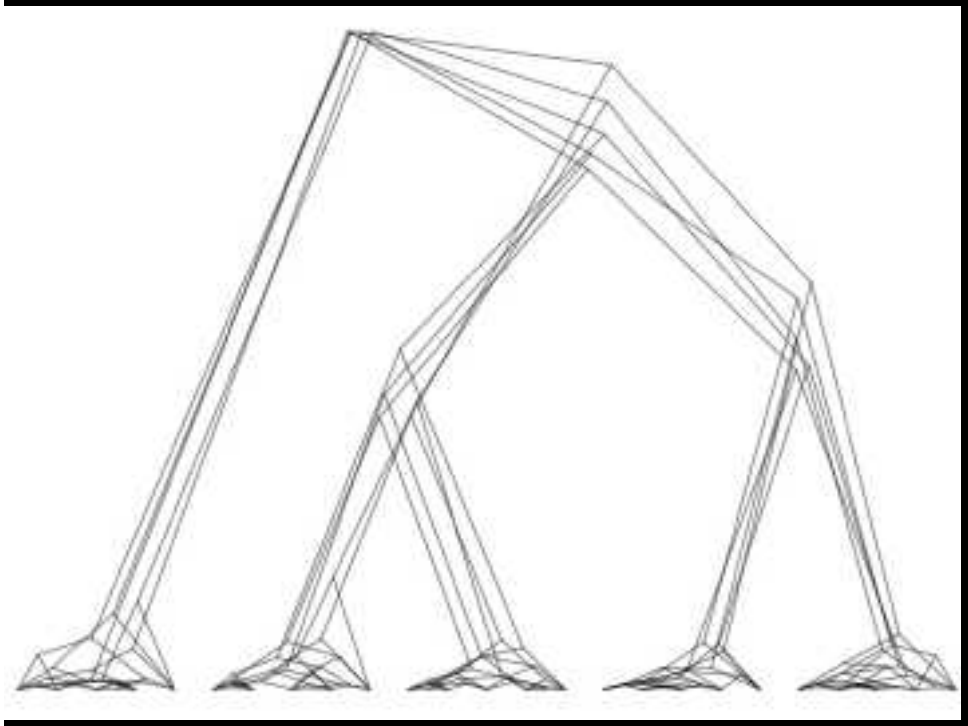
population genetics doesn't matter

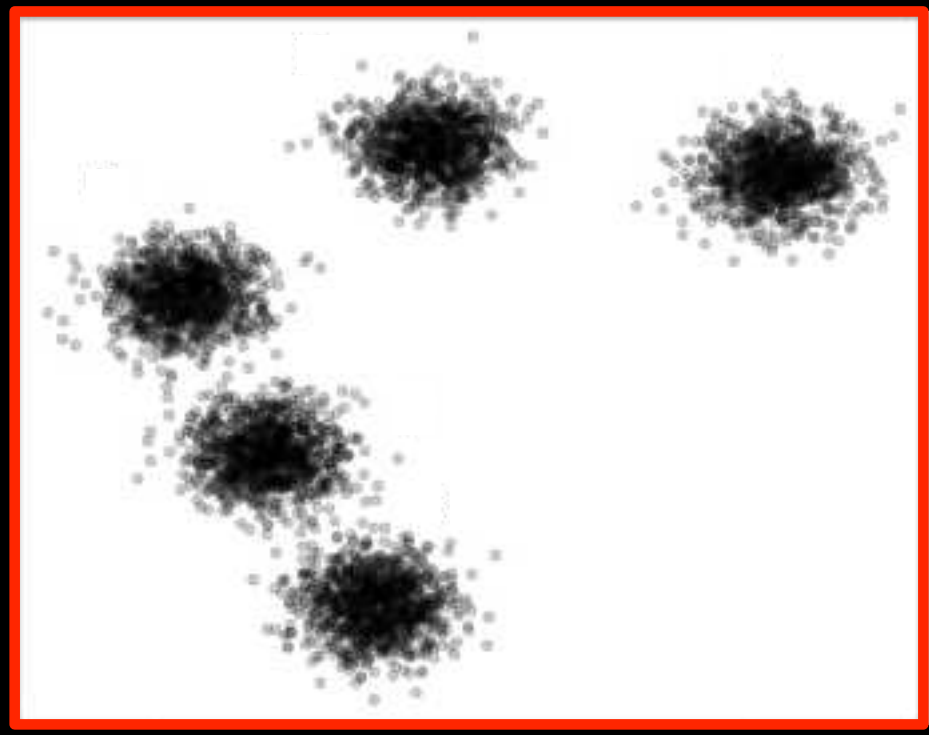
Sewall Wright

J.B.S. Haldane

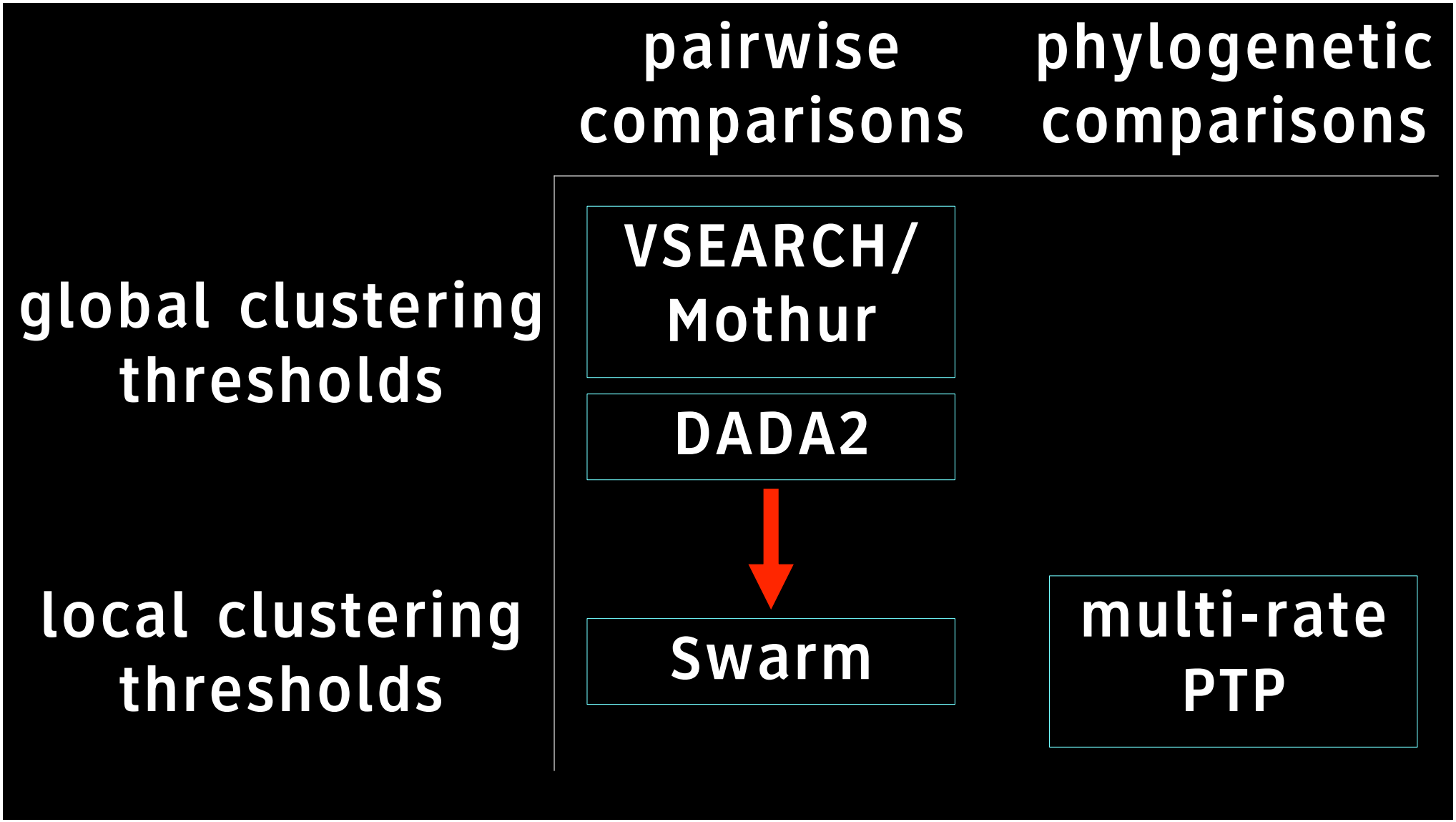
Ronald Fisher


sampling, storage
nucleotide extraction
amplification, sequencing
cleaning, dereplication
clustering
more cleaning
taxonomic assignments
phylogenetic placements
α,β diversities, co-occurrences





Barraclough (2019) The Evolutionary Biology of Species


pairwise comparisons
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global clustering thresholds
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VSEARCH/ Mothur
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Swarm
multi-rate PTP

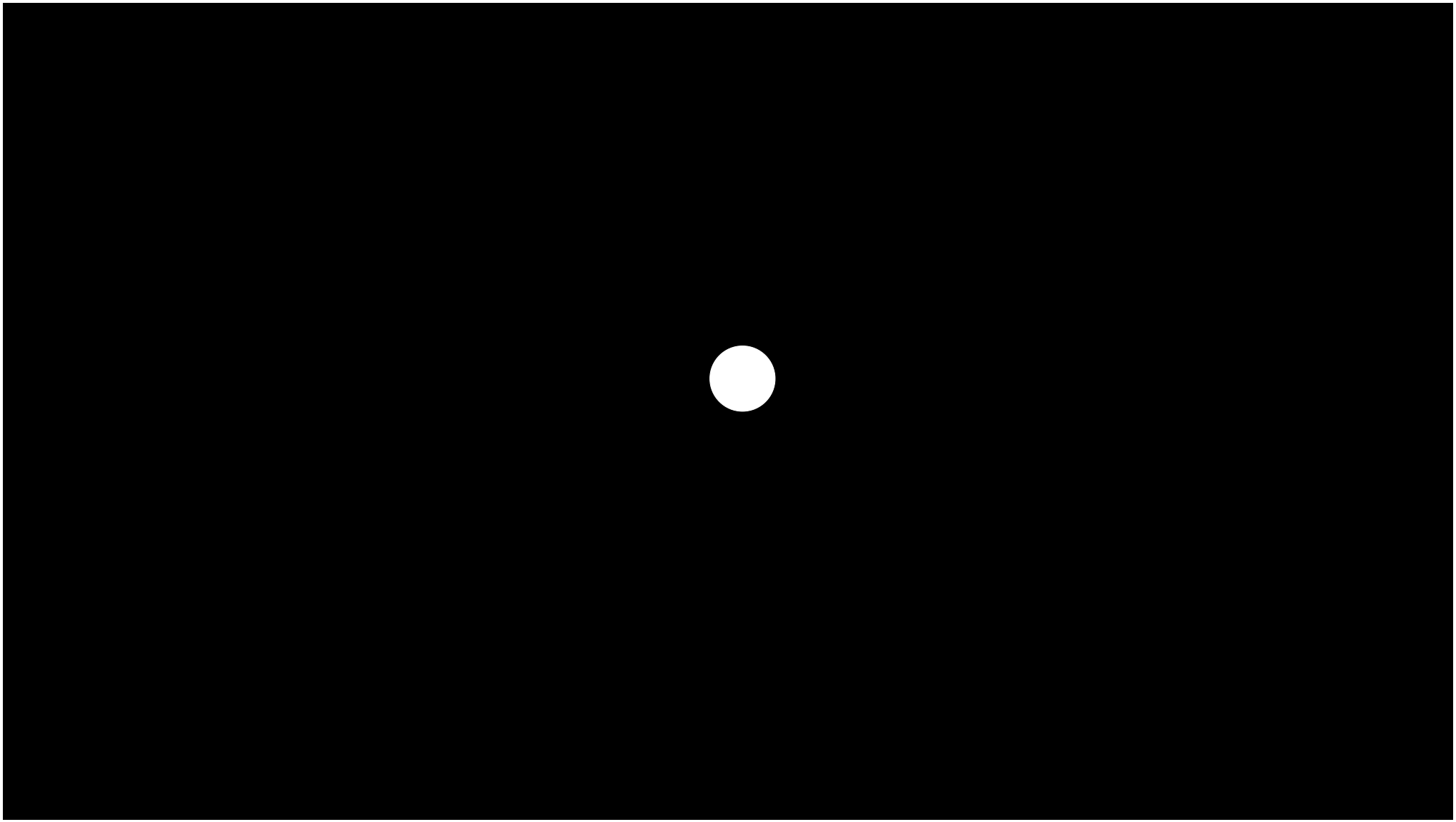
Bioinformatics, 38(1), 2022, 267–269
doi: 10.1093/bioinformatics/btab493
Advance Access Publication Date: 9 July 2021
Applications Note

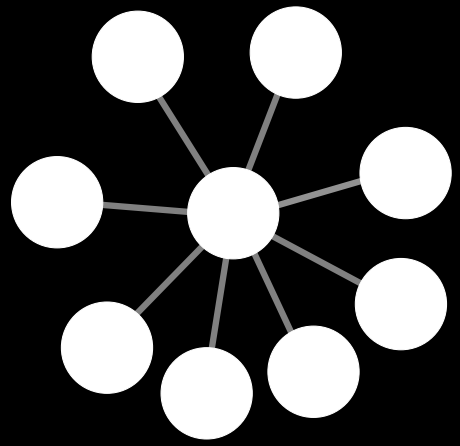
OXFORD

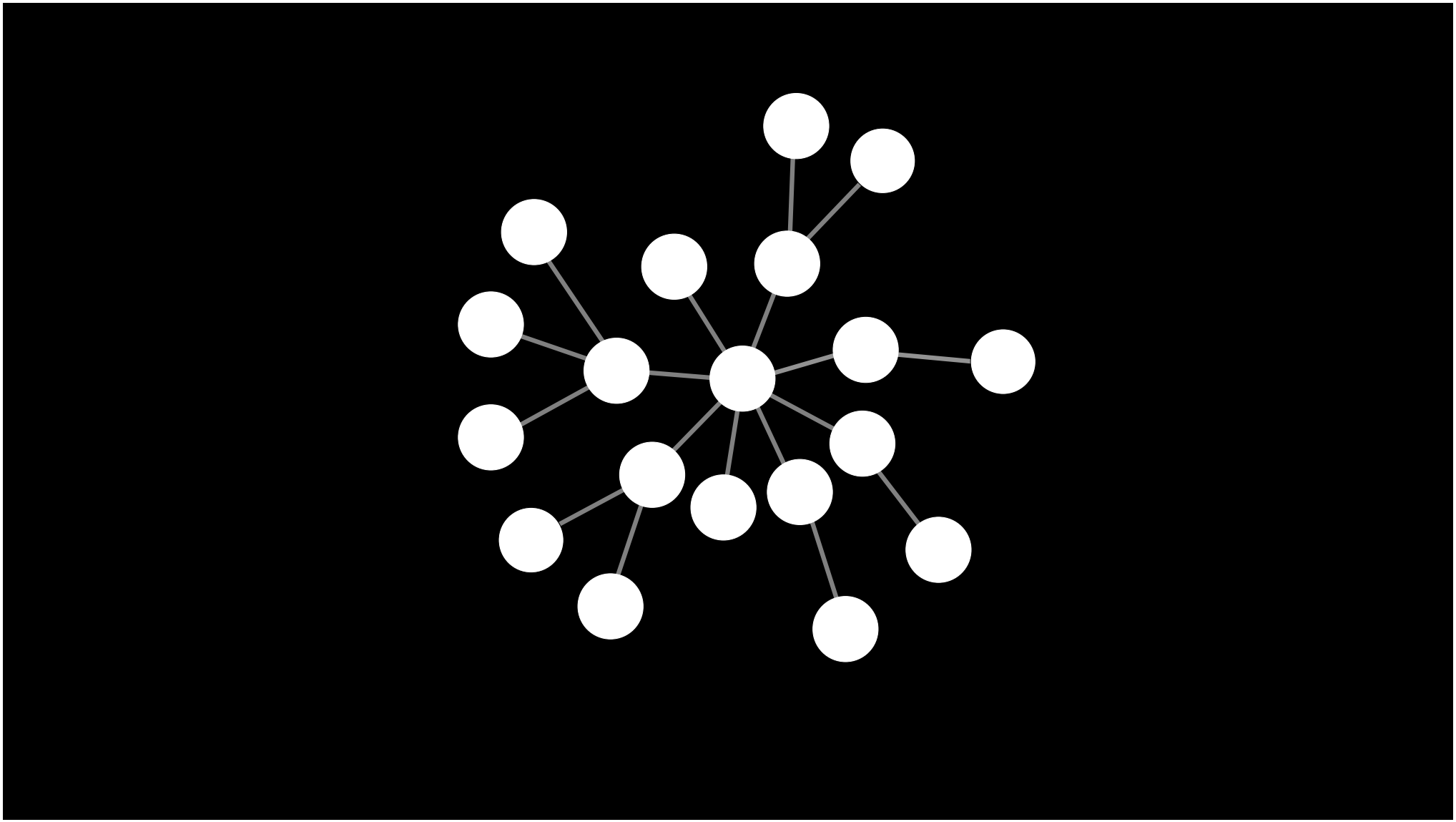
Sequence analysis

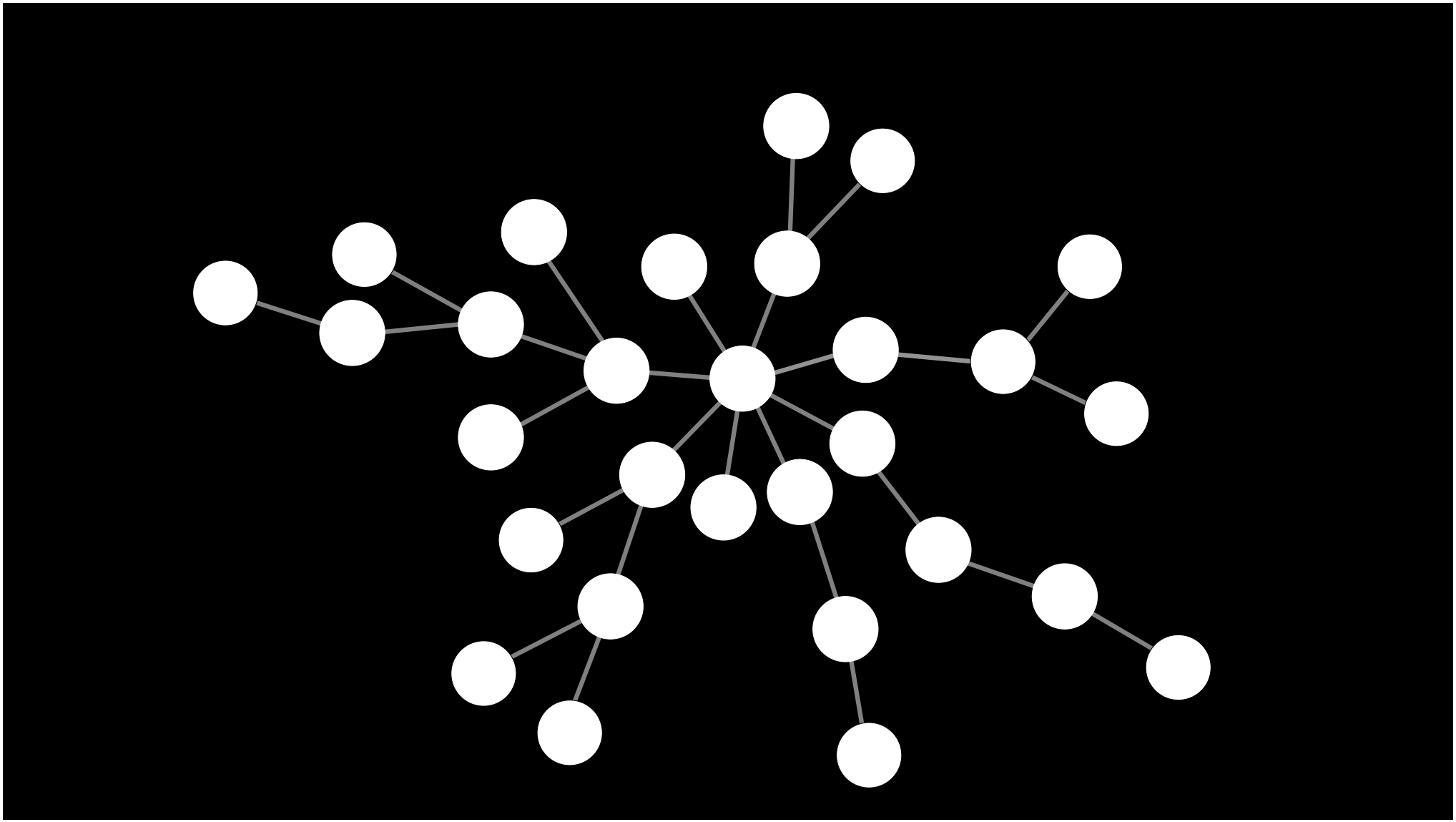
Swarm v3: towards tera-scale amplicon clustering

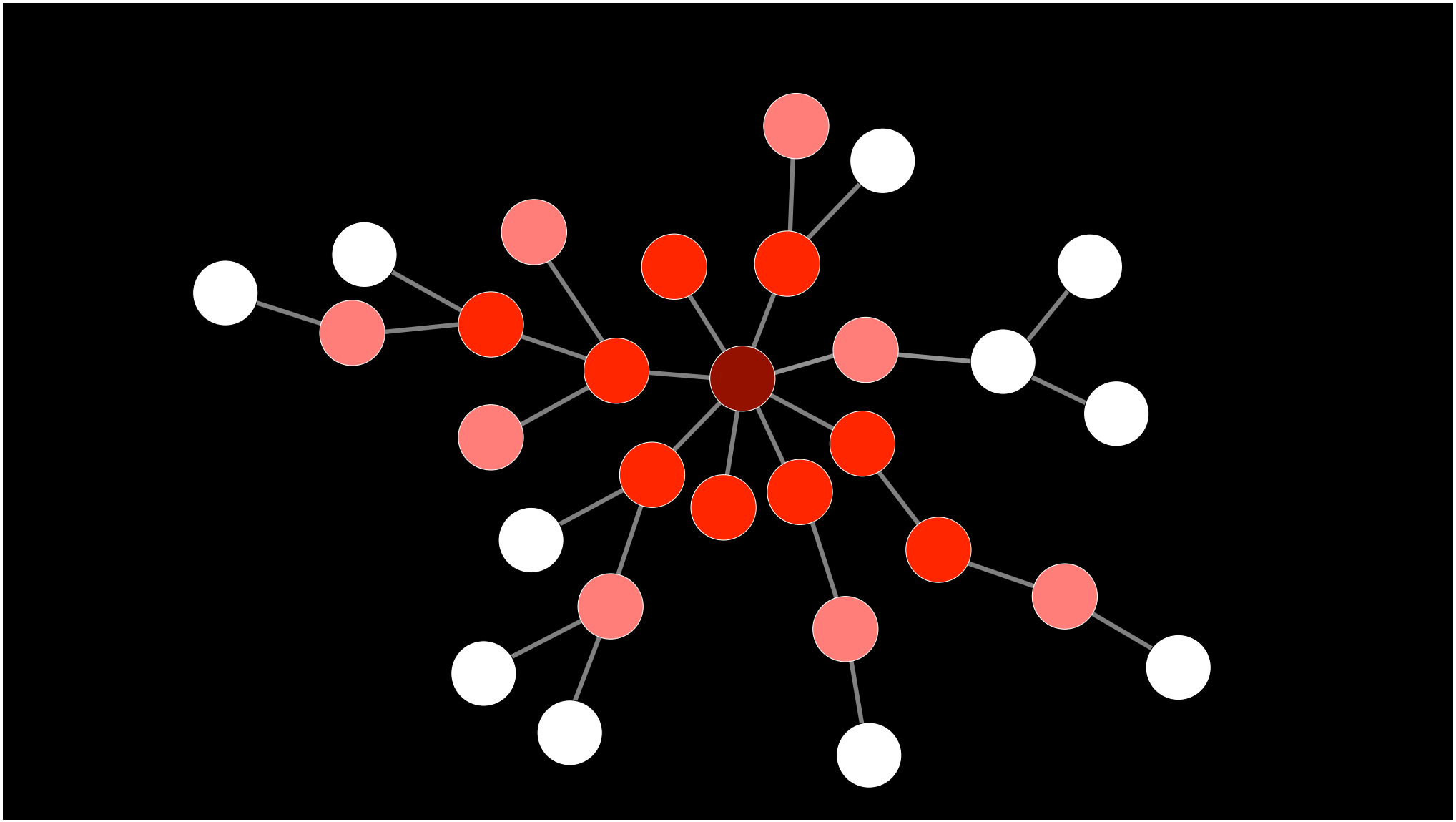
Frédéric Mahé[1,2,*], Lucas Czech [3,4], Alexandros Stamatakis[3,5], Christopher Quince[6,7,8], Colomban de Vargas[9,10], Micah Dunthorn [11,12] and Torbjørn Rognes[13,14]

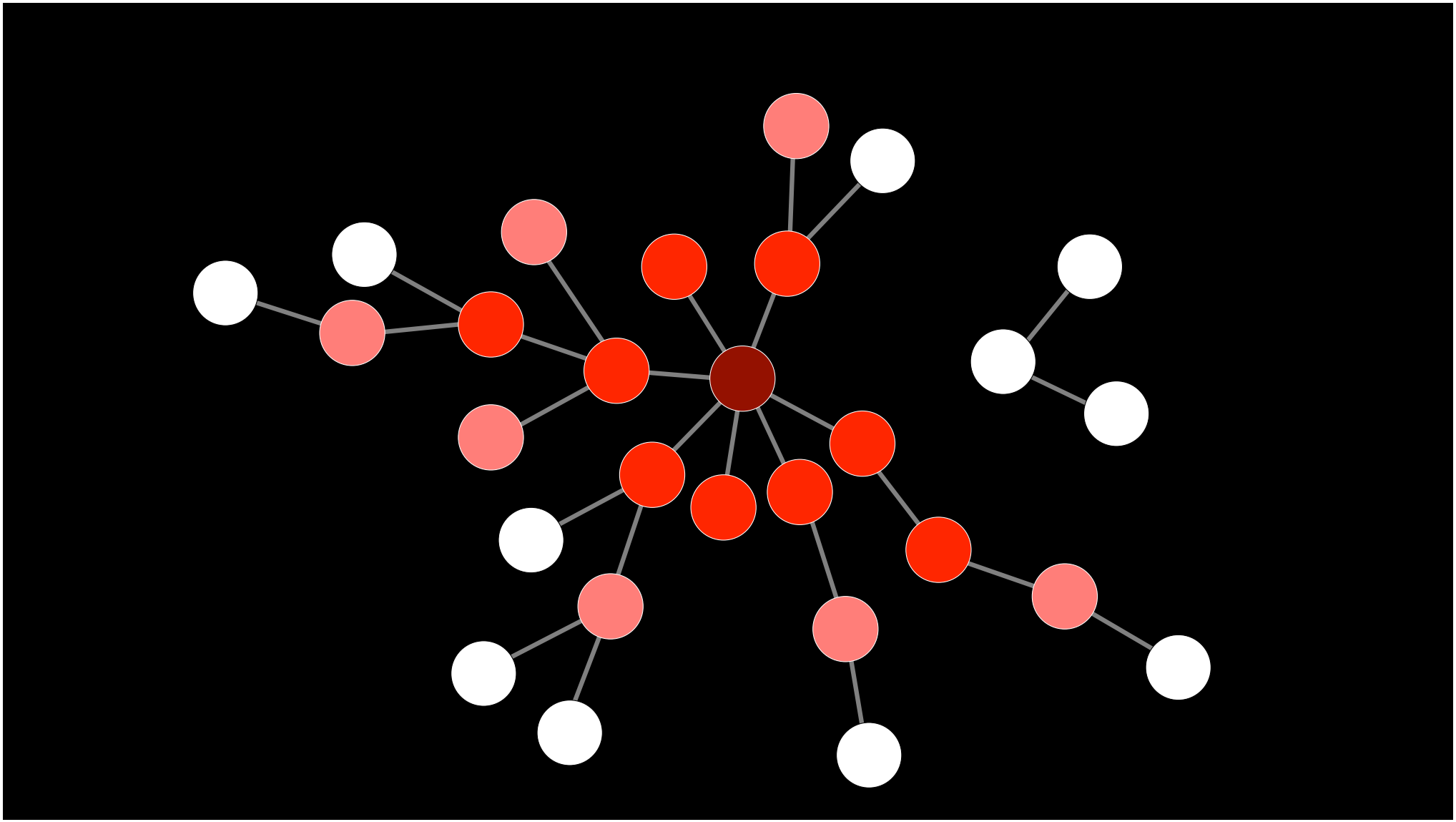


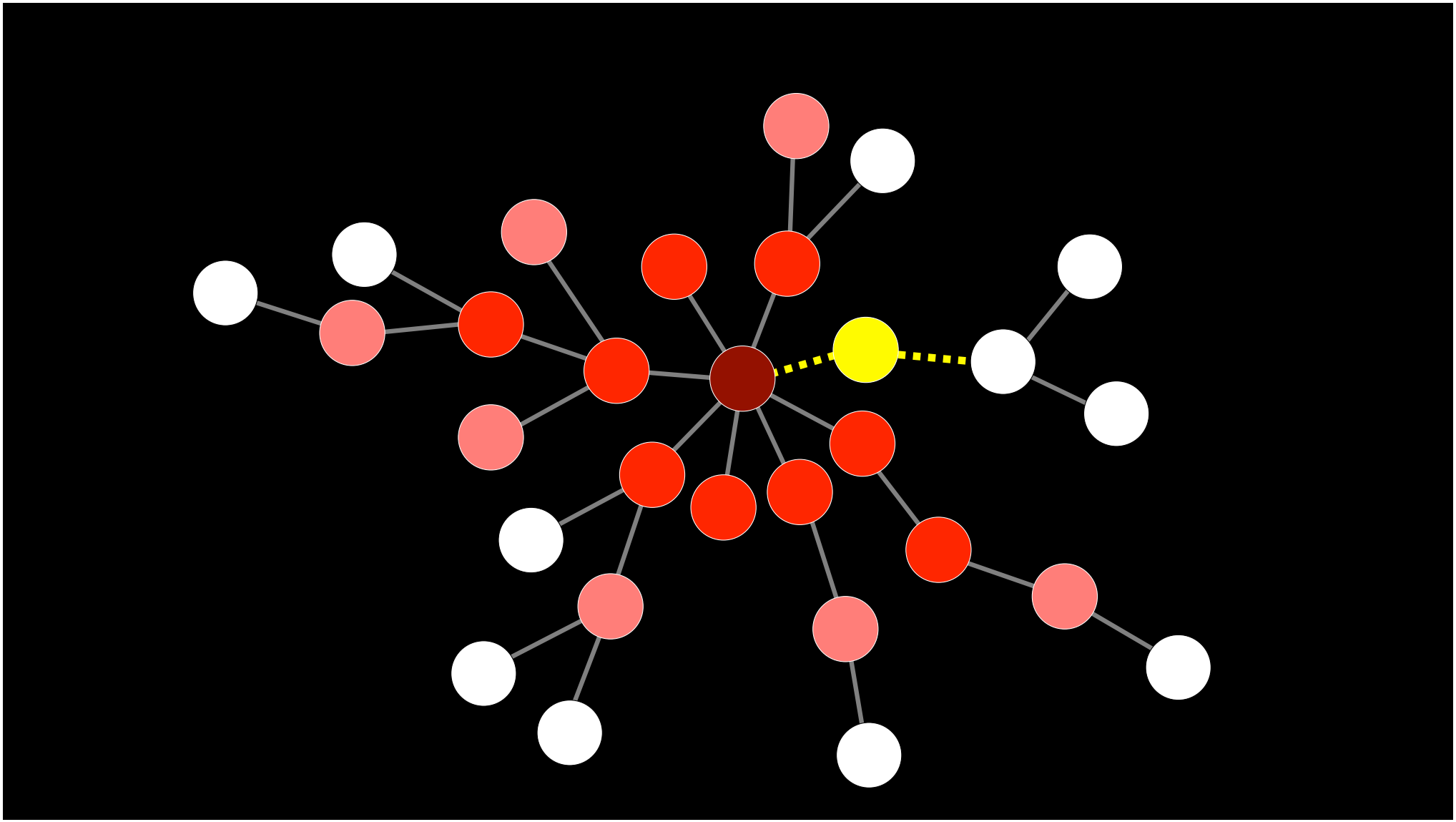


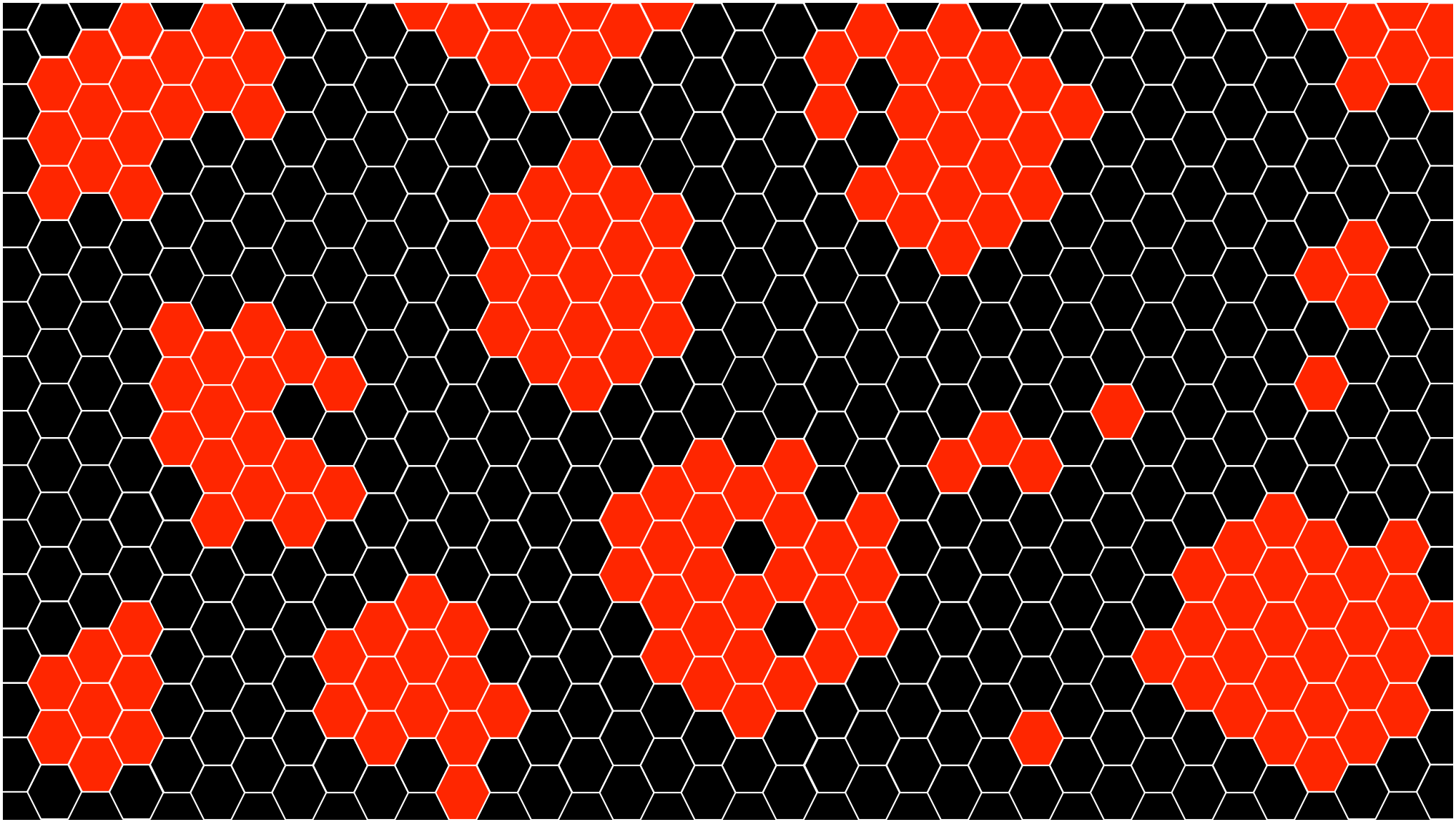


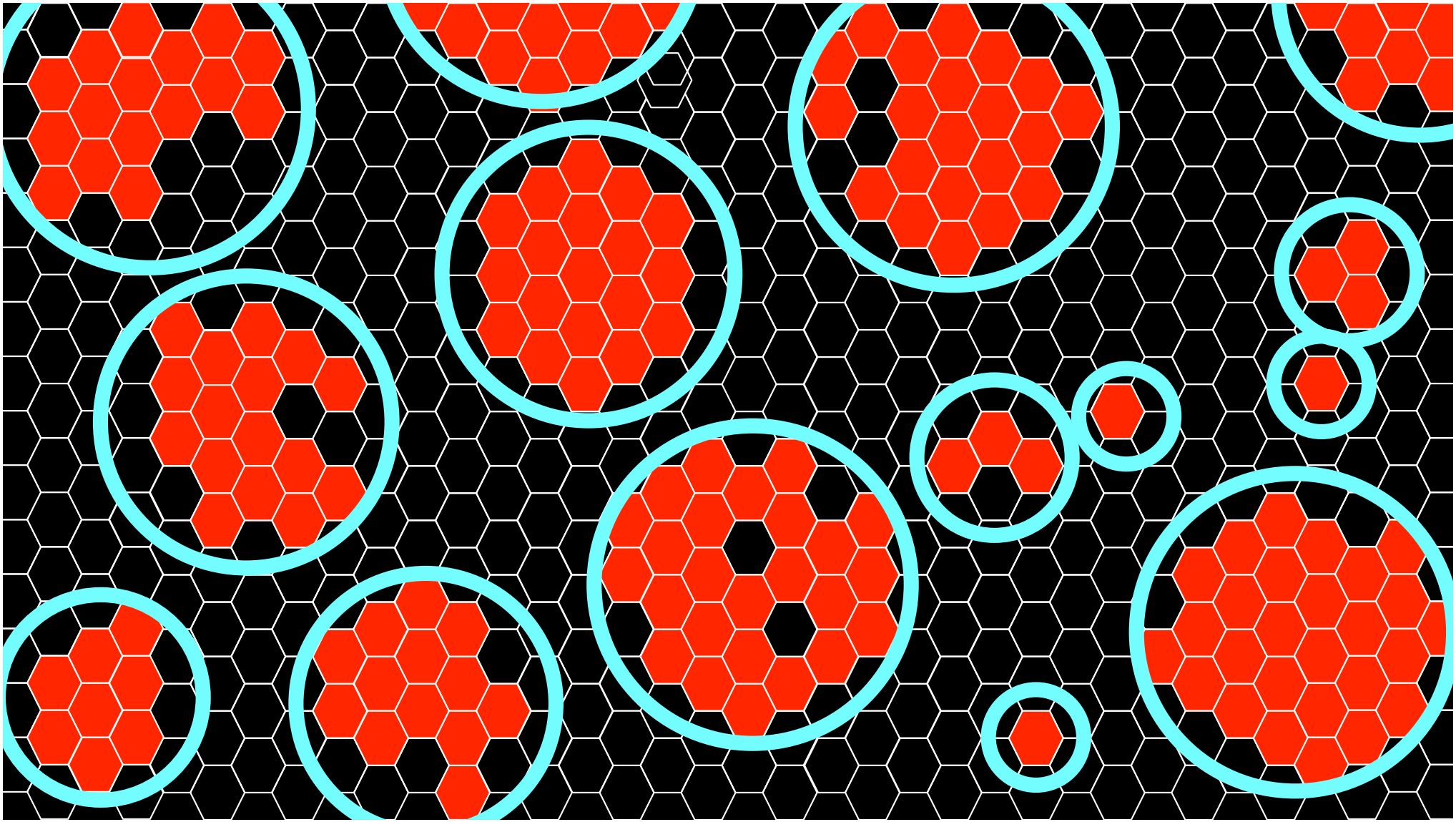


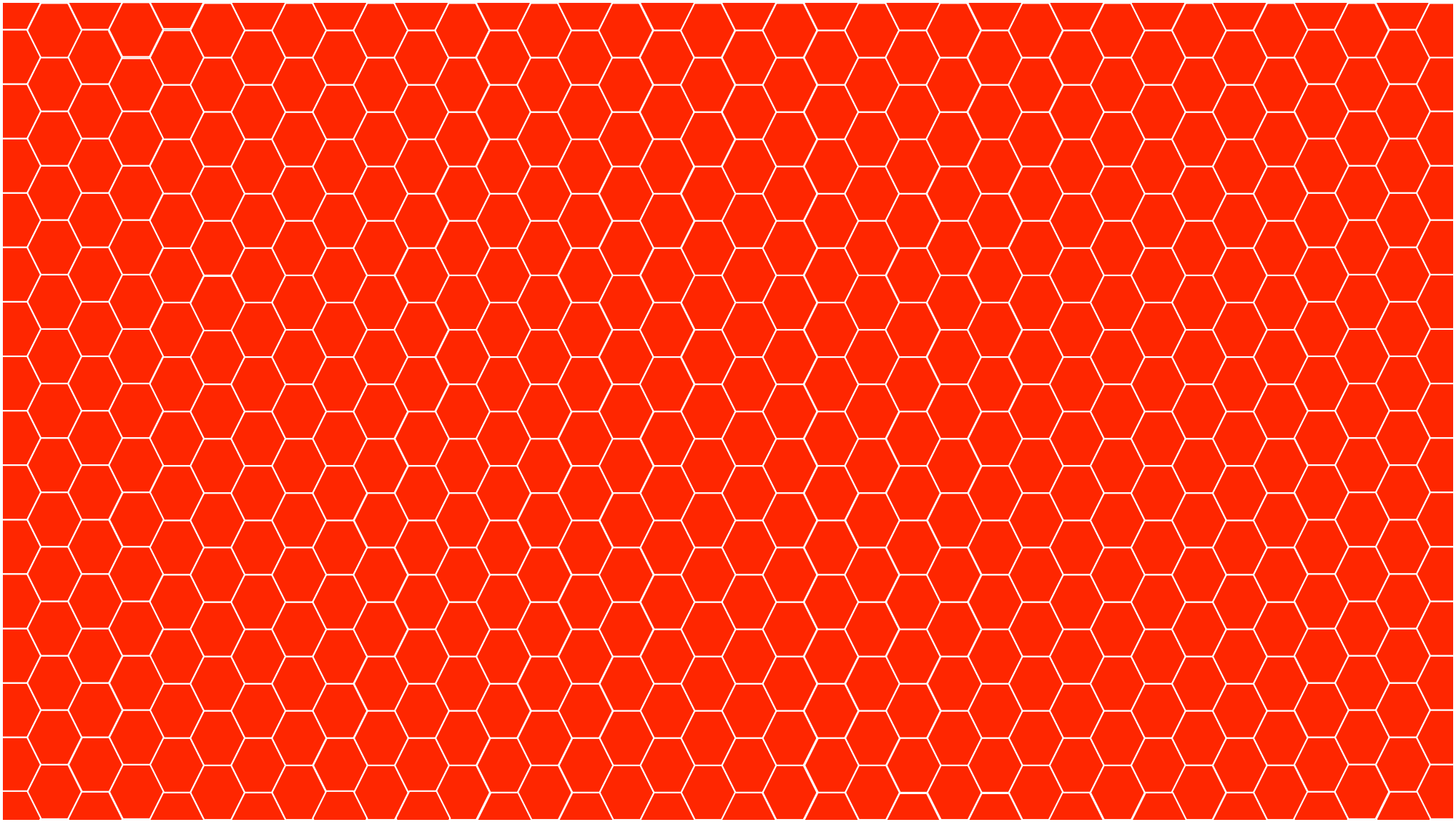


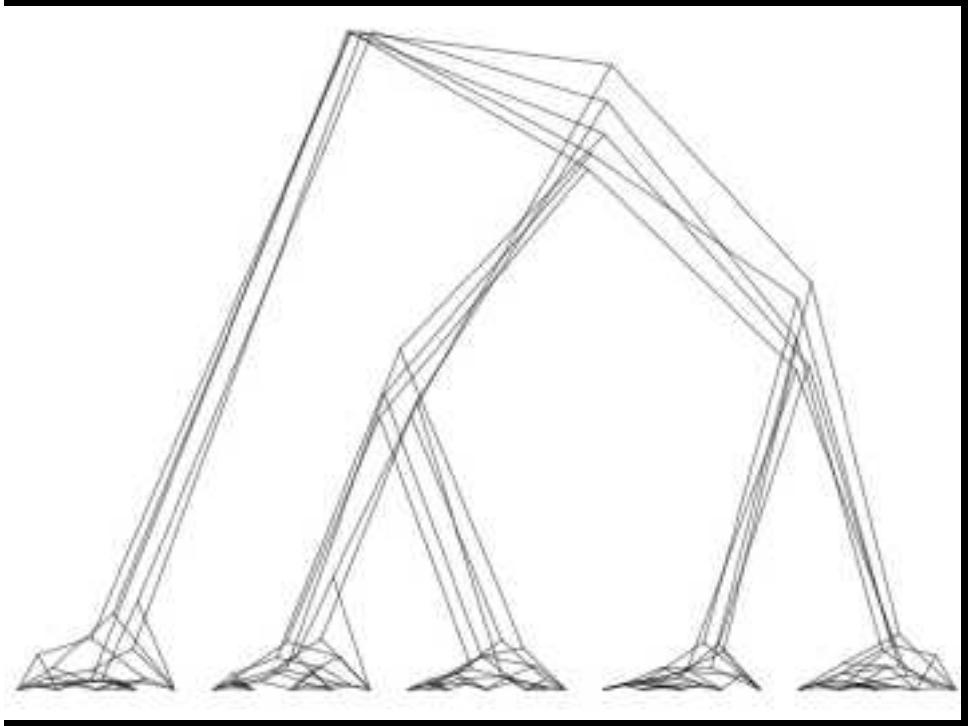


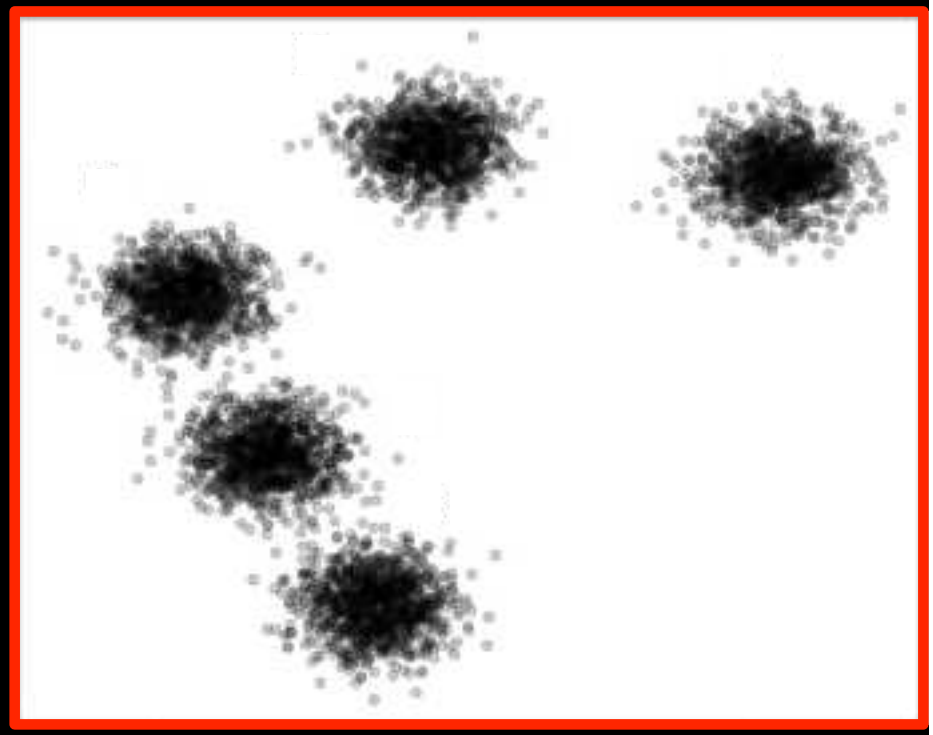












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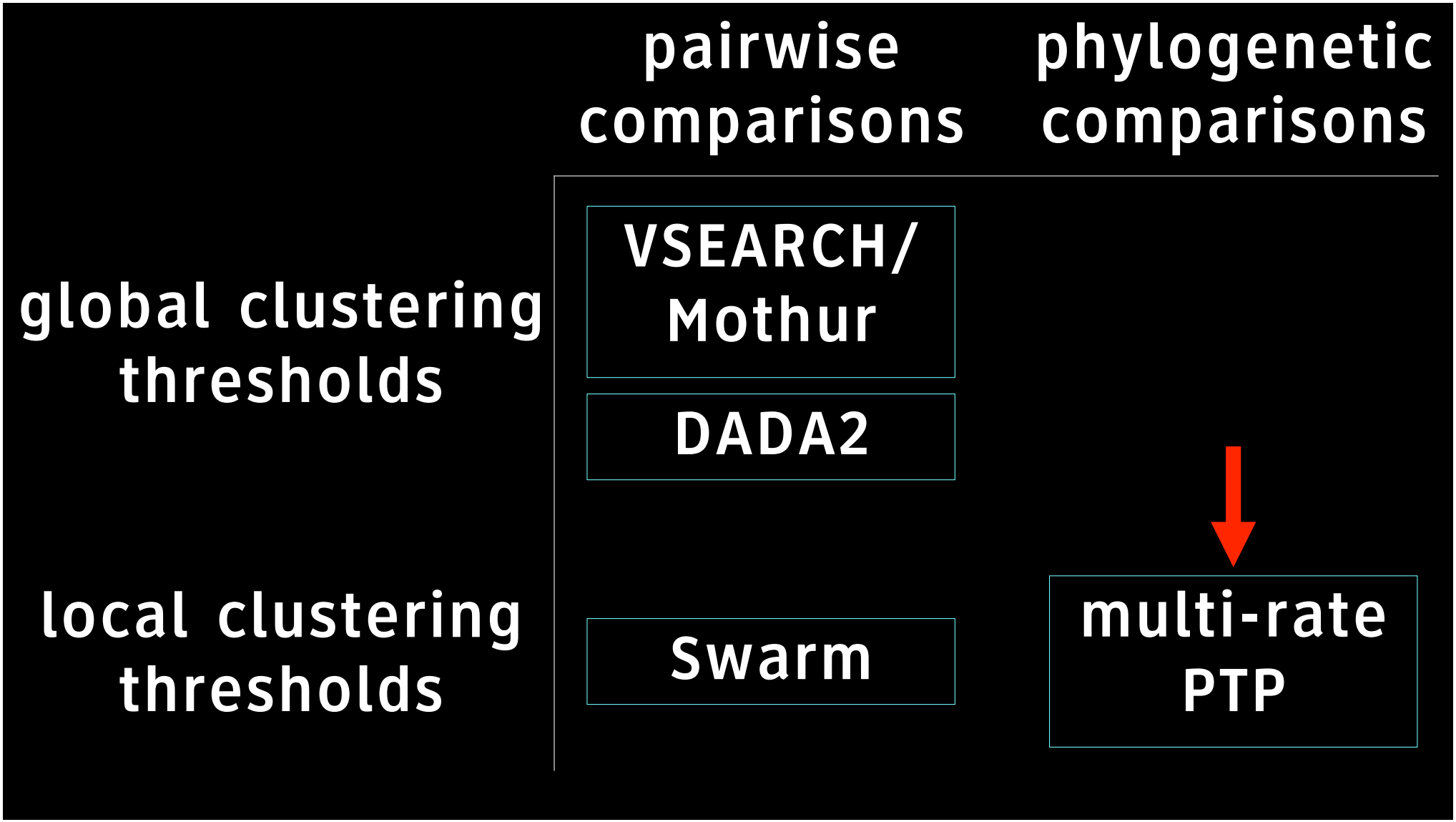
pairwise comparisons
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Swarm
multi-rate PTP

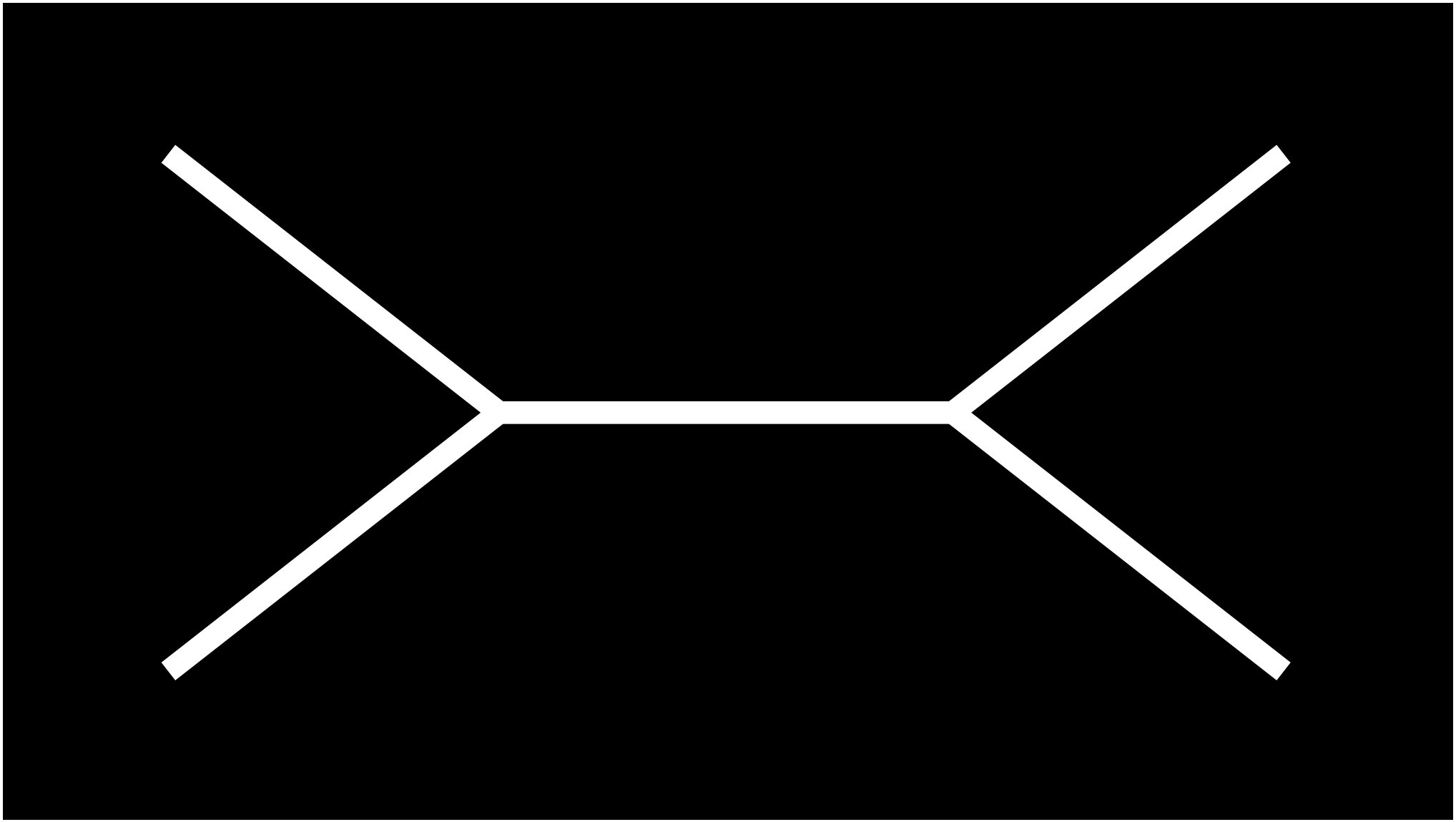
Bioinformatics, 33(11), 2017, 1630–1638
doi: 10.1093/bioinformatics/btx025
Advance Access Publication Date: 20 January 2017
Original Paper

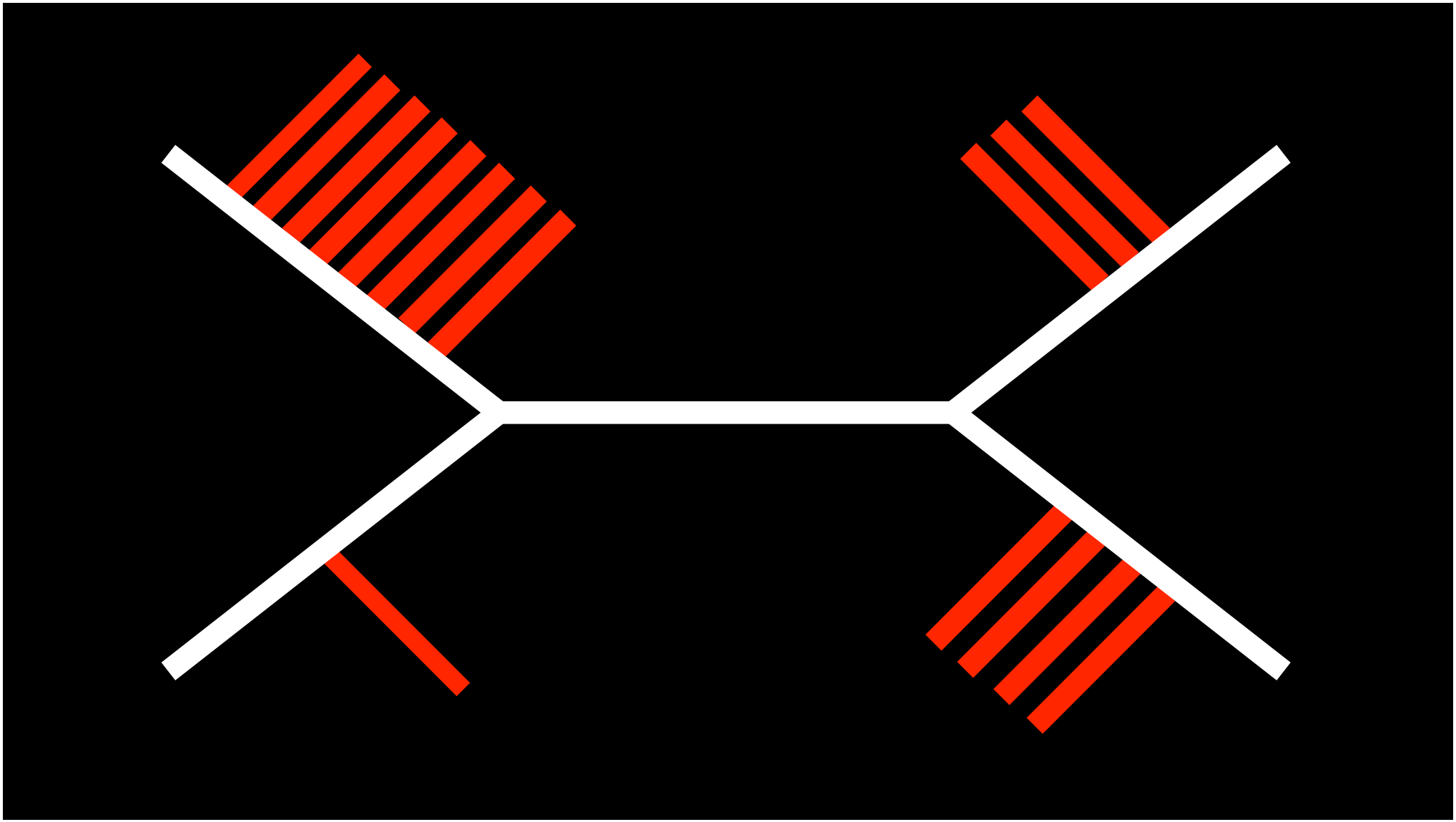
OXFORD

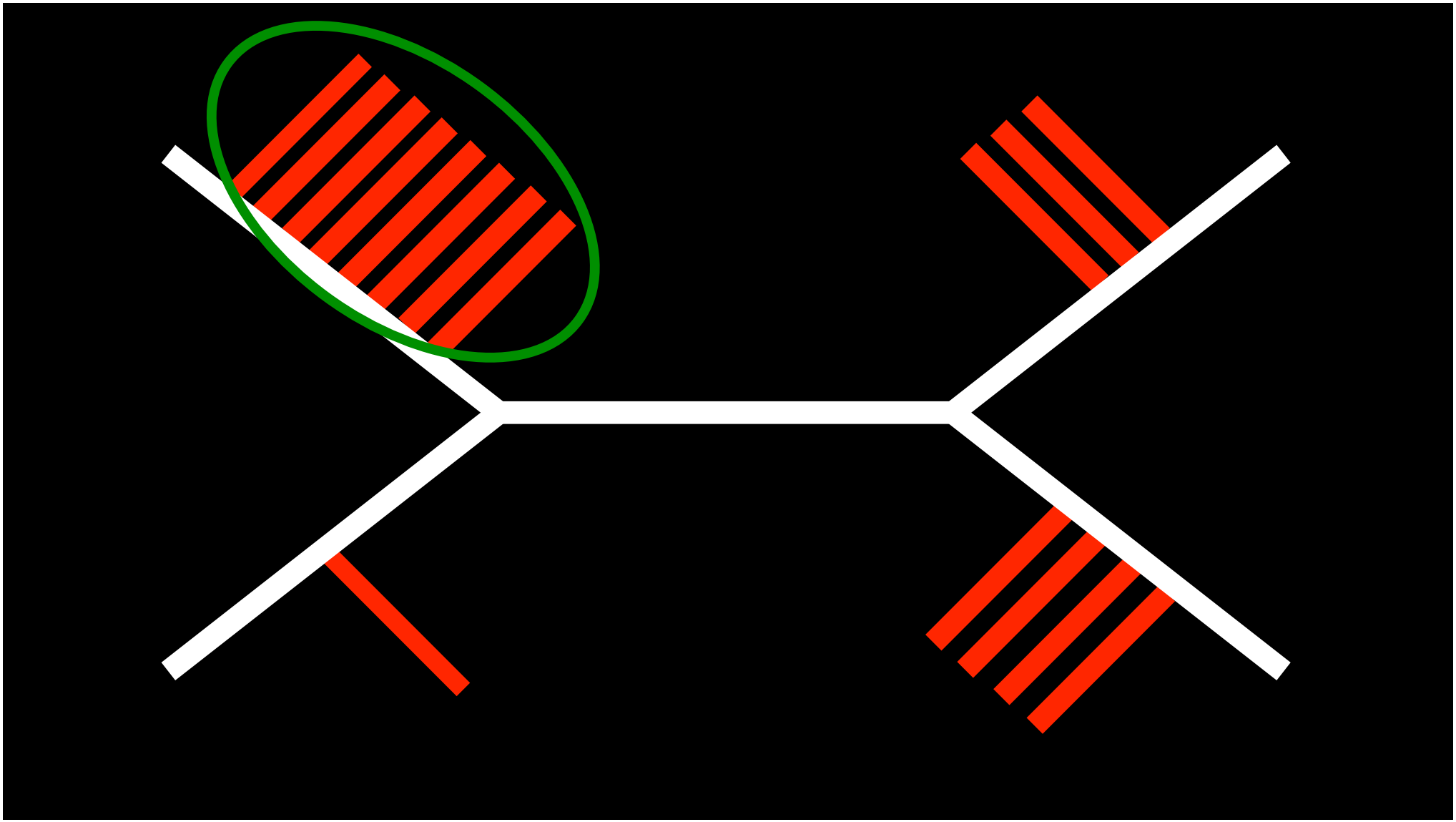
Phylogenetics

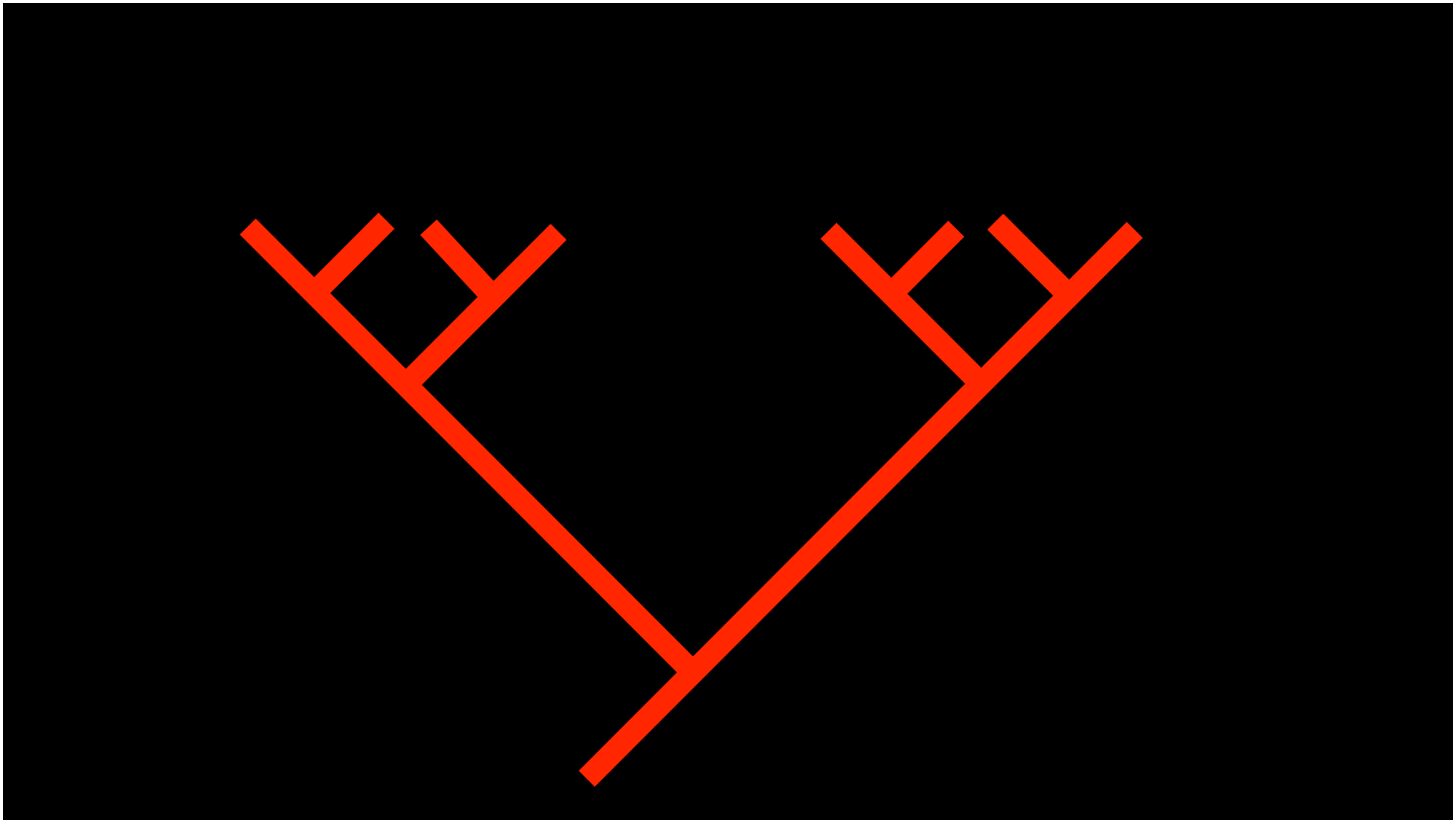
Multi-rate Poisson tree processes for single-locus species delimitation under maximum likelihood and Markov chain Monte Carlo

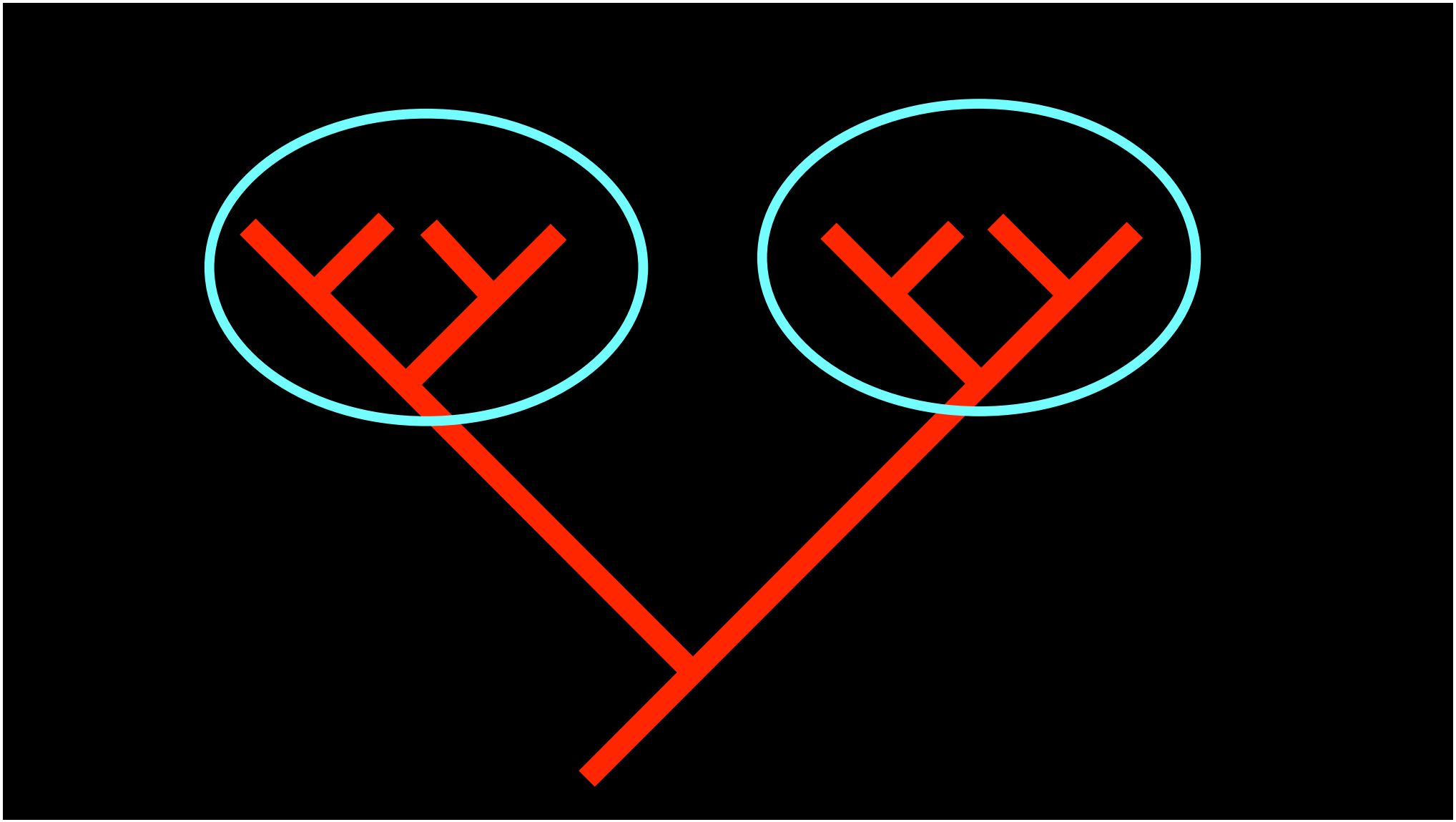
P. Kapli[1,*], S. Lutteropp[1,2], J. Zhang[1], K. Kobert[1], P. Pavlidis[3], A. Stamatakis[1,2,*] and T. Flouri[1,2,*]

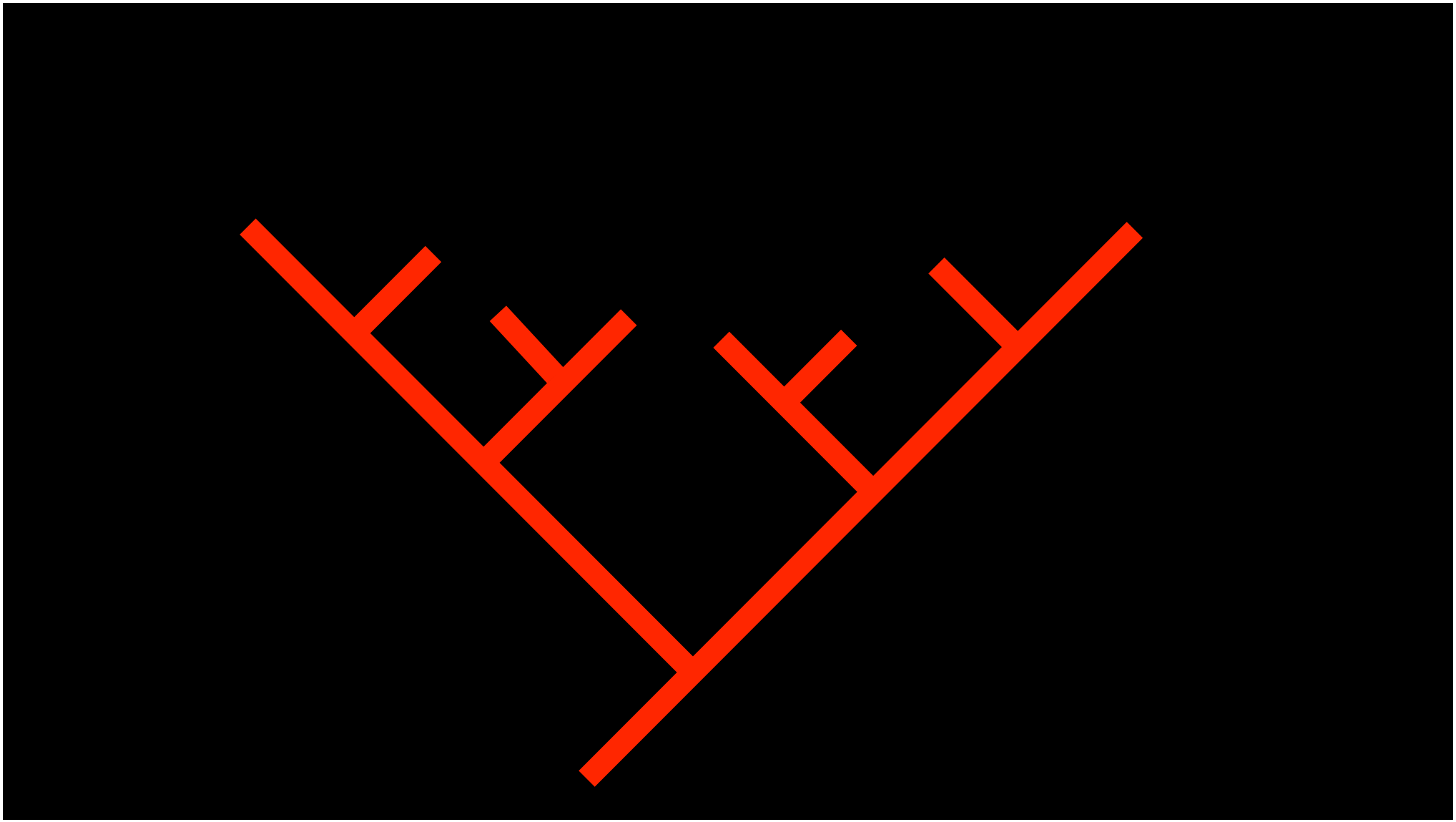


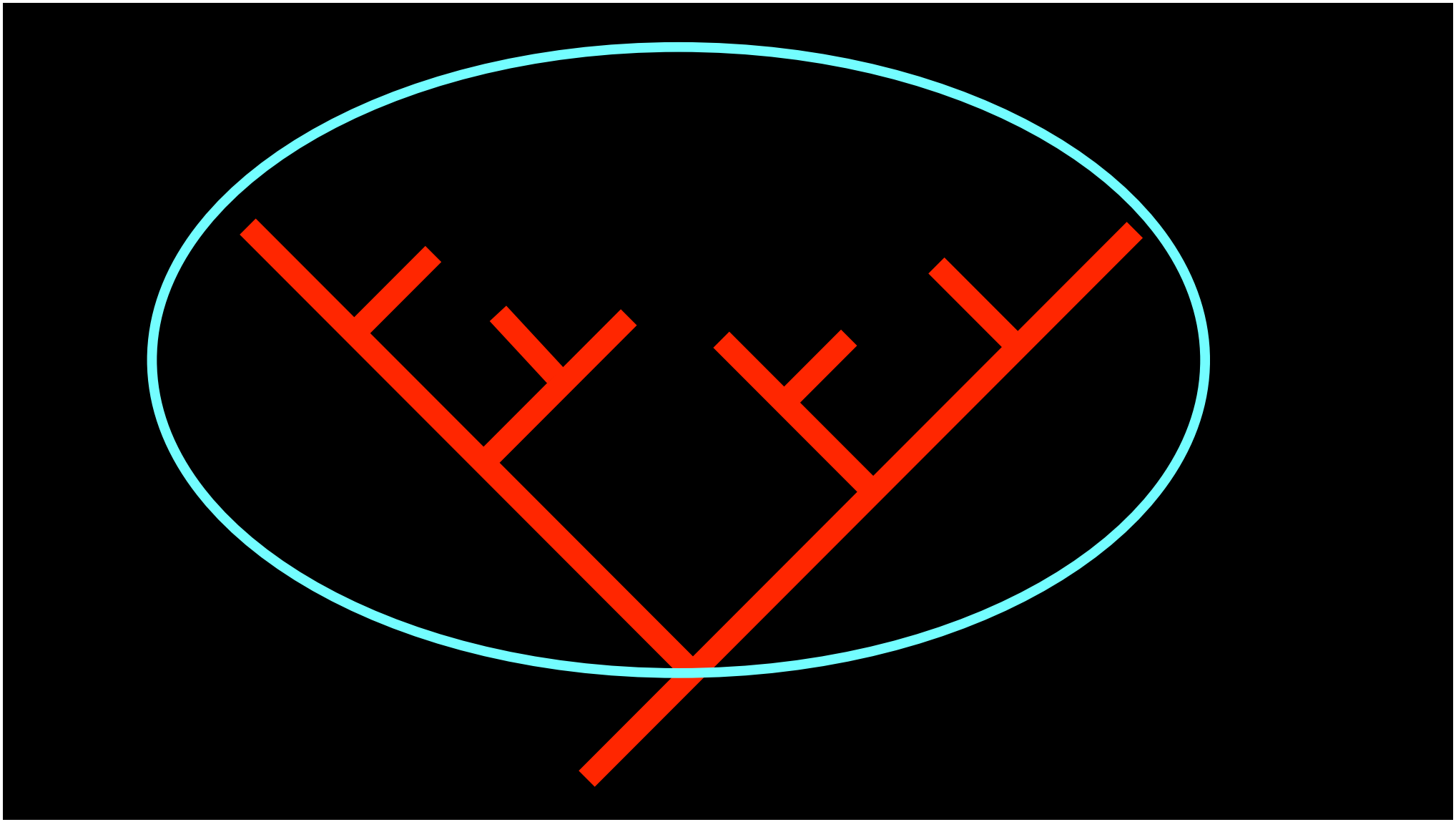


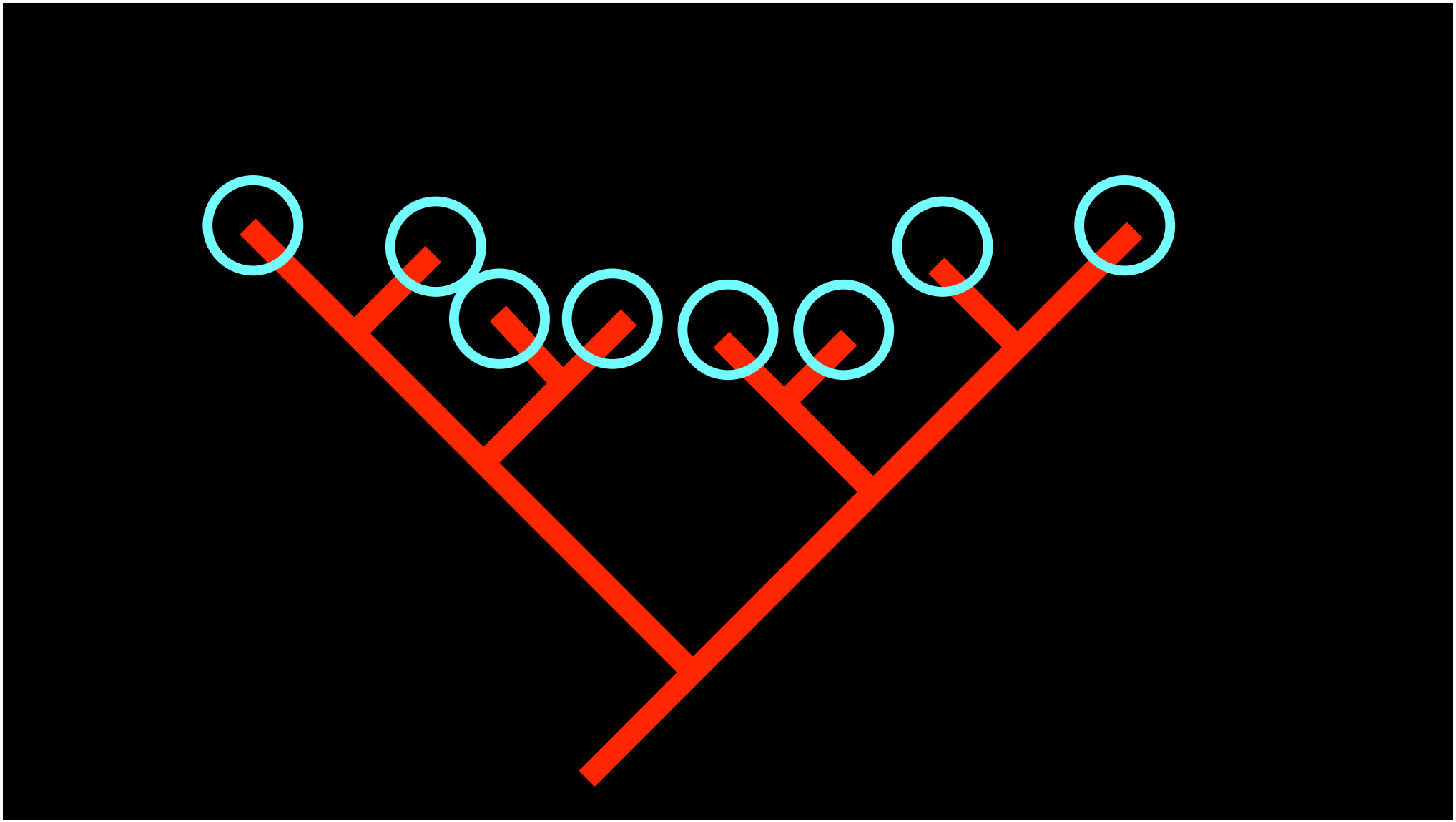


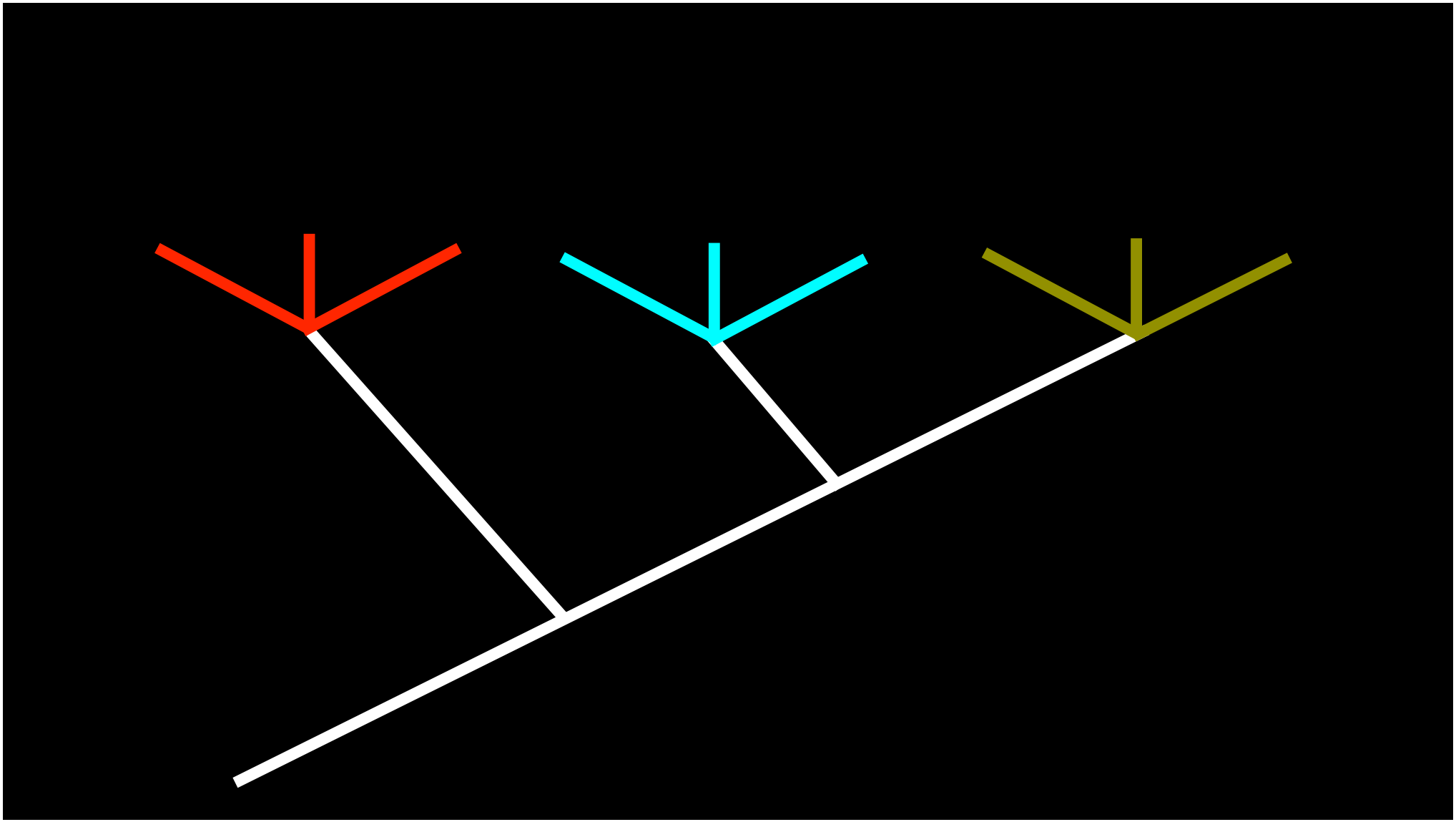


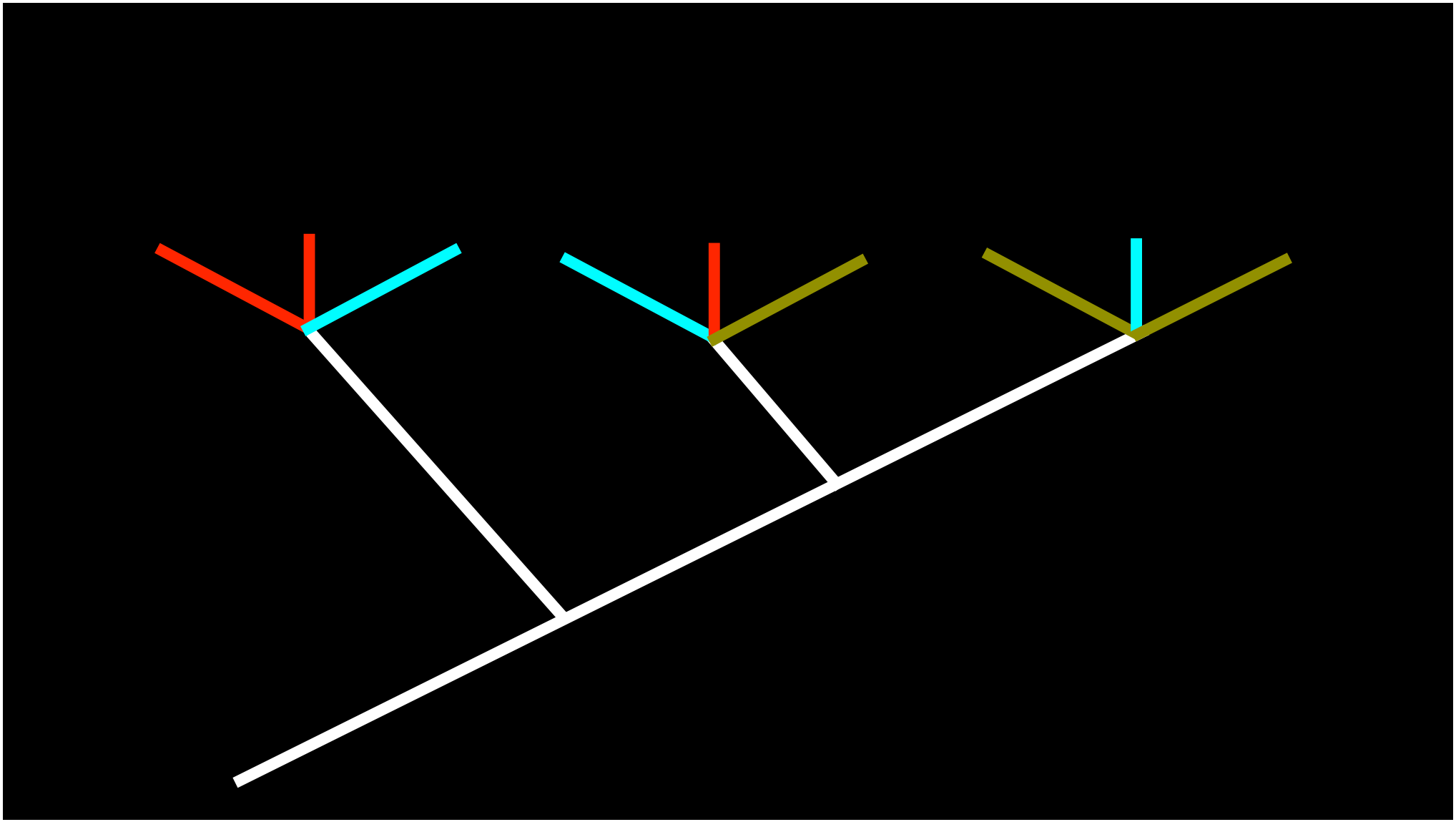


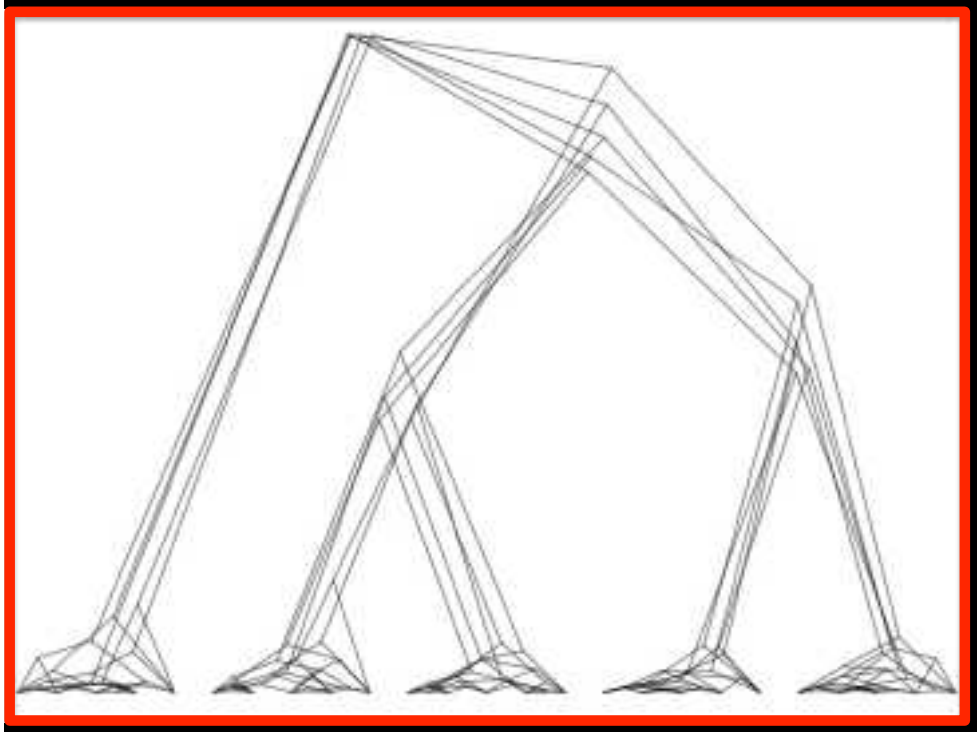


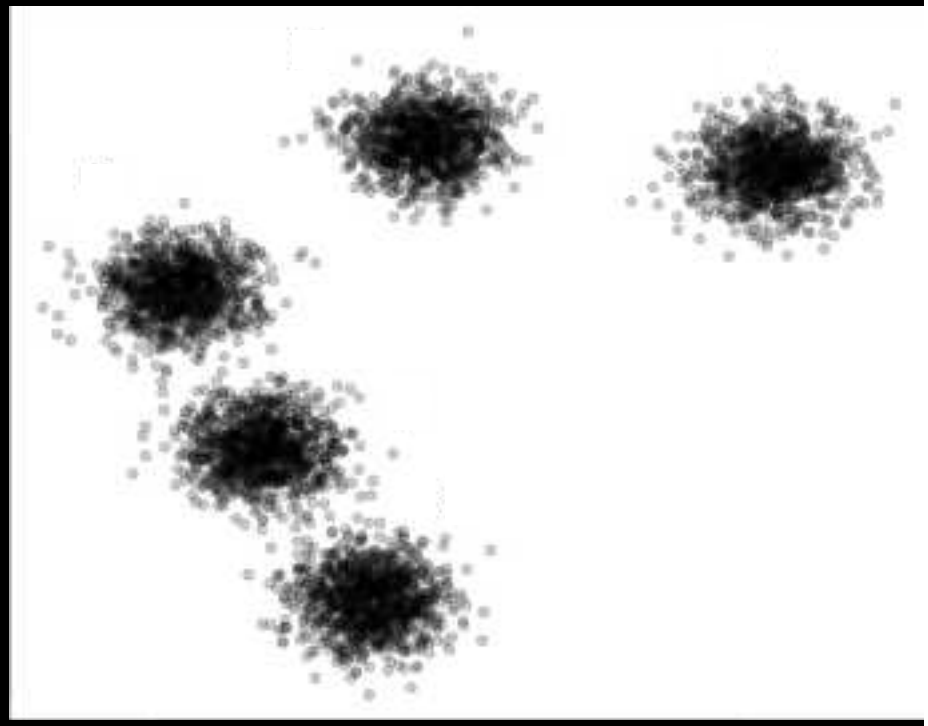












Barraclough (2019) The Evolutionary Biology of Species

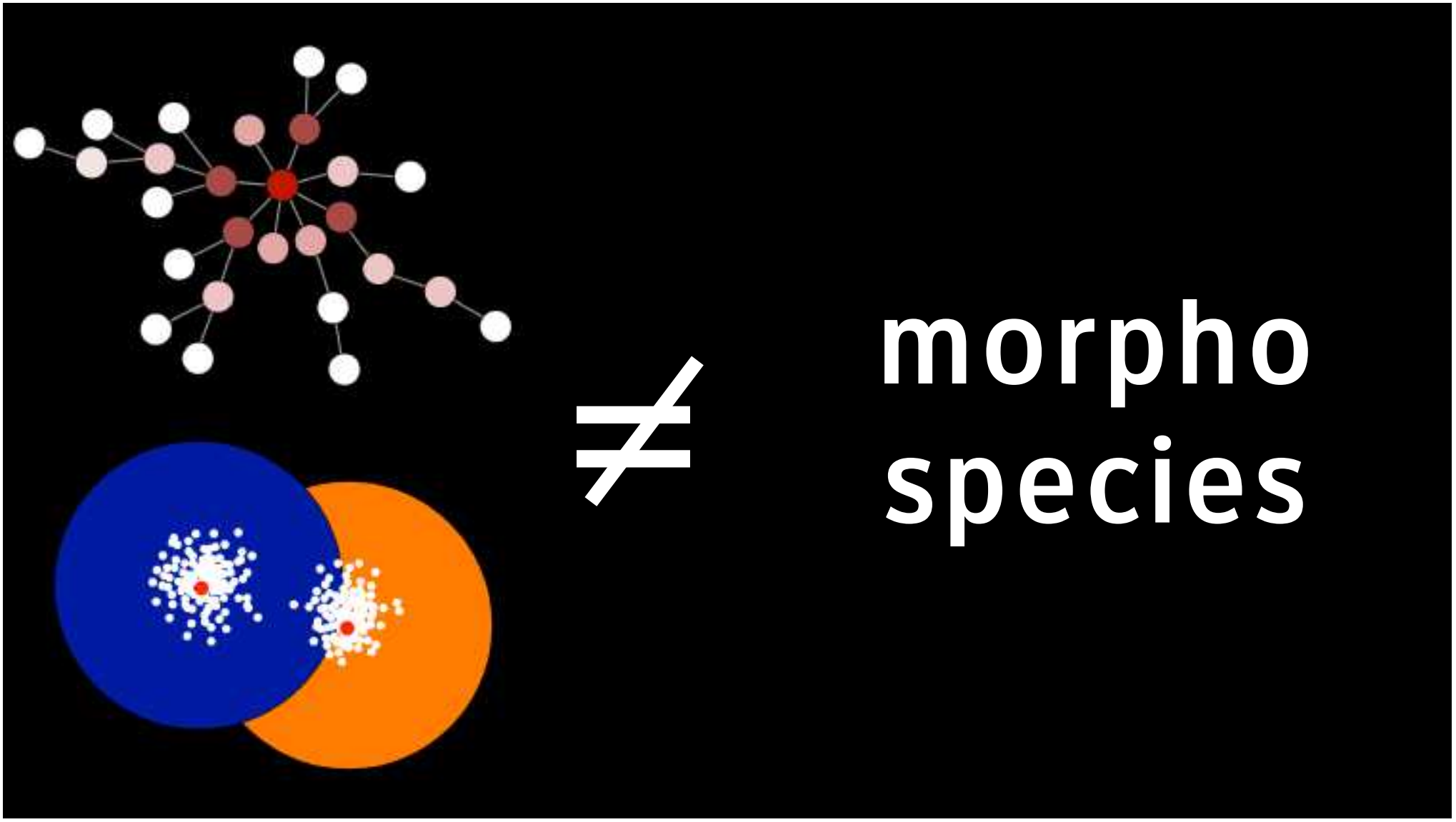
where to now with OTUs

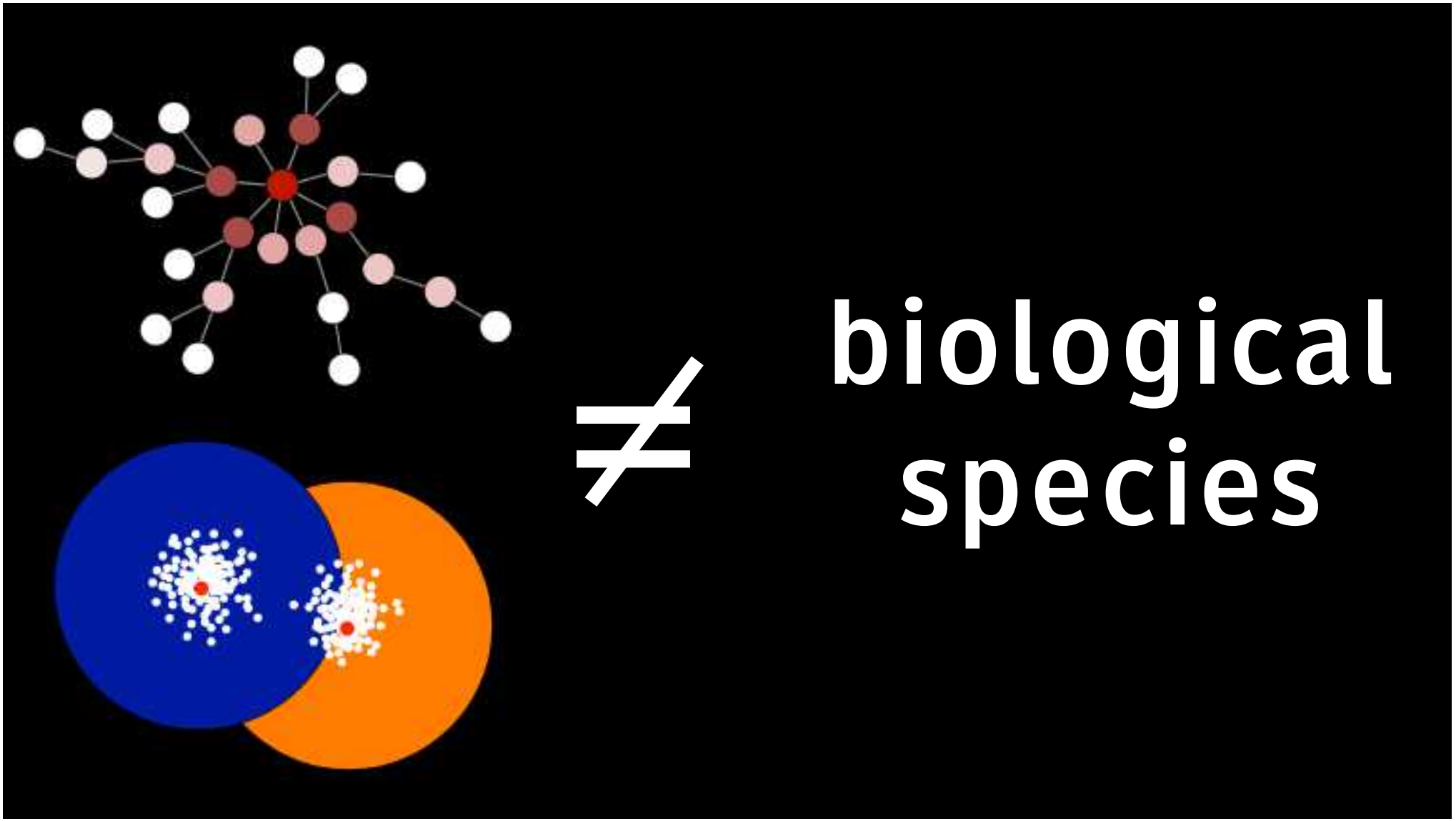
operational taxonomic units

operational taxonomic units

are

operational criteria for species delimitation


≠
morpho
species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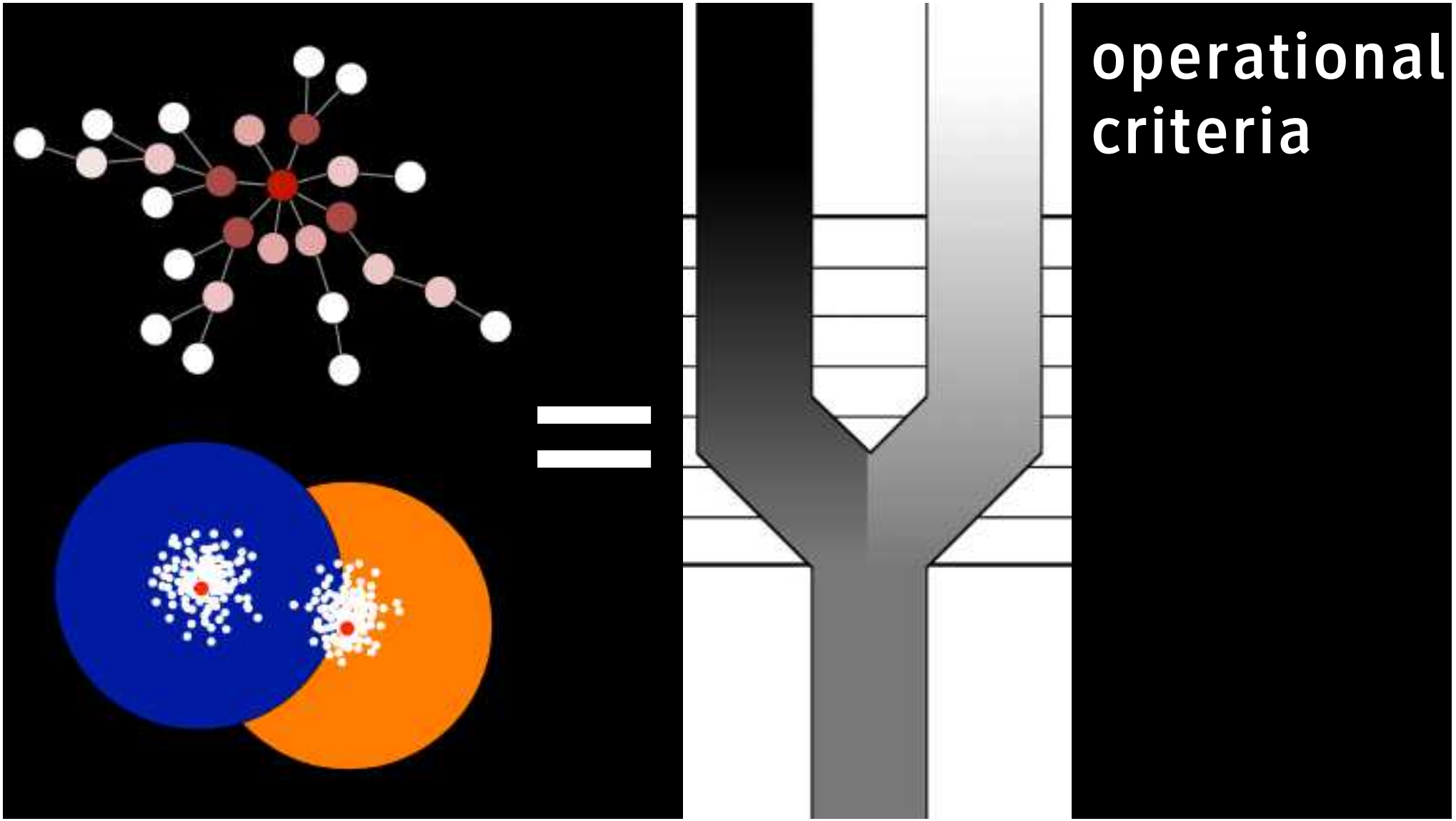
biological
species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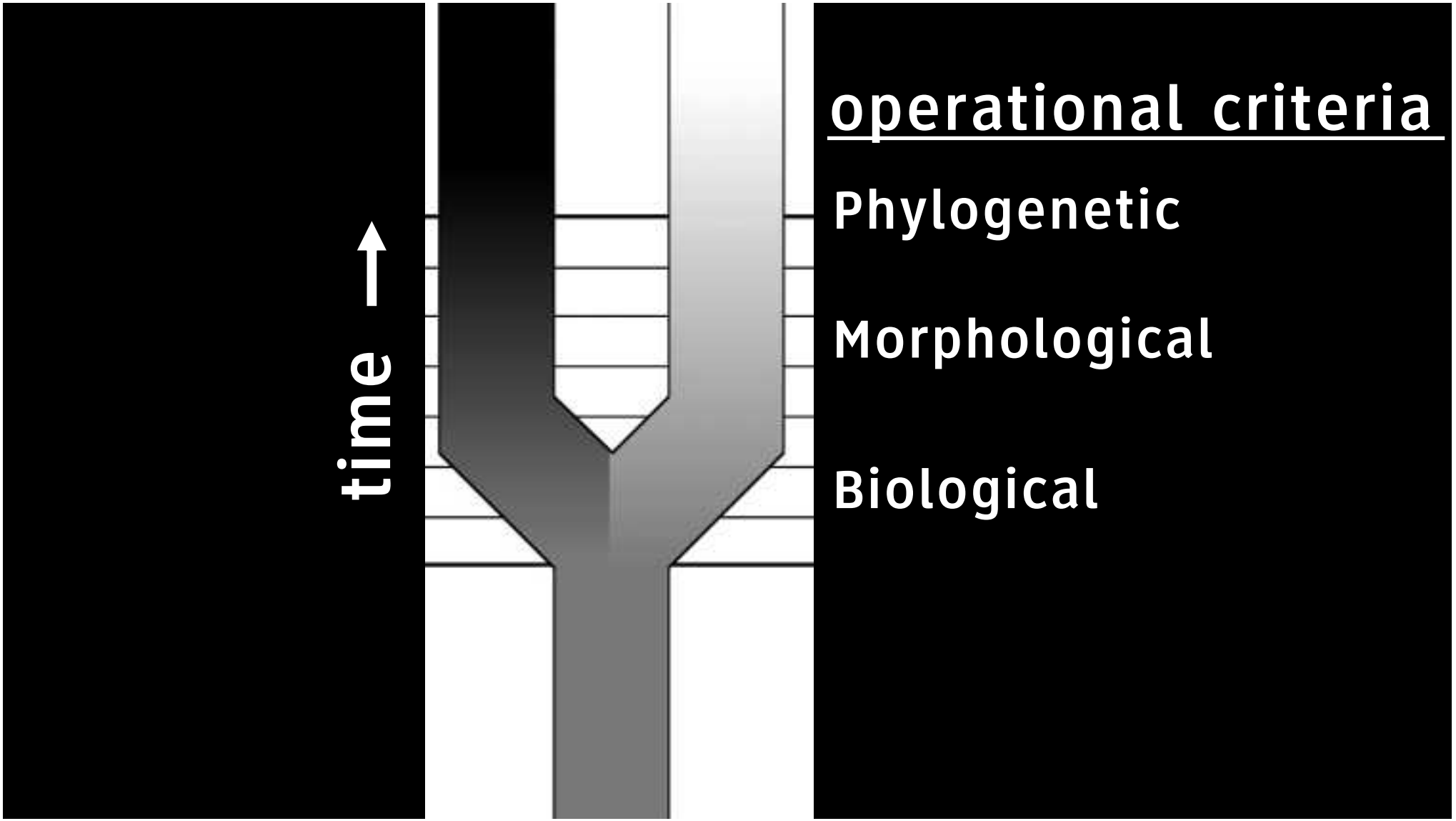
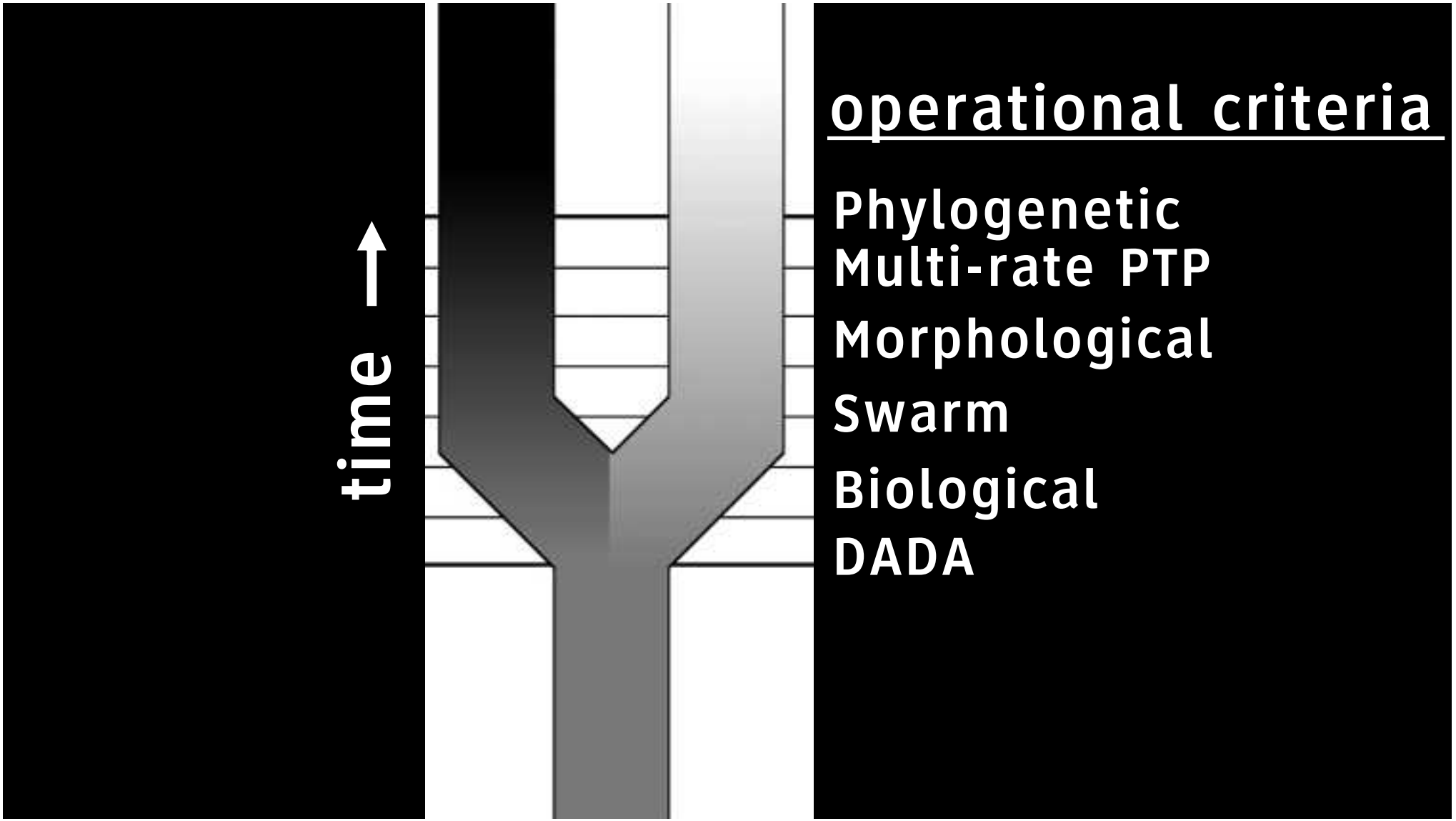
criteria


time
operational criteria
Phylogenetic
Morphological
Biological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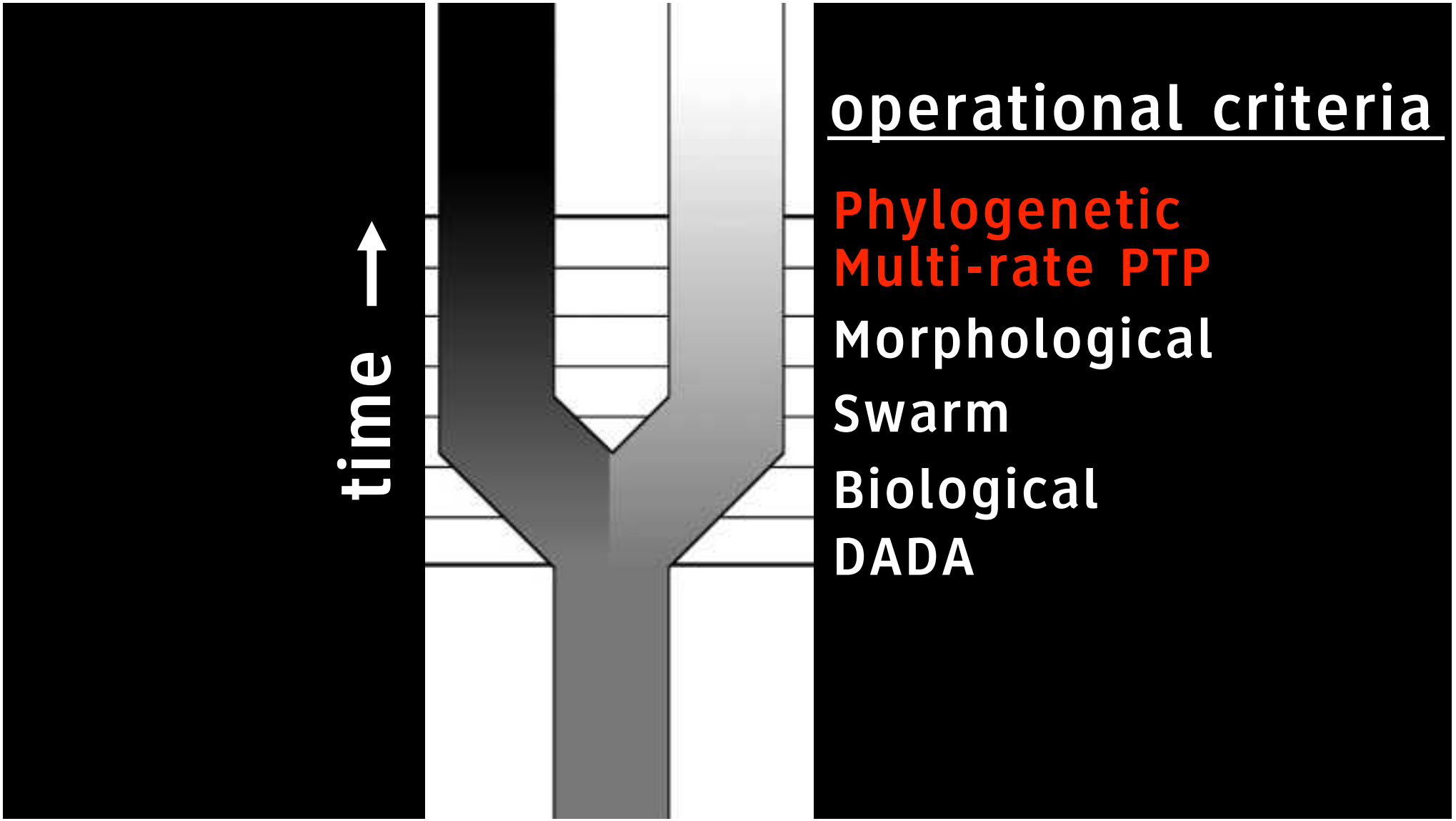
time
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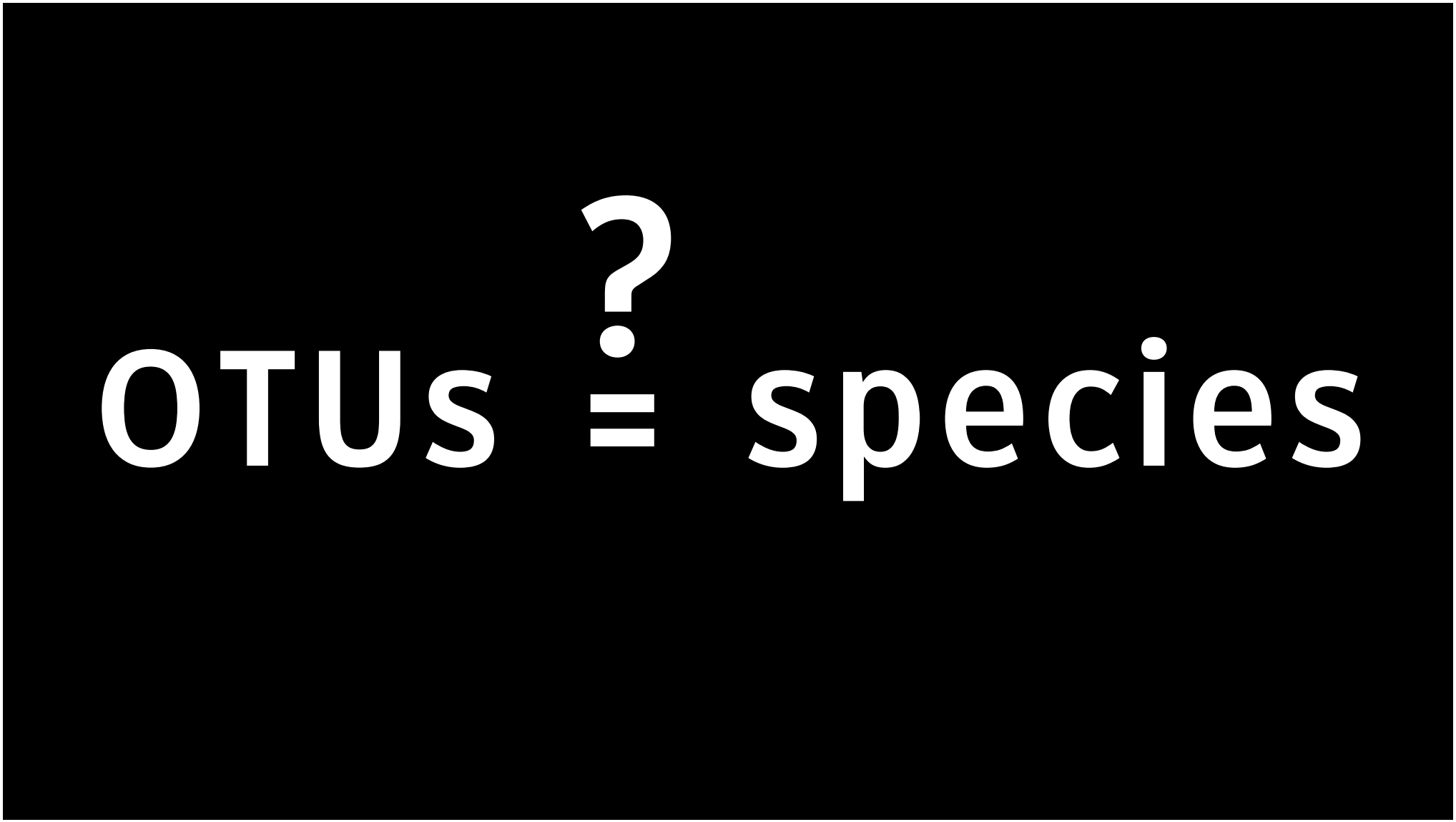
in conclusion


OTUs ≟ species

OTUs ? = separately evolving metapopulation lineages

thanks to:

CIRAD
Frédéric Mahé

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Alexandros Stamatakis
Pierre Barbera

Institut de Ciències del Mar
Ramiro Logares