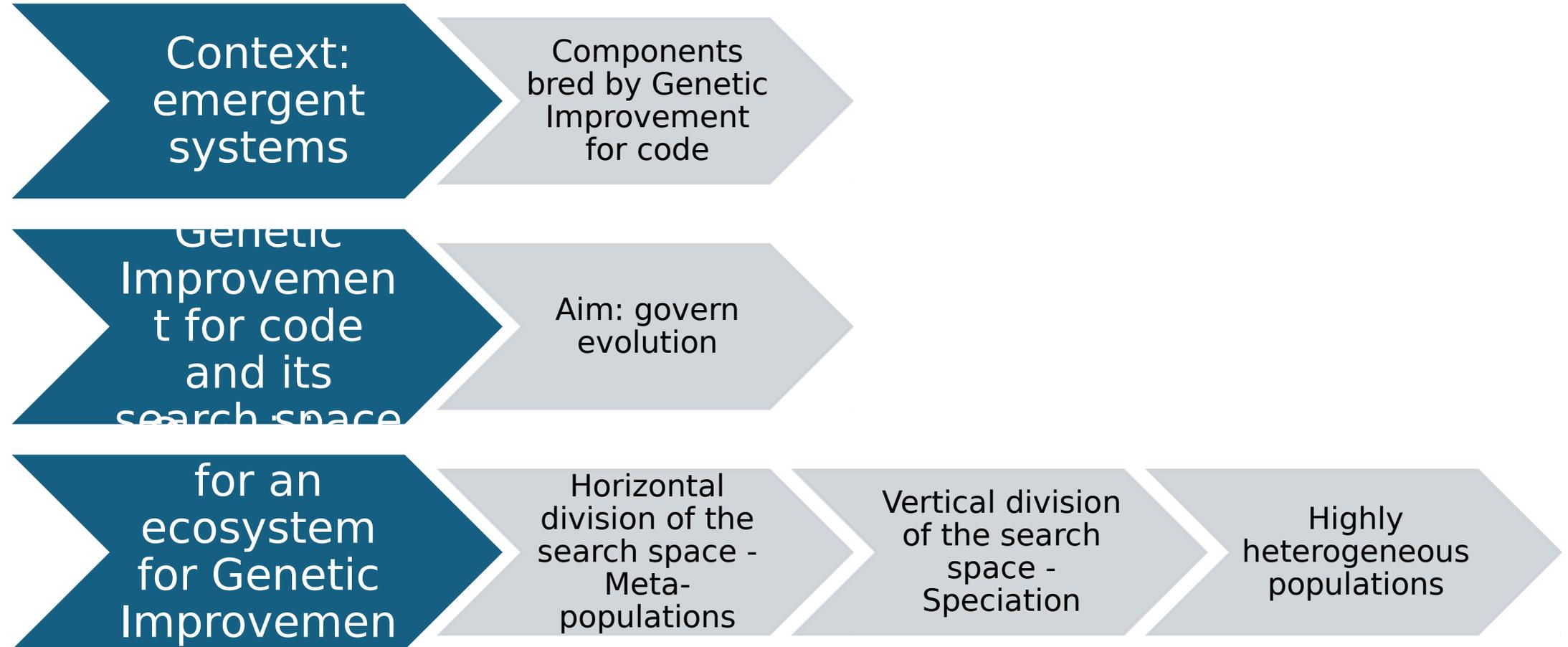


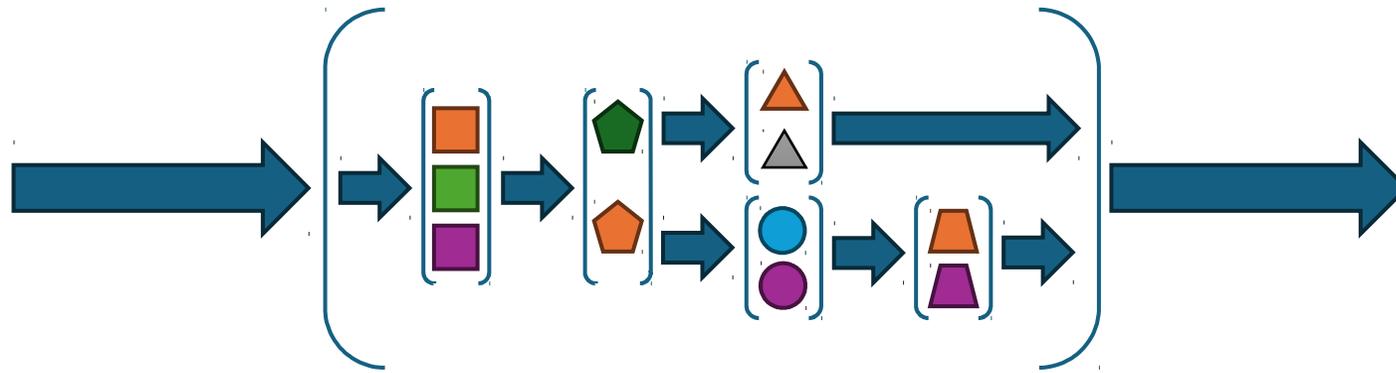
# **Ecosystem Curation in Genetic Improvement for Emergent Software Systems**

Zsolt Nemeth, Penn Faulkner Rainford, and Barry Porter

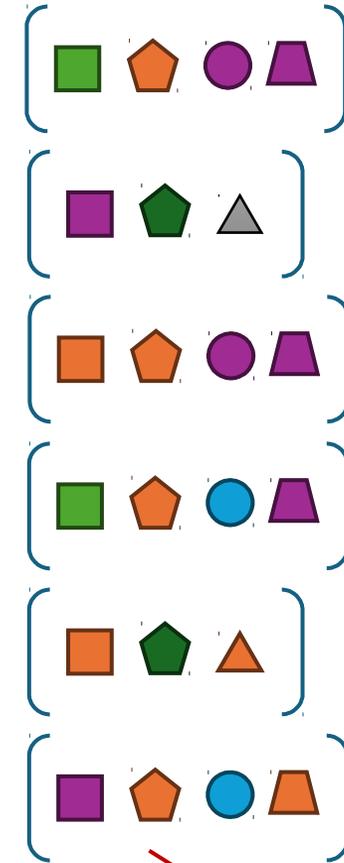
# Overview



# Emergent Systems



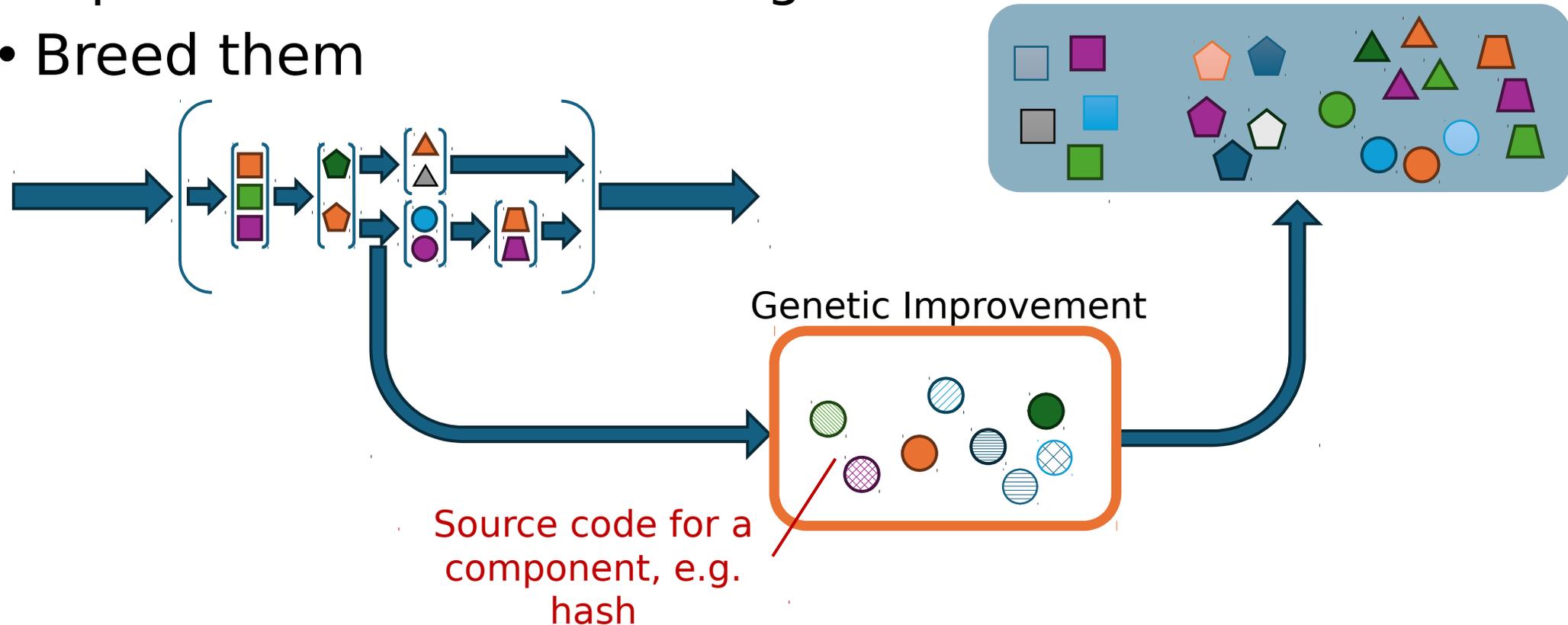
- Adaptable system
- Dynamically (re)composed on-the-fly
- Interchangeable, hot-swappable components



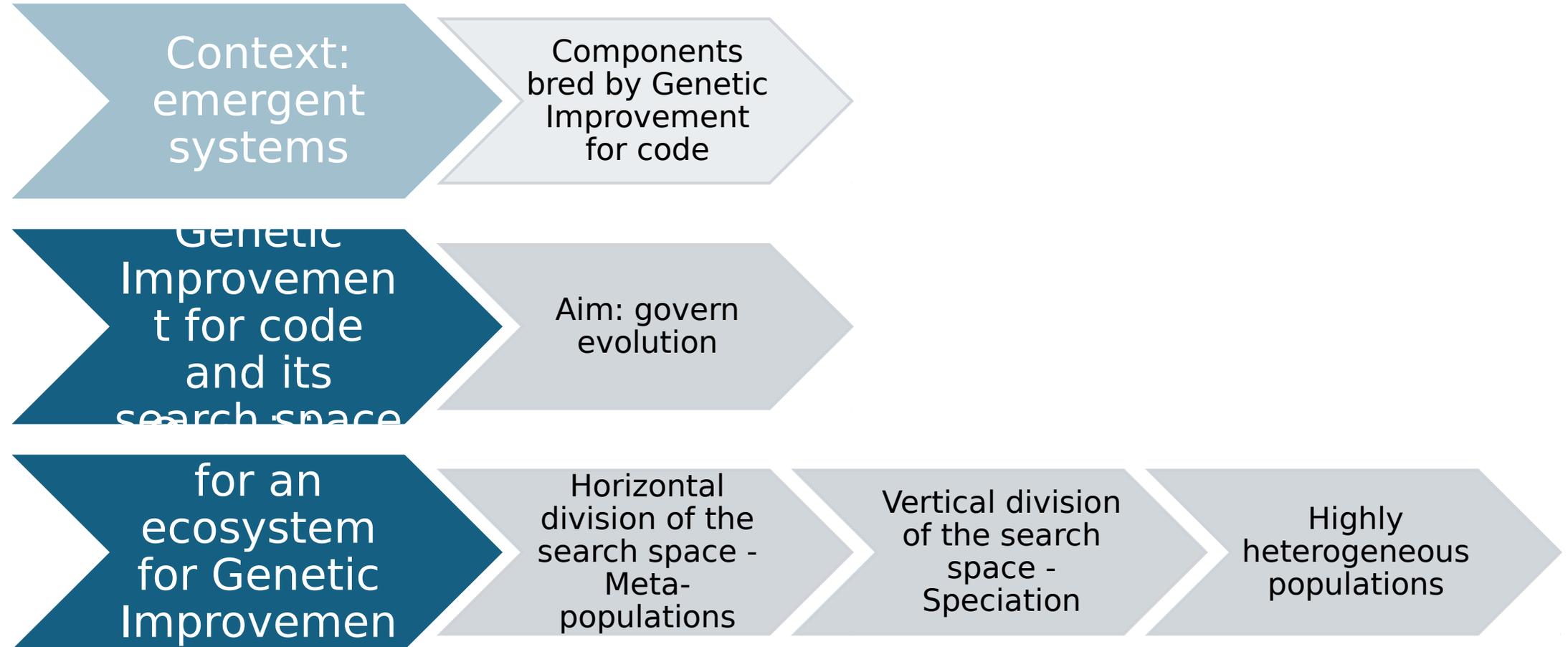
Actual configurations

# GI for Source Code in Emergent Systems

- A pool of available building blocks assumed
- Breed them



# Overview



# GI for Source Code

- Genotype = the source text itself
- Phenotype = semantics, runtime characteristics

Bernstein  
hash

$$h = ((h \ll 5) + h) + \text{key}[c]$$

Kernighan-Ritchie  
hash

$$h = ((h \ll 5) - h) + \text{key}[c]$$

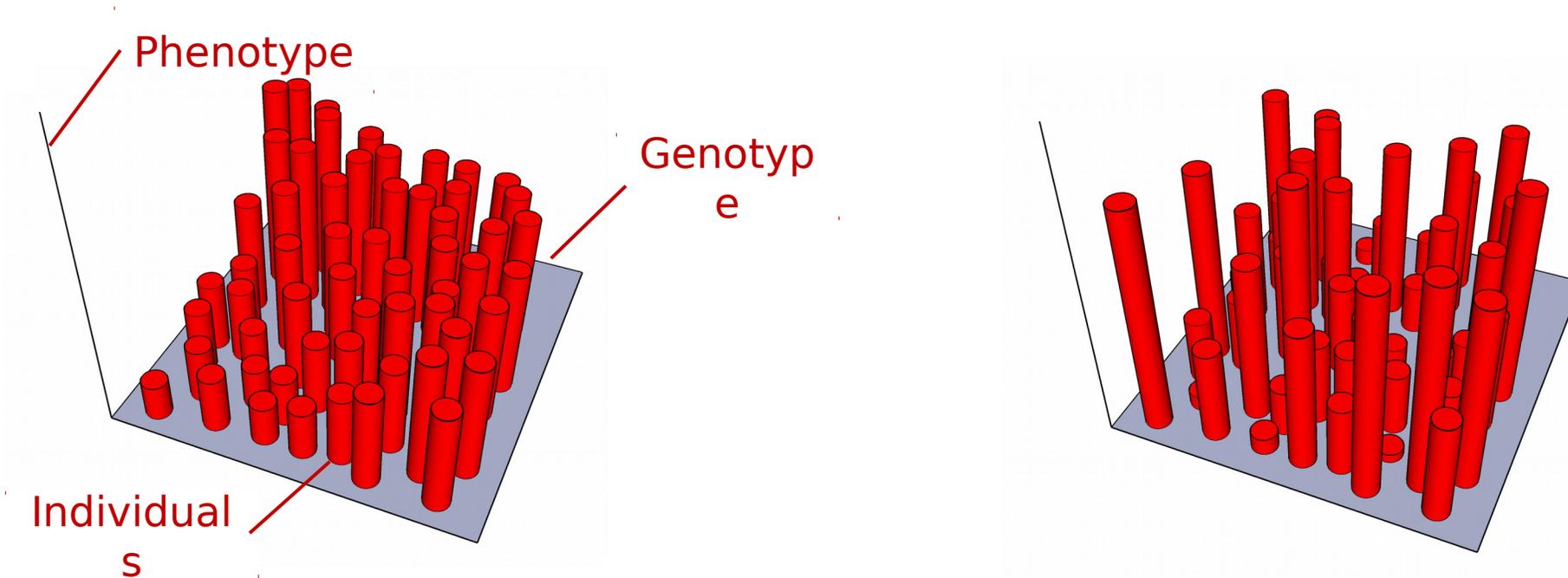
Compilation  
error

$$h = ((h < 5) + h) + \text{key}[c]$$

Bernstein  
hash

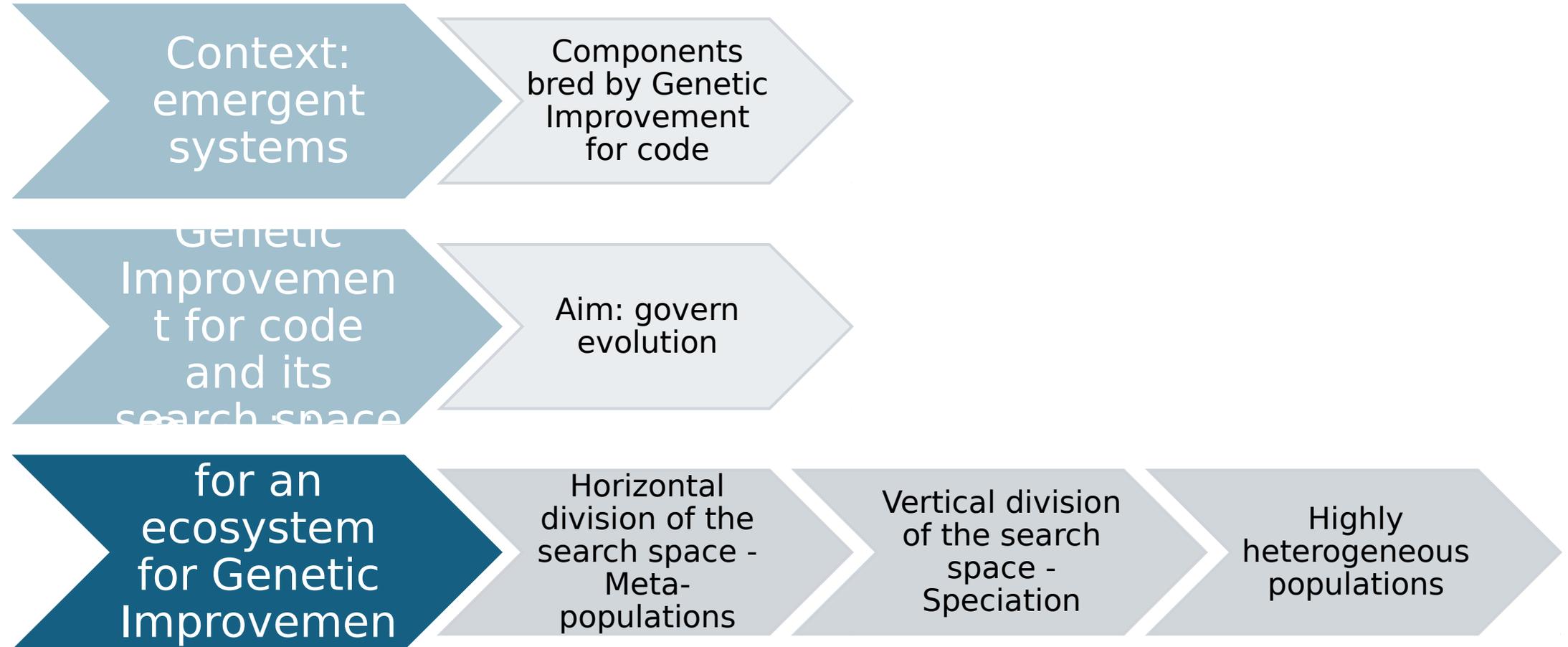
$$h = \text{key}[c] + 33 * h$$

# The Search Space

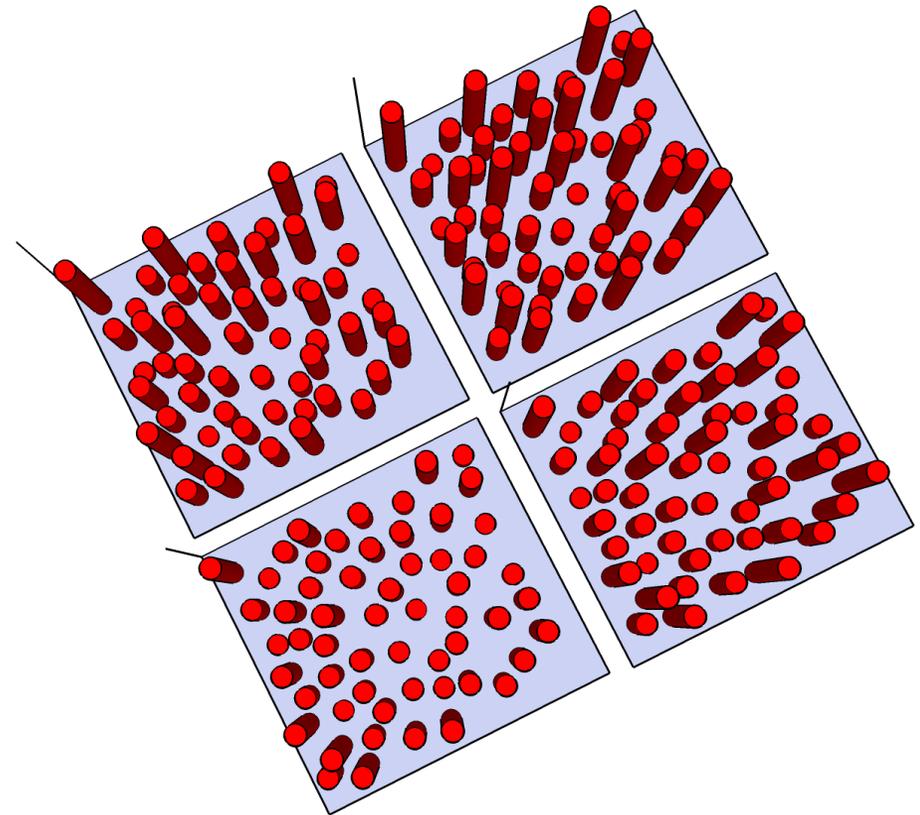
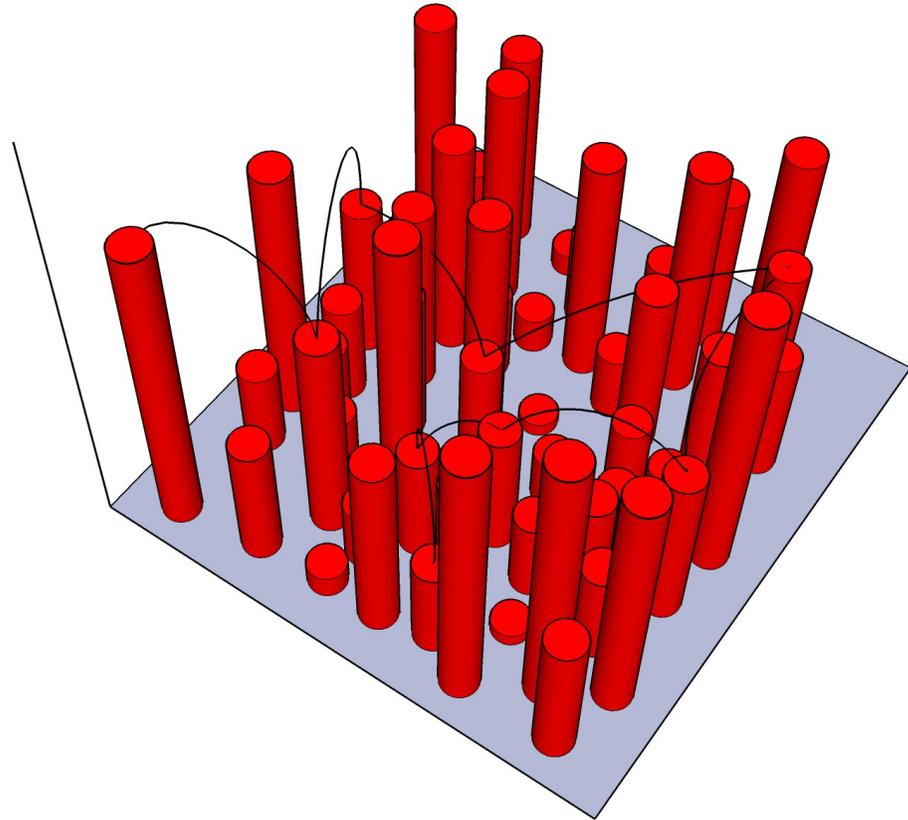


- genotype similarity (distance) is largely irrelevant
- fitness landscape is extremely rugged

# Overview



# Horizontal Exploration: Meta-Populations

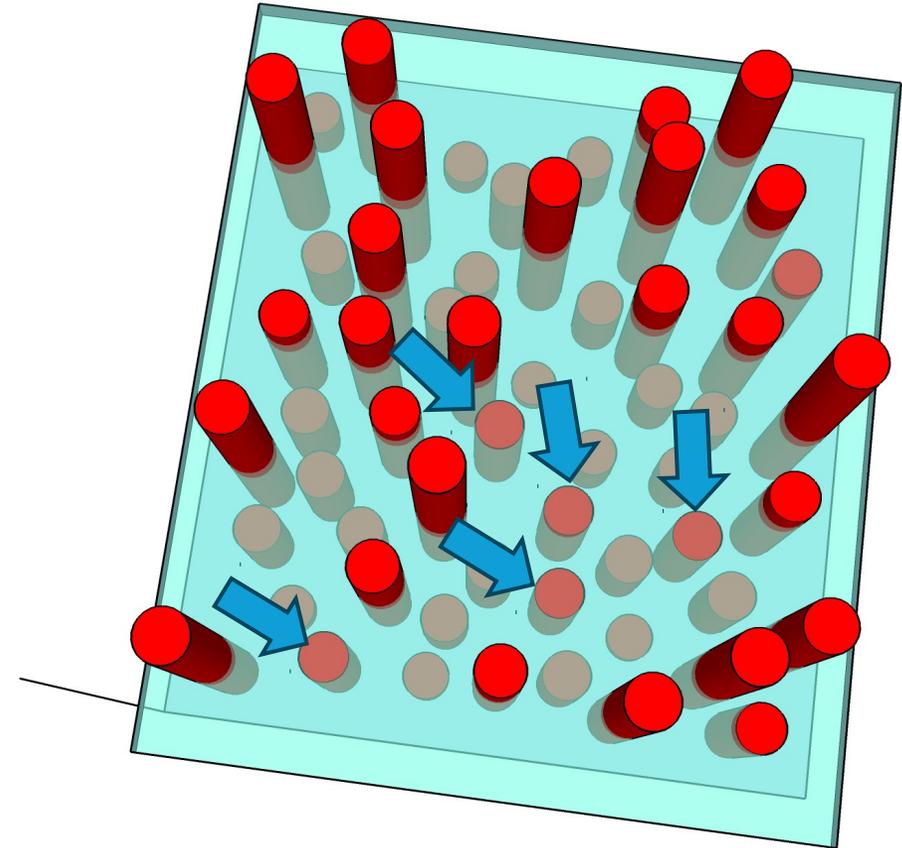
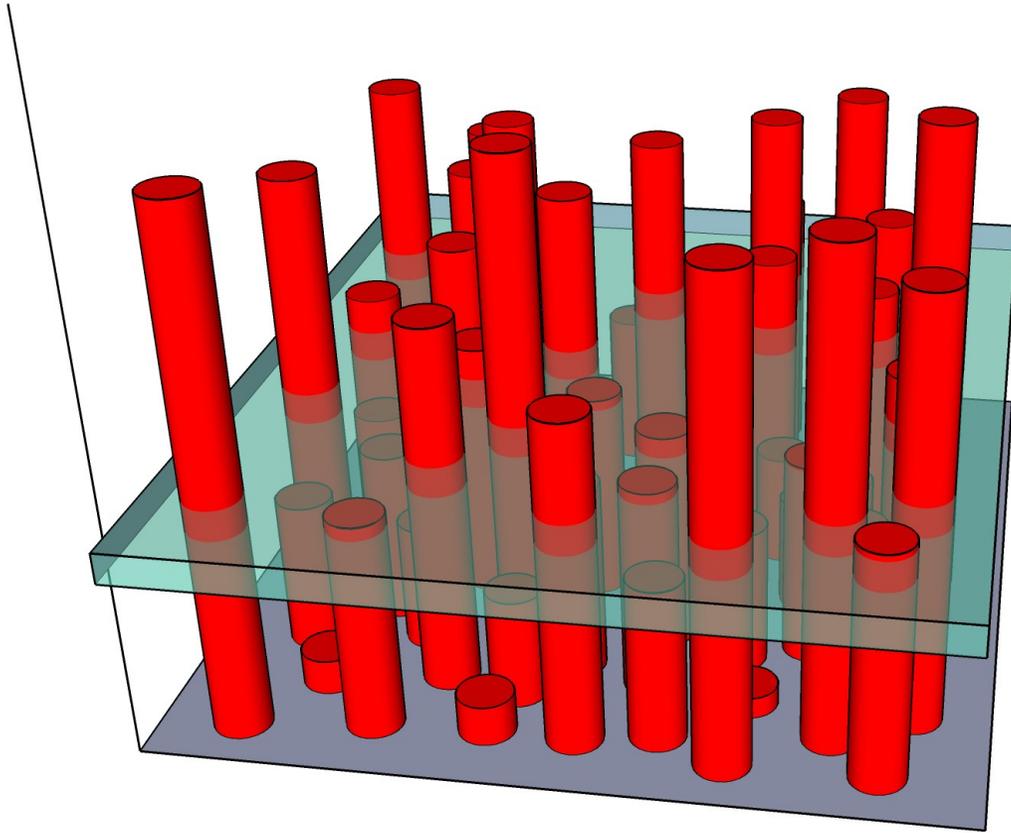


- Simultaneously evolving spatially separated genetic pools
- Occasional genetic interchange (migration)

# Horizontal Exploration: Meta-Populations

- Alternative search trajectories
  - Rugged landscape : trapped in local optima is inevitable
- Migration
  - Balance speciality vs generality
  
- Challenges
  - Number and size of meta-populations
  - Metrics to characterise populations and individuals
  - Migration strategies

# Vertical Exploration: Species

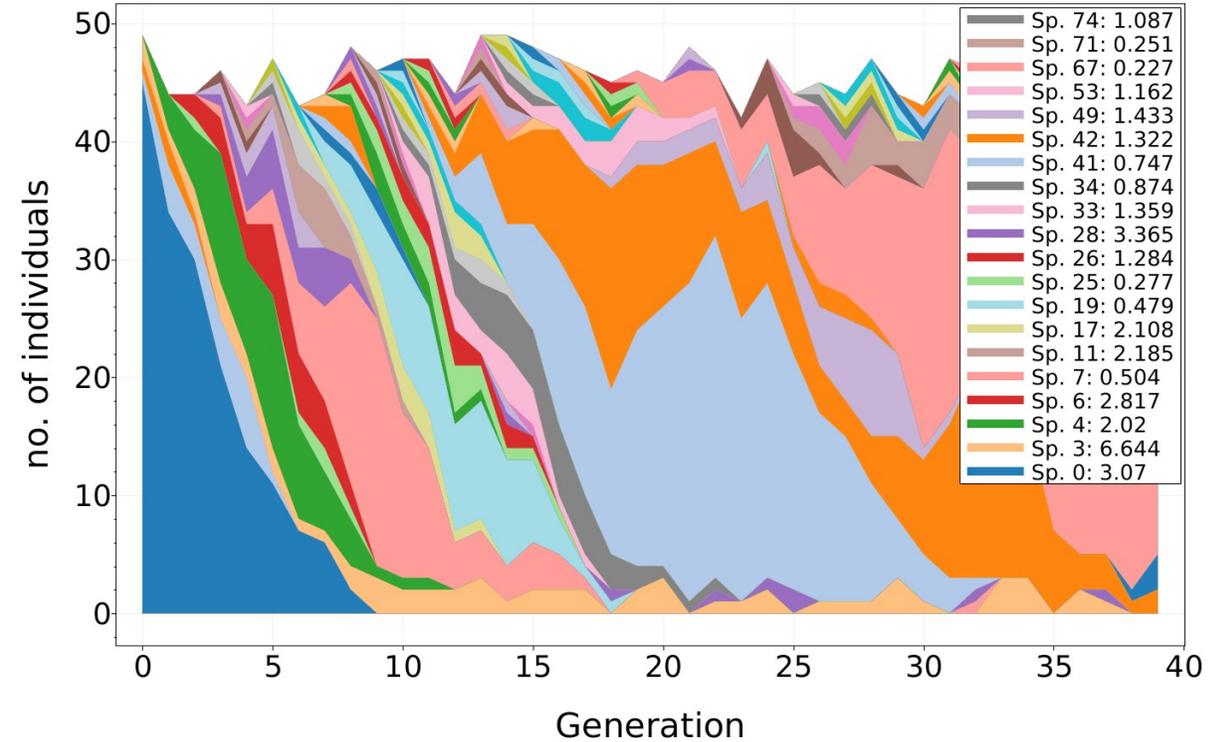
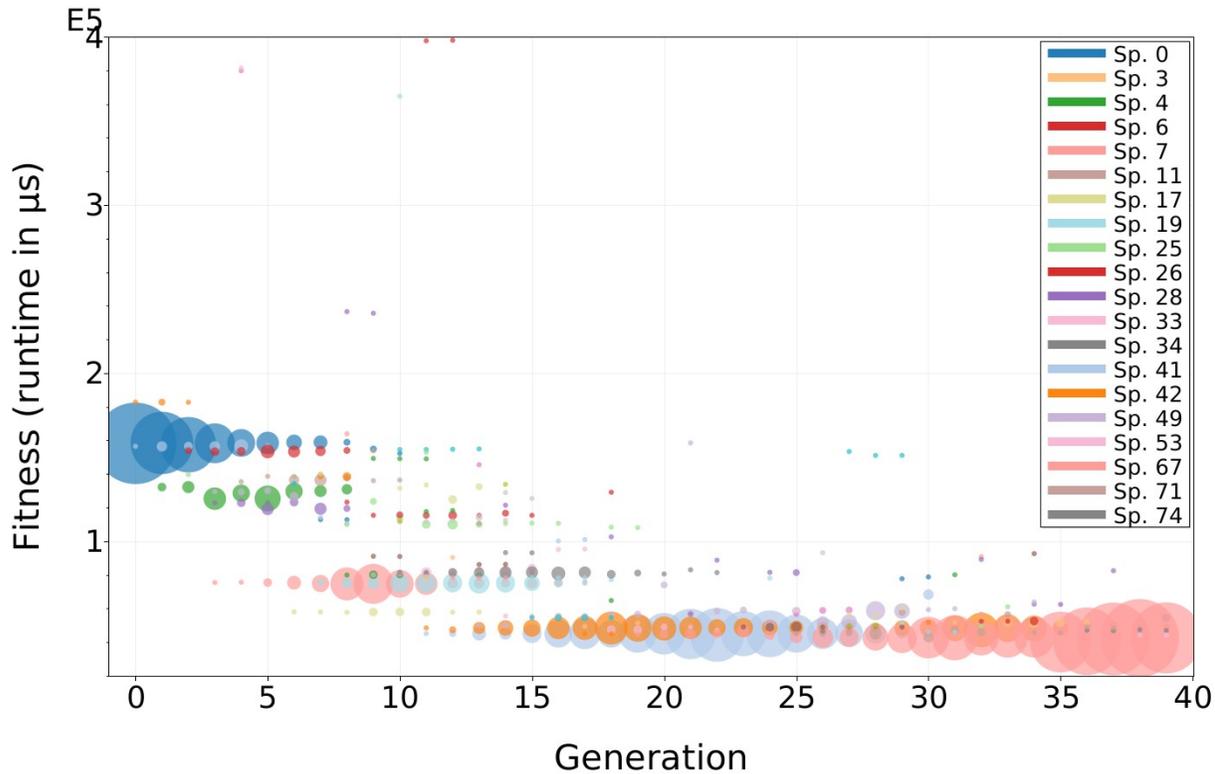


- Looking for meaningful diversity
- Neutral planes are not planes at all

# Vertical Exploration: Species

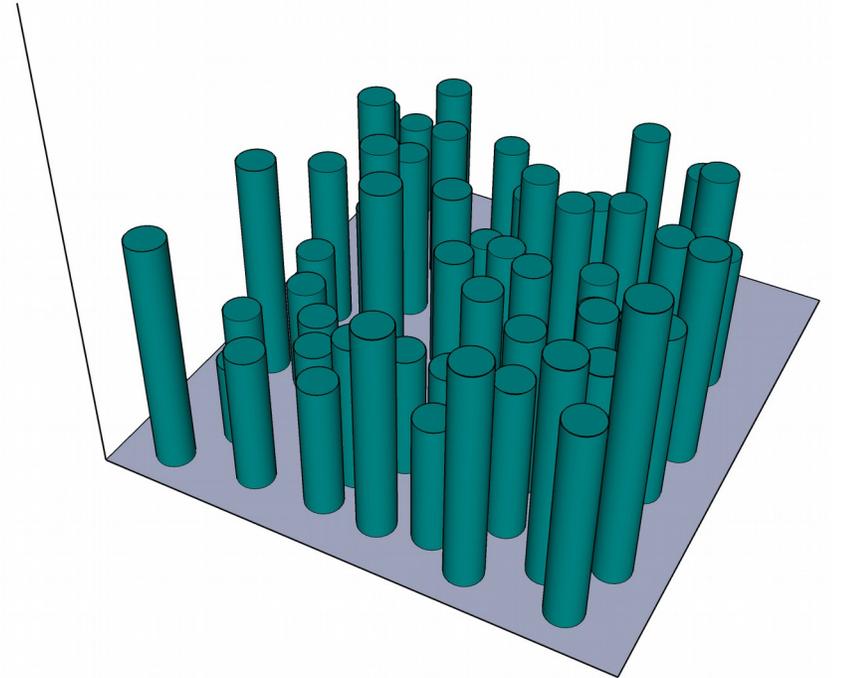
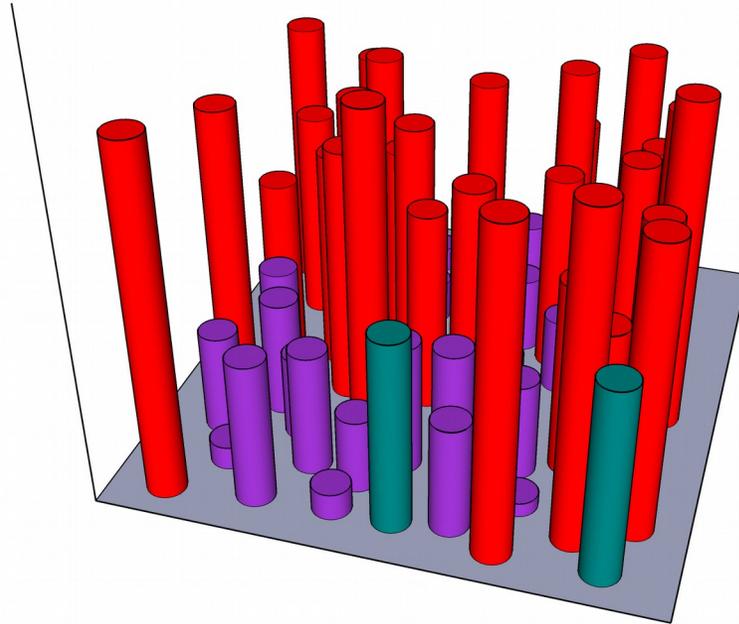
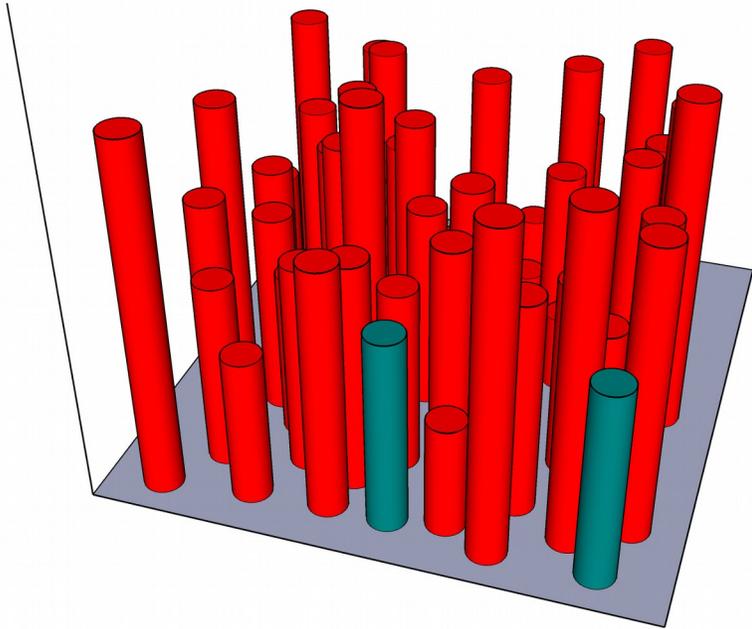
- Meaningful diversity
  - Genotype = **algorithm** + implementation → Phenotype
  - Phenotype based speciation: **algorithm** ← Phenotype
- Challenge: Phenotypic speciation
  - Functional and non-functional attributes
  - Probability divergence metrics applied on functional attributes
  - Species metric:
    - Selective
    - Characteristic
    - Insensitive to implementation
    - Easily computable

# Vertical Exploration: Species (sneak preview)



come: Nemeth, Faulkner Rainford, Porter: Phenotypic Species Definitions for Genetic Improvement of Source Code. Under review

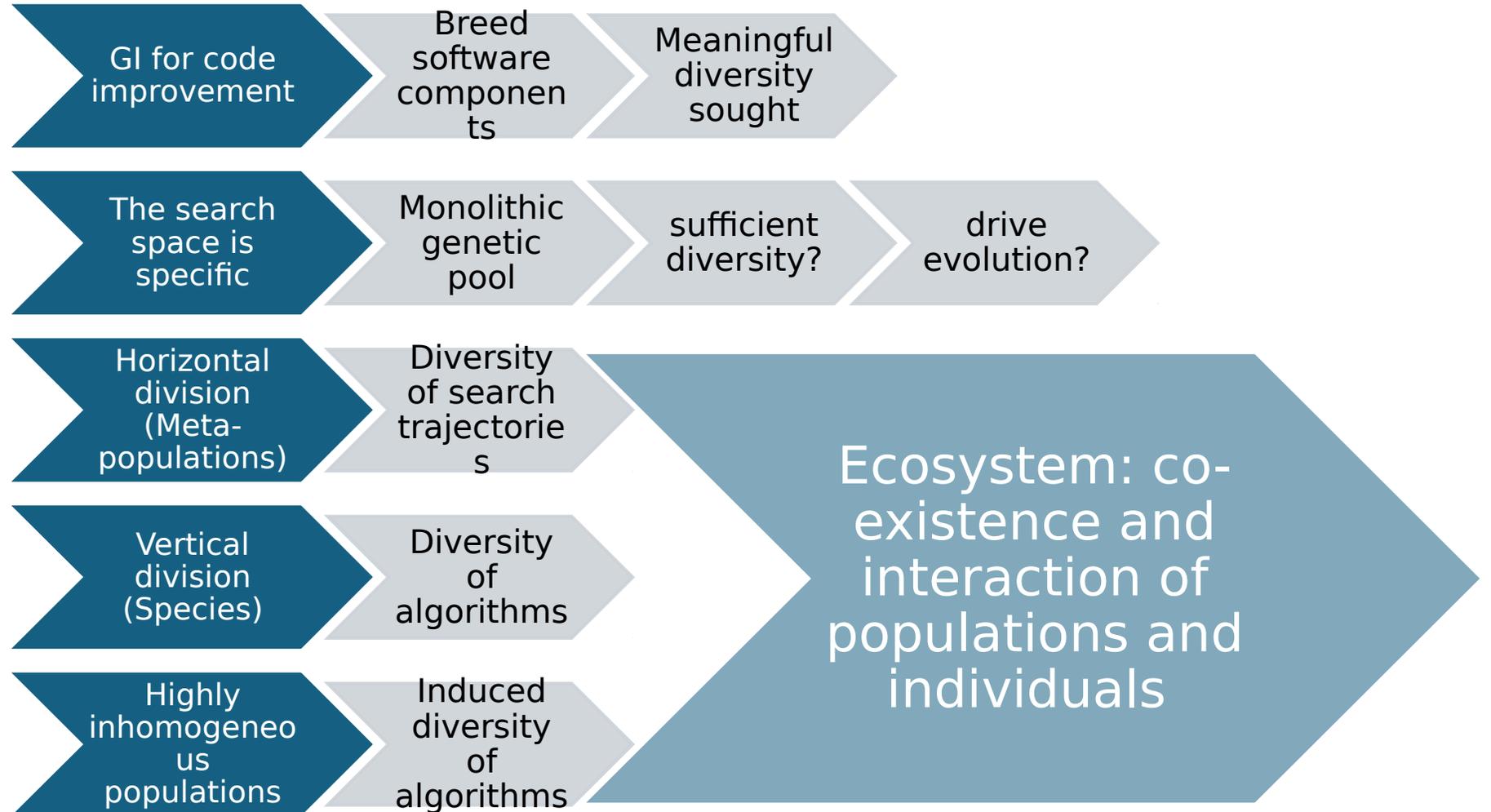
# Highly Heterogeneous Populations



# Highly Heterogeneous Populations

- Introduce successful genes to the pool
  - co-existence and interaction of individuals from very different origin
- Vertical separation from the beginning
  - Profound diversity
- Challenge: maintain diversity, avoid over-dominance
  - Specific immutable, non-contributing individuals
  - Predator-prey models

# Conclusions



# Acknowledgements

- The research was supported by Leverhulme Trust Research Grant 'Genetic Improvement for Emergent

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