

A

Grounding = immigration

fresh verified samples from a fixed external source enter the training mix every generation

Recombination = sex

a child inherits from several parents, reassembling variants that arose in different lineages

Epistasis (entangled skills)

a variant's fitness contribution depends on the variants present at the other loci

The composed society

selection, recombination, diversity preservation and grounding on one population

Speciation

reproductive isolation: diverged lineages no longer produce viable (mergeable) offspring

Biological model

Wright-Fisher simulator (NumPy)



closed forms · bitwise-reproducible

immigration-drift equilibrium:
 $g \approx 0.05$ retains $\geq 95\%$ diversity;
observation floor $1 - e^{-mp}$

Fig. 2A

blending conservation law
(first-order cancellation);
union-operator gain; Fisher-Muller

Fig. 4

NK landscapes: outbreeding depression; directed sex restores the gain; mate-pool breadth optimum

Fig. 5

four-arm ablation: grounding, sex, diversity each removed
→ three distinct failures

Fig. 6

BDM incompatibility model:
isolation cliff; quadratic snowball

Fig. 7A-B

Trained networks

RNN · MLP · VAE
on a synthetic oracle;
convolutional VAE on MNIST
sign-level tests · exact oracles



collapse & rescue in every architecture; MNIST: dry 30 → 1 modes,
10% grounding holds 30/30;
estimator-bias learning kernel

Fig. 2B

merge rescues two forgetting specialists ($\approx 0.50 \rightarrow 0.955$)

Table S2

adds no discriminating test at this tier

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barrier decomposition under permutation+rescaling; conflict sweep 0.97 → 0.03; emergent null

Fig. 7C-D

Language models

LoRA specialists
on Qwen 0.5B & 7B;
exact-match verifier
seed-replicated signs



established at LLM scale in prior work (refs. 21, 30);
not re-run here

merged specialists beat every parent (5 seeds at 0.5B; 7B); routing vs averaging: the headroom rule

Fig. 3A-B

bred-and-screened offspring beat the blind blend in every seed (hard, unsaturated tasks)

Table S2

open — the stated gap

convention conflict → hybrid breakdown; duration null; pre-merge predictive test (13 cond. × 3 seeds)

Figs. 7E-F, 3C-D