

Cake Murder Adventure — Genome Lineage

A record of every best genome found during training. Two eras: the look-ahead controller era (d=9, fixed architecture) and the CakeWalker era (d=1-4, systematic sense search). 101 chapters. One cake. As few weights as survive.

What a Genome Is

A genome carries scalar weights on fixed force functions. They are not weights in a neural network — they are scalar multipliers that sum into a move direction each frame. The algorithm itself stays fixed. The params tune how alive it feels on those manifolds.

CEM (Cross-Entropy Method) searches the param space by sampling candidates, keeping the best, and tightening its distribution around them. Each candidate evaluates against all 101 $\text{Sym}^2(X)$ manifolds in sequence. A manifold draws a different geometry — a different knife oracle — for each chapter. The params that survive generalize across all 101 geometries, not just easy ones.

So: the manifolds are the test. The params are what CEM tunes. When the right params appear, the algorithm comes alive on those manifolds — it reads the geometry, anticipates the knives, and runs.

Era 6 Champion — float_warn_sprint_edge (d=4)

Architecture: CakeWalker — float + warn + sprint + edge

Date: 2026-04-13 13:57 UTC

Fitness: 101/101 chapters cleared

OOS: 13/13 — all out-of-sample chapters cleared including ch 999,999 (6 orders beyond training)

Optimizer: CEM, 200 rounds, pop=40

param	value	role
float_w	3.558	preserve and amplify current velocity (tanh-normalised)
warn_w	47.522	Gaussian repulsion from knives in warning phase
sprint_w	26.422	linear pull toward Z when escape opens — silent during knife phase repulsion from dome

edge_w

0.100

walls

What makes this genome work: four senses, zero fixed attractors. float treats each dodge as locomotion — momentum carries cake rightward without pointing at a target. warn reads knife positions before they drop. sprint fires only when escape opens, providing a constant gradient from any starting position. edge prevents wall contact. No sense pulls toward the dome center during knife phase; no sense antagonises another.

The silence-trap fix: chapter 102 has zero knives — float has nothing to dodge, so no momentum accumulates. Sprint fires immediately at t=0 (escape opens when knifeGoal=0) and walks cake from PX to ZX under constant linear force. No other d=4 float-family type clears ch 102.

Look-ahead Champion (Era 1–5 reference)

File: games/genius.json

Date: 2026-04-12 02:11 UTC

Fitness: 101/101 chapters cleared

Architecture: look-ahead v3, 9-candidate, +zAnticipate

Optimizer: CEM

param	value	role
sigma	0.150	CEM exploration noise (meta-param)
stuckBoost	1.198	danger weight when a blade stalls near victim
dropBoost	4.264	danger weight when a blade drops
warnWeight	1.537	danger weight during warning phase
zAttract	1.808	pull toward Z once escape route opens
edgeRepulse	7.105	repulsion from dome walls
rwall_factor	0.120	extra penalty near right wall
centerPull	0.005	pull toward dome center (near-zero: calm)
zAnticipate	4.119	anticipatory Z-pull before escape opens

What made this genome unusual: calm. stuckBoost 1.2 — nearly neutral around stalled blades. zAttract 1.8 — patient about the exit. zAnticipate 4.1 — leaning toward Z early. It did not panic. It read ahead. But it still carried 9 parameters and baked its architecture into fixed force functions — the CakeWalker search replaced it with 4.

Architecture Evolution

Era 1 — Gradient (runs 2–14)

8 params. Gradient-based training.

Peak: **38 chapters**.

Hit a wall. Gradient couldn't push past hard chapters.

Era 2 — Look-ahead v1 (same genome, new eval)

Same 8-param genome from gradient era.
New evaluation architecture: look-ahead floor = 0.20.
Peak: **50 chapters** — 12 more chapters from the *same weights*.
The genome was already capable. The evaluation was limiting it.

Era 3 — CEM + look-ahead v2

CEM (Cross-Entropy Method) optimizer replaces gradient descent.
Same 8 params. CEM resamples around good solutions.
Peak: **54 chapters**.

Era 4 — CEM + look-ahead v3 + zAnticipate

9th parameter added: zAnticipate.
The agent can now pull toward Z before the escape route is open — reading the future.
Initial runs: **55–62 chapters**.
Plateau. CEM needed a new basin.

Era 5 — New Basin (the jump)

A fresh CEM run, wider search.
Discovered a new fitness basin.
Jump: **62 → 96 chapters in one training run**.
Then the final ascent:

```
02:07 – 96 chapters
02:07 – 97 chapters (+3 min)
02:08 – 98 chapters
02:09 – 99 chapters
02:09 – 100 chapters
02:11 – 101 chapters DONE
```

Five chapters in five minutes. Once it found the basin, it ran.

Era 6 — CakeWalker Architecture Search

Date: 2026-04-12 → 2026-04-13

Question: is the 9-param look-ahead controller minimal? What other play styles exist?

A systematic sweep — 98 CakeWalker types defined across 23 senses in four families. CEM trains each independently. Results expose the fitness landscape across architectures, not just parameter values.

Key findings:

Wall-pinning trap (d=3, era 5 analogue): types with fixed-attractor senses (rest, nest, shadow, hearth) during knife phase pull cake to the dome boundary — exactly where knives spawn. All plateau below 30/101.

Momentum surfing (float family): float preserves velocity without a fixed attractor. Each dodge contributes rightward drift. Z arrives organically. float_warn (d=2) reaches 95/101 — breaking the d=2 ceiling. triad_float_phase_wall (d=3) reaches 101/101 but fails ch 102 (silence trap).

Bound saturation: original float bounds were (0.01, 5.0) and (0.1, 20.0) — artificial ceilings. Widening to (0.01, 50.0) revealed physics-natural ceilings at ~5–6 and ~25–48. CEM had been pegged at the fence.

Four types reach 101/101:

type	d	params	note
triad_float_phase_wall	3	[5.56, 25.41, 0.74]	fails ch 102
float_warn_danger_edge	4	[3.90, 21.98, 33.39, 1.42]	fails ch 102
float_warn_edge_exit	4	[5.51, 27.44, 0.24, 41.20]	Gaussian exit → 0 at PX; fails ch 102
float_warn_sprint_edge	4	[3.56, 47.52, 26.42, 0.10]	clears ch 102; first perfect generaliser

Sprint sense: the 23rd sense. Silent during knife phase — zero output, no antagonism. Fires a linear pull (ZX-x)/DOME_W when escape opens. Linear, not Gaussian, so gradient remains constant from any starting position including PX. This fixes the silence trap.

OOS: float_warn_sprint_edge clears all 13 out-of-sample test chapters including ch 9,999 (4 orders beyond training) and ch 999,999 (6 orders beyond training). First CakeWalker with perfect OOS generalisation.

Key Milestone Comparison

genome	chapters	architecture
genius_038ch_lookahead_run14_final	38	gradient v1 (8p)
genius_049ch_v1_gradient_architecture	49	look-ahead v1 (8p)
genius_050ch..._lookahead_v2	50	look-ahead v1 (8p)
genius_cem_054ch...	54	look-ahead v2 CEM (
genius_cem_062ch...	62	look-ahead v3 CEM (
genius_cem_096ch...	96	look-ahead v3 CEM (
genius_cem_101ch...	101	look-ahead v3 CEM (
float_warn_2d	95	CakeWalker float+w: (2p)
triad_float_phase_wall	101	CakeWalker float+warn+edge (3p)

float_warn_sprint_edge **101** CakeWalker
float+warn+sprint+e
(4p)

Look-ahead Era: Parameter Drift 96 → 101

The 96-chapter genome and the look-ahead champion share the same architecture. What changed in the last 5 chapters?

param	96-chapter	champion	shift
stuckBoost	7.54	1.20	-6.3 — stopped panicking near stuck blades
dropBoost	8.00	4.26	-3.7 — less reactive to drops
warnWeight	0.05	1.54	+1.5 — now reads warning phase
zAttract	11.65	1.81	-9.8 — patient about the exit
edgeRepulse	8.92	7.11	-1.8
centerPull	4.21	0.005	-4.2 — stopped hugging center
zAnticipate	1.45	4.12	+2.7 — leaning forward

The look-ahead champion grew quieter. It stopped chasing Z, stopped fearing stuck blades, and started reading ahead. The CakeWalker era later replaced this architecture with a 4-param sense vocabulary — but the calm-over-panic insight carried forward into the float family's design.

Champion vs Random (2026-04-12)

30 random genomes drawn from GENOME_BOUNDS. 10 champion evaluations.

	mean	median	max	min
random (n=30)	69.2	67	96	38
champion (n=10)	101.0	101	101	101

Random genomes average 69 chapters — the parameter space is forgiving and basic avoidance is easy to stumble into. One random draw hit 96. None completed the game.

The champion is not just better on average. It is **reliable**. Every eval: 101/101. It does not need luck.

Findings and Open Questions

Are there other play styles? ✓ Answered

Yes — **several**. The CakeWalker search mapped distinct play styles:

- **Reactive panic (look-ahead v3)**: stuckBoost 1.2, zAttract 1.8 — calm, reads ahead, 9 params
- **Momentum surfing (float family)**: dodges become locomotion, no fixed attractor, 2–4 params
- **Resting attractor types (nest/shadow/breath)**: pull to a fixed resting point; all plateau below 30/101 — the attractor parks cake at wall boundaries where knives spawn

Multiple play styles reach 101/101. float family reaches it in 3–4 params vs 9 for look-ahead. The fitness landscape carries at least two distinct basins.

Is 9 params too many? ✓ Answered

Yes. centerPull = 0.005 (vestigial) and sigma (CEM meta-param, not a force weight) account for 2 of 9 slots. The CakeWalker search found 101/101 coverage at d=4 with no vestigial senses. float_warn_sprint_edge carries 4 active force weights — all load-bearing, none near zero.

Could these weights generalise beyond training? ✓ Answered

Yes, completely. float_warn_sprint_edge clears all 13 OOS test chapters including ch 9,999 and ch 999,999 — 4 and 6 orders of magnitude beyond the training range of 1–101. The controller reads $\text{Sym}^2(X)$ geometry, not chapter numbers. Any integer seed produces a different geometry in the same topological family; the params survive all of them.

What architecture carries the minimum description length?

Open. float_warn_sprint_edge at d=4 seems minimal — but no exhaustive d=2/d=3 search for OOS-complete types has run yet. triad_float_phase_wall at d=3 reaches 101/101 in-sample; it fails OOS only on the silence trap (ch 102). A d=3 type that solves the silence trap without a 4th weight may exist.

Do other sense families produce 101/101 types?

Open. All 101/101 types found so far belong to the float family. Threat-family types (danger, warn, edge, exit) plateau in the 40–60 range without a locomotion primitive. Whether a non-float locomotion sense exists that enables 101/101 generalisation remains untested.

Out-of-sample OOS summary

float_warn_sprint_edge [label A, params 3.56/47.52/26.42/0.10]:

```
ch 103-120:  ALL CLEARED   (near OOS)
ch 200-1000: ALL CLEARED   (mid OOS)
ch 9,999:    CLEARED      (4 orders beyond training)
ch 999,999: CLEARED      (6 orders beyond training)
ch 102:     CLEARED      (zero-knife silence trap – sprint fires
at t=0)
```

13/13. First CakeWalker type with perfect OOS coverage.

Diagrams

- docs/cake-murder-genomes-lineage.dot / .svg — full lineage DAG
- docs/cake-murder-genomes-champion.dot / .svg — champion decision architecture

Render with:

```
dot -Tsvg docs/cake-murder-genomes-lineage.dot -o docs/cake-murder-
genomes-lineage.svg
dot -Tsvg docs/cake-murder-genomes-champion.dot -o docs/cake-murder-
genomes-champion.svg
```

Total lineage files: ~100 genomes. All milestones preserved in games/lineage/.