

The MAZE is a Modern Memory Palace

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1. The oldest question about knowledge

Every civilisation that gathers knowledge faces the same question. Where do you keep the way to it? Knowing a thing is cheap. Finding it again is expensive. The history of memory is the history of answers to that question.

The Greeks gave the first systematic answer. It is called the art of memory. Simonides of Ceos, the story goes, left a banquet hall moments before the roof collapsed. The bodies were crushed beyond recognition. Simonides identified every guest by remembering where each had sat. Place, he concluded, is the key to memory. Cicero and Quintilian turned the insight into a method with two acts. First you lay out places: empty, fixed, ordered rooms in a building you know well. Then you put images in them. To recall, you walk the building again. Each room hands you back what you deposited there.

This method carried the intellectual life of antiquity, the medieval schools and the Renaissance. Orators held hour-long speeches with it. Preachers held whole theologies in it. It worked. And it had three defects that were never solved. This essay argues that the MAZE — a running knowledge system built on a balanced ternary address space, currently loaded with the full English Wikipedia, with music and with art — solves all three. It is not an analogy to the memory palace. It is the same instrument, completed.

2. The three defects of the classical palace

The first defect: the building was arbitrary. Any house would do. The places carried no meaning of their own; they were pegs. One man in the sixteenth century saw this as the flaw it was. Giulio Camillo spent a royal fortune on a theatre whose places would themselves be meaningful. His ordering rule was explicit: what was created first sits on the lowest level, the arts of man sit on the highest, "by reason of chronology." A visitor to the finished theatre would leave with all knowledge in order. The theatre was never finished. It could not be. Camillo had to assign every place by hand, and knowledge outran him.

The second defect: every palace was private. Simonides' method lives in one head. The palace dies with its owner. It cannot be inherited, checked, or shared. Two scholars with perfect palaces still had no common floor plan.

The third defect was named before the method even matured, by its sharpest critic. Plato, in the *Phaedrus*, has an Egyptian king reject the invention of writing: external marks produce reminding, not memory; they yield people who appear wise and are not. The objection applies to every external store built since, including the internet. Looking something up is not knowing it. A palace on paper is a filing cabinet.

Alongside the palace tradition ran a second tradition, and the two kept touching. Ramon Llull built rotating discs that combined nine fundamental concepts into statements — a generator of knowledge, inspired by the Arabic *zairja* with its 28 categories. The machine produced combinations but gave nothing a fixed place; the alignments were arbitrary. Giordano Bruno fused Llull's wheels with the palace and named the three gates through which anything reaches a mind:

vision, hearing, and thought. Robert Fludd built a Temple of Music and read the theatre stage itself as a projected palace. And Leibniz, who acknowledged Lull and left an unpublished manuscript on the art of memory, divided perfect scholarship into three arts: reasoning, inventing (combinatorics), and memory with imagination. His *characteristica universalis* was the dream of both traditions at once: a notation in which every concept has its own character and reasoning becomes calculation. Frances Yates, who reconstructed this whole history, ends her book precisely there. The art of memory, she shows, does not die in the seventeenth century. It flows into Leibniz and goes underground.

The claim of this essay is that it surfaces again in the MAZE.

3. The MAZE in one page

The MAZE is an address space built on balanced ternary: the number system with three digits, written $+1$, 0 and -1 . Three is the economical base for a number system; the argument goes back, in spirit, to Leibniz's principle that the richest world rests on the fewest elements. Every whole number has exactly one representation in balanced ternary. That single fact does the work of this essay, so it deserves a worked example.

Take the number 47. In balanced ternary it reads $(+1, -1, -1, +1, -1)$ over the weights 81, 27, 9, 3, 1. Check: $81 - 27 - 9 + 3 - 1 = 47$. No other digit string over these weights yields 47. The string is five digits long, so 47 lives at depth 5. Depth is capacity: at depth d there are 3^d strings, and the largest reachable number is $(3^d - 1)/2$. The series of these ceilings runs 1, 4, 13, 40, 121. Growth is logarithmic the other way round: every tripling of the collection costs one digit. Seven million Wikipedia articles fit inside depth 15, because 3^{15} is about 14 million. A hundred million items fit inside depth 17.

Four properties of this notation matter here.

Identity over scale. Writing 47 at depth 8 adds leading zeros: $(0, 0, 0, +1, -1, -1, +1, -1)$. The number does not change. A thing keeps its address when the collection around it deepens.

Mirror. Negating every digit negates the number. The mirror of 47 is -47 , and it is computed, not assigned. Every address has exactly one counter-address.

Compression is rounding. Dividing an address by 3 and rounding to the nearest integer removes the last digit. The error is at most half a unit. Repeating this walks the address up, stage by stage, toward zero. Every collection in the MAZE therefore exists at every compression stage simultaneously, as its own coarser rounding. Expansion is the way back down.

Addition has a carry. Adding two addresses digit by digit can overload a position: a digit sum of ± 2 . The repair rule leaves a residue at the position and passes one unit to the next deeper position. Worked example: 43 is $(+1, -1, -1, -1, +1)$ and 25 is $(+1, 0, -1, +1)$. Aligning at the lowest digit, the raw digit sums read, from the lowest position upward: 2, -2 , -1 , 0, 1. Two positions are overloaded; call that count the strain, $\sigma = 2$. One repair sweep resolves them: the 2 becomes -1 with a unit carried up, the -2 absorbs that unit to -1 , and the result reads $(+1, 0, -1, -1, -1) = 81 - 9 - 3 - 1 = 68$. The number of sweeps needed, q , is bounded by the depth plus one. Doubling a whole tradition works the same way: $47 + 47$ gives $\sigma = 5$ and resolves in one sweep to 94, with a zero standing where a crossing stood. The arithmetic never leaves the address space. Combining knowledge is calculation on places.

Into this address space three corpora have been loaded: the full English Wikipedia, music, and art. One address space, three domains. A knowledge item sits at an address as a knot. A work of art or a musical tradition enters differently: as a route, a recorded sequence of turns, each turn stating where the new ordering principle stands relative to the old — above (+1), level (0), below (−1). Western polyphony, coded this way over six transitions, lands on 47. A tradition that repeats becomes a periodic route and compresses to a closed form, $v_p/(3^p - 1)$. The distinction is old. In the cathedral of Chartres the windows are fixed images and the sculpted figures beside them are the ones who walk. Knots and routes. The palace always had both.

4. How the MAZE settles the three defects

The first defect was the arbitrary building. In the MAZE the places are not assigned; they are computed from content. The address of a tradition follows from its own turning points. The address of a sum follows from the carry. Camillo's ordering rule survives intact and is now automatic: depth is chronology of construction. Ring 1 borders the origin; whatever is built later, out of more turns, lives deeper. Camillo's theatre stopped at seven levels because a man was placing everything by hand. The MAZE has no top level and places everything by arithmetic. His theatre is finished — not by finishing his building, but by replacing the building with a number system.

The second defect was the private palace. The MAZE has one shared floor plan — the number line in ternary dress — and it survives every owner. Yet the classical strength is kept: you remember what you place yourself. A user's own archive enters the shared space as a personal wing: the same addresses, furnished with the user's own material, marked as his. Two people can now compare palaces room by room, because for the first time the rooms coincide.

The third defect was Plato's. His charge was that an external store yields reminding, not memory, because nothing is walked, nothing is done. The MAZE answers the charge on its own terms. Nothing in it is looked up; everything is walked to. The user's whole traffic with the system reduces to five verbs. Where: read an address and its digit string. Neighbour: step one cell along the ring. Mirror: cross to the counter-address. Join: add two addresses through the carry. Up: compress one stage toward zero. Each verb is an act, and the answer to any question is not a stored text but a reading — the digit string told back in words, which the reader must think through to possess. That is memory in Plato's sense, running on an external substrate. The store finally passes the Phaedrus test, because the address is not retrieved. It is recomputed at every step.

5. Ariadne, or where the way is kept

The lineage shows sharpest in the oldest maze of all. Knossos was a true labyrinth: many passages, dead ends, a monster at the centre. No one inside could know the way, because the building carried no addresses. Hence the thread. Ariadne stood at the entrance and held one end; Theseus paid it out going in and rewound it coming out. Note what the thread is: a linear record of the turns taken, stored outside the walker's head. It is the first external route storage in history. It is also, literally, a winding.

Chartres answered Knossos by removing choice. One path, no dead ends, no thread needed — the path itself became the thread, laid in stone. The price: one route for everyone, and nothing left to find. The memory palace answered differently: every man his own building, the thread moved inside, into trained recall. The price: the thread now lived in one skull and died with it.

The MAZE keeps what each solution won and drops what it cost. From Knossos, the richness of many ways: 3^d routes at depth d , real choice at every step. But no thread need be carried, because

the address is the thread. Whoever stands at 47 can read the entire way back out of the number itself, digit by digit. This thread cannot snap, cannot be lost and cannot be forgotten, because it is recomputed at every step. From Chartres, the certainty: every address exists and every route is valid, without the single compulsory path. From Simonides, the furnished rooms — on a shared plan that outlives its owners. And at the centre, where Knossos kept a monster and Chartres a goal, the MAZE keeps zero: rest, the empty address, reached by unwinding digit by digit. Four answers to one question — where do you keep the way — in ever more durable material: thread, stone, memory, number.

One figure remains. Ariadne herself never enters the labyrinth. She is neither the walker nor the building. She is the one who makes another's route readable. In the MAZE that is the exact function of the answer-as-reading: the interface stands at the door, holds the end of the computed thread, and tells the walker, in his own language, the way he has come and the ways that stand open. Homer already knew the deeper layer: he places in Knossos a dancing floor built for Ariadne, on which the crane dance traced the labyrinth's path again and again. Before the labyrinth was a building, it was a repeated choreography — in the terms of this essay, a periodic route. A tradition.

6. Bruno's three gates, loaded

Bruno wrote that there are three gates through which anything binds a soul: vision, hearing, and mind. Look at what stands loaded in the MAZE: art, music, and Wikipedia. The three corpora are not an arbitrary sample of culture. They are Bruno's three gates, one corpus per gate, on one address space. An answer in the MAZE can therefore in principle arrive in three guises — something to see, something to hear, something to read — and Fludd's Temple of Music, the palace built to be performed, stands in the direct ancestry of a maze that can be played as well as read.

Leibniz closes the account. His three arts of the perfect scholar — reasoning, inventing, memory — are in the MAZE a single machine. The reading is the reasoning. The carry is the inventing: combinatorics executed as arithmetic on places. The address space is the memory. What he described as three separate faculties turn out to be verbs on one number system. His *characteristica universalis* asked for a notation in which every concept has its character and disputes end in "let us calculate." Every thing in the MAZE has its number, and combining two things is a calculation whose strain and settling time can be read off. The demand is met, in the smallest alphabet that can meet it.

7. Two properties the old palaces never had

The gaps speak. In the classical art the loci had to be prepared empty before images were placed. The MAZE prepares all of them at once: the number system lays every room in advance. An unfilled address is therefore not a failure but a prepared, unfurnished room. The gaps come in two kinds, and the compression stages tell them apart. A local gap is an empty cell whose coarser rounding, one stage up, is occupied: the district exists, this room stands open. A structural gap is a column of emptiness running through every stage: a whole wing no one has entered. A user who asks a question that lands on emptiness has not failed; he has surveyed the palace and found a room. And an empty mirror address is stronger still: it is a readable prescription. The digit string of -47 states, turn by turn, what the counter-tradition of polyphony would have to be. The palace can describe rooms whose furniture does not yet exist.

The coding can be tested. Coding a tradition is a human act, so it can err, and the notation says exactly where errors matter. Disagreement between two coders about the last turn of a route shifts the address by 2. Disagreement about the first turn shifts it by $2 \cdot 3^{(d-1)}$ — at depth 5, by 162. The

notation is robust at the end of a route and brittle at its beginning. The falsification is therefore cheap and precise: two readers code the same tradition blind, and their distance, digit by digit, measures the objectivity of the rule. This test has not yet been run. It is the next step, and the essay says so plainly.

8. Conclusion

The art of memory posed one question for twenty-five centuries: where do you keep the way? Its practitioners answered with borrowed buildings, and the answers kept their three defects — arbitrary places, private palaces, and Plato's charge of mere reminding. Camillo tried to give the places meaning and could not finish. Llull built a generator without addresses. Leibniz saw that the endpoint was a number for every concept, and the trail went cold. The MAZE picks the trail up where he left it. The places are computed, the floor plan is shared, the personal wing keeps Simonides' law that you remember what you place yourself, and nothing is retrieved that is not walked. It is a memory palace whose architect is a number system — the modern memory palace, with Ariadne's thread woven into every address.

Annotated references

1. **Frances A. Yates, *The Art of Memory* (Routledge & Kegan Paul, 1966).** Why read it: the standard history of the whole tradition, from Simonides through Camillo and Bruno to Leibniz. Yates is the one who shows that the art of memory does not die but flows into the *characteristica universalis* — the exact junction where this essay picks up. Reading advice: chapters on Camillo's theatre and the final chapter on Leibniz first.
2. **Quintilian, *Institutio Oratoria*, Book XI, chapter 2.** Why read it: the clearest ancient manual of the two-act method — lay the places, deposit the images, walk the building to recall. The passage on rooms, forecourts and statues as custodians is the classical palace in one paragraph.
3. **Cicero, *De Oratore*, Book II, 351–354.** Why read it: the source of the Simonides story and of the founding principle that order of place is the key to memory. Short, and the whole tradition stands on it.
4. **Plato, *Phaedrus*, 274c–275b.** Why read it: the strongest objection ever raised against external memory — writing as an elixir of reminding, not of memory. Any external knowledge store must answer this passage; the essay's five-verbs argument is addressed to it directly.
5. **Giulio Camillo, *L'idea del teatro* (1550).** Why read it: the one Renaissance attempt at a palace whose places carry meaning, ordered by the chronology of creation. Camillo's ordering rule is the depth logic of the MAZE, stated four and a half centuries early. Reading advice: read it with Yates's chapter alongside; the original is fragmentary.
6. **Ramon Llull, *Ars Magna* (c. 1305); with Anthony Bonner, *The Art and Logic of Ramon Llull* (Brill, 2007) as guide.** Why read it: the combinatorial branch of the family — a machine that generates knowledge from few elements but assigns no addresses. The contrast with a bijective address space shows precisely what was missing.

7. **Giordano Bruno, *Theses de Magia / De Magia* (c. 1588).** Why read it: the source of the three gates — vision, hearing, mind — through which anything binds. The three corpora loaded in the MAZE follow this triad one for one.
8. **Robert Fludd, *Utriusque Cosmi... Historia*, Vol. II (1619), the sections on the Temple of Music and the theatre.** Why read it: the palace built to be performed. Fludd is the precedent for a maze that can be heard as well as read.
9. **G. W. Leibniz, *Dissertatio de arte combinatoria* (1666).** Why read it: the young Leibniz acknowledging Llull and formulating the programme — every concept its character, reasoning as calculation — that a numbered knowledge space finally executes. Reading advice: the preface and the statement of the characteristic suffice.
10. **Donald E. Knuth, *The Art of Computer Programming*, Vol. 2, section 4.1 on positional number systems.** Why read it: the standard technical treatment of balanced ternary, including uniqueness of representation, negation by digit-flip, and truncation as rounding — the four properties this essay leans on. Knuth calls balanced ternary the prettiest number system; here it is also the most useful.
11. **Homer, *Iliad*, Book XVIII, 590–606; Plutarch, *Life of Theseus*, 21.** Why read it: the oldest layer of the labyrinth — Ariadne's dancing floor at Knossos and the crane dance that traced the path as repeated choreography. The labyrinth as periodic route precedes the labyrinth as building.
12. **J. Konstapel, "About Magic and the Memory Palace," constable.blog, 1 November 2010.** Why read it: the programme text of this essay, written sixteen years before the system existed — the trinity as the most efficient base for a number system, Llull, Camillo, Bruno's gates, Leibniz's three arts, and the closing proposal to reintroduce the memory palace. The present essay reports that the proposal has been carried out.