Universal Matrix: Least-Action Cartesian Construction Protocol Permitted Tools and Primitive Moves

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Technical report: a response to the polar–coordinate critique

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Abstract

The *Universal Matrix* heuristic was presented in 2024 as a graphical system and rules for information and processes representation and meta-heuristic organisation [1]. In 2025 each picture–only step was translated into a precise twelve–step rule set, proving that four principles—**Least Action, No Ambiguity, Self-Reflection, Inheritance**— force a unique sequence of shapes [2]. Silvania Sh. (2025) has counter-argued that, if one silently adopts polar coordinates, alternative constructions (for example a regular pentagon at step 5) could satisfy the same principles [3].

This note shows that a *Cartesian* reading is not optional but *minimal.* Every step can be carried out by an artisan using only self-evident, primitive moves: placing dots, drawing straight lines, transferring length with string. Polar methods presuppose angle measurement and trigonometry—knowledge and tooling that lie outside the least-action scope. Therefore the constructive protocol is restated explicitly in Cartesian terms, with no compass, no hidden geometry, and no ambiguity.

Permitted Tools and Primitive Moves

1. **Primitive Point** — place a dot anywhere.
2. **Straightedge Draw** — draw the unique straight line through any two existing points.
3. **Length Transfer** — copy a chosen segment onto any ray with string or folded paper.
4. **Intersection Mark** — record the unique intersection of two non-parallel lines.
5. **Visual Tests** — decide by eye whether a point lies on a line or inside a triangle.

No compass, protractor, angle bisector, or numeric measurement is allowed.

Global Principles

1. **Least Action** — Introduce exactly *one* new element (point or segment) per step.
2. **No Ambiguity** — At each stage exactly one configuration satisfies all rules; every rival construction is rejected.
3. **Inheritance** — Each configuration strictly contains the prior one.
4. **Self-Reflection** — Steps 7–12 replay Steps 1–6 inside the hexagon produced at Step 6.

Result - Twelve-Step Construction (Cartesian)

Step	Action (adds one element)	Uniqueness Logic
1	Place point **A**.	Only primitive move available.
2	With length-transfer on an arbitrary ray from **A**, mark **B** so that $AB = u$.	Ray is arbitrary, but once fixed, **B** is unique.
3	Draw $\overline{AB}$. Place **C** with $C \notin \overline{AB}$.	If collinear, no area appears $\Rightarrow$ dead end; off-line is forced.
4	Draw triangle edges. Place **D** with $D \notin \triangle ABC$ and $D \notin$ its edges.	Interior placement is ambiguous; an exterior convex quadrilateral is unique.
5	Draw diagonals $\overline{AC}, \overline{BD}$; their intersection is **E**.	Two lines intersect once $\Rightarrow$ forced point.
6	Transfer length AE (via string) to mark a circle "centered" at **E**. Then, by repeatedly copying this radius around, place six points $\mathbf{P}_1 \ldots \mathbf{P}_6$ on that circle and connect them in order to form a regular hexagon.	Equal-length stepping needs no angles; six placements exhaust the circle $\Rightarrow$ hexagon uniquely determined.
7	*Mirror 1* – Reinterpret **E** as the common intersection of the three long diagonals.	No new element.
8	*Mirror 2* – Erase two diagonals and leave only the vertical long diagonal (fixed by the original ray). Draw two perpendicular chords; their intersections are $\mathbf{I_1}$, $\mathbf{I_2}$.	Orientation fixed at Step 2; chords are forced by symmetry.
9	*Mirror 3* – Draw the other two long diagonals; all three meet at **E**.	Completes the star; inclusion is compulsory.
10	*Mirror 4* – Erase two diagonals drawn at step 9. Connect $\mathbf{I_1}$ and $\mathbf{I_2}$ to opposite vertices; new intersections are $\mathbf{V_1}$, $\mathbf{V_2}$.	Exactly four segments close the inner quadrilateral; fewer leave a gap, more duplicate.
11	*Mirror 5* – Draw the second diagonal $\overline{V_1V_2}$; it meets $\overline{I_1I_2}$ at **E**.	Single missing diagonal completes the mirror of Step 5.
12	*Mirror 6* – Use hexagon from step 6. Draw six "skip-one" chords (two interlaced triangles); their six intersections give $\mathbf{R_1} \ldots \mathbf{R_6}$, the inner hexagon.	Six chords enforce and saturate symmetry; any change breaks the axioms.

The final figure X_{12} nests all prior stages, satisfying Self-Reflection and completing the Universal Matrix.

Discussion

Steps 3 and 4 allow for the construction of triangles and quadrilaterals without symmetry and with varying side lengths. This does not interfere with any of the later steps in the sequence. It is, however, possible to construct an equilateral triangle by using two intersecting circles, which can be drawn using a string and a pencil. Yet this introduces an additional step—and ambiguity: the triangle can be oriented either upwards or downwards within the circle.

If this method is pursued, the second intersection point of the two circles can be used to form a quadrilateral. The diagonals of this shape can then be intersected, and a smaller circle can be drawn around the resulting center, allowing the sequence to proceed into the hexagon construction.

This creates a trade-off: one may choose a truly minimal method that produces an irregular triangle and quadrilateral, or accept a few additional steps to enforce symmetry early on through equal-length construction.

This discussion is important because the construction rules aim to eliminate ambiguity. At present, it is unclear which path reduces ambiguity more effectively: fewer steps with irregular figures, or more steps that produce symmetric ones. The original formulation of the sequence presented the Universal Matrix as the core of a cyber-cognitive system. Its purpose is to synchronize human and artificial cognition under the same, fully visual rule set. To eliminate the "black box" in AI, both human and machine must operate in complete harmony, where every operation performed by AI is fully explainable.

The Universal Matrix, as both a visual heuristic and a rule-based framework for cyber-cognitive systems, is envisioned as a key to this challenge. Future research will aim to demonstrate its applicability and practical use.

While the twelve-step protocol is already near-optimal under the stated rules, some speculative refinements have been considered. Introducing symmetry earlier via intersecting circles may reduce ambiguity in placement, but this increases the step count and breaks Least Action. Similarly, fixing an initial axis could eliminate directional ambiguity but would compromise the protocol's emergent neutrality. Attempts to merge later symmetric steps or infer constructions from global symmetry are feasible for automation but unsuitable for manual execution. Formalizing the rule set as symbolic grammar may help expose structural redundancies, yet it changes the protocol's nature from constructive to descriptive. Overall, the current construction balances rigor and minimalism more effectively than any proposed variant.

On Self-Reflection and Inheritance

Polar-Coordinates critique helped to realize that **Self-Reflection is not a prerequisite but an *emergent* result**. One can follow the sequence from Step 1 to Step 12 without ever naming that rule; it reveals itself automatically once the inner construction mirrors the outer. In other words, the builder does not need to know about self-reflection in advance—the symmetry surfaces on its own.

Inheritance, on the other hand, operates mainly at the *numerical* level: each step adds exactly one new point ($|S_n| = n$). Geometrically, earlier figures may be erased or overwritten. For instance, Step 6 displays only the outer hexagon; the quadrilateral of Step 5 is no longer drawn, yet the knowledge of its centre and radius guides the hexagon. Likewise, Step 12 visibly contains only the rotated inner hexagon from Step 6; the intermediary shapes of Steps 7–11 are implicit.

Accordingly, if one wishes to state the *absolutely minimal* global priciples, **Least Action** and **No Ambiguity** suffice. Self-Reflection appears *naturally*, and Inheritance is better described as "conservation of acquired measurements" (centre, radius, orientation) rather than strict visual containment.

This observation is also relevant to the principle of minimum tooling. A construction based on polar coordinates assumes access not just to circular placement but to angle division, angular measurement, and underlying trigonometric knowledge. To gain such knowledge would require the prior construction of regular angles, crafting of reliable arc-based tools, and a method of maintaining consistency—all of which introduce complexity far beyond the self-evident ruler-and-string logic. Simply *using* trigonometry presupposes a deep conceptual apparatus and thus violates the spirit of least action.

In contrast, the Cartesian approach complies with a more intuitionistic view: we proceed only with what is evident at each step, never assuming a conclusion before it becomes constructible. The sequence unfolds without appealing to hidden structure or a predetermined symmetry. In this sense, self-reflection arises without invoking the law of excluded middle—one does not assume the inner construction mirrors the outer; it becomes visible, and true, only in hindsight.

Conclusion

By stating the Cartesian framework explicitly, and by including the non-collinearity and exterior-placement tests at Steps 3 and 4, this protocol closes the loophole raised by polar coordinates critique. With nothing more than straightedge, string, and common intuition, even an artisan of antiquity can reproduce the Universal Matrix—no trigonometry, no compass, no hidden knowledge.

References

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