¿Does bidirectional communication influence the efficiency of P systems with active membranes?

Antonio E. Porreca & Milano Team
Università degli Studi di Milano-Bicocca, Italy

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Spoiler:
¡yes, it does!

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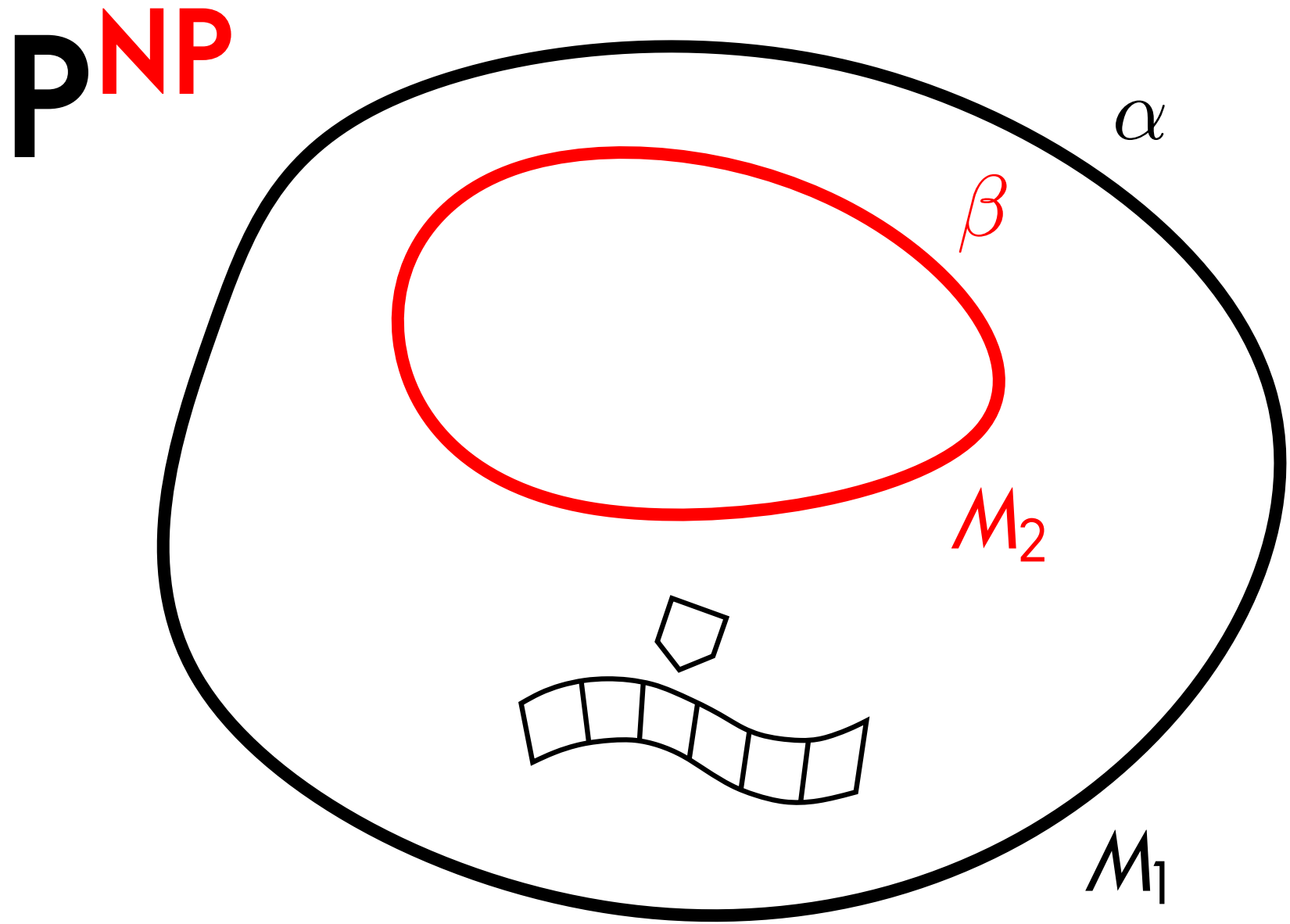
Simulating TMs with oracles using send-in



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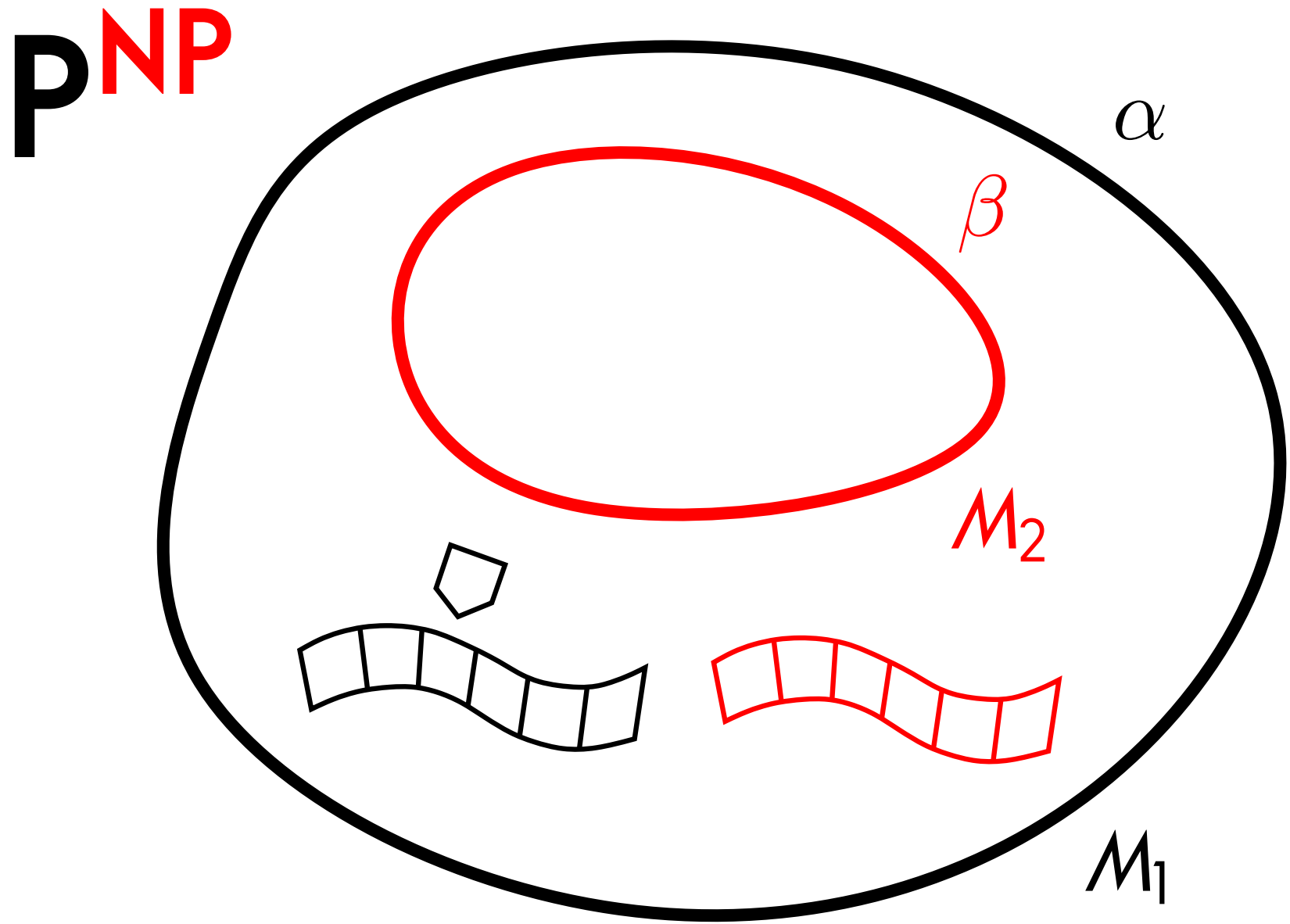

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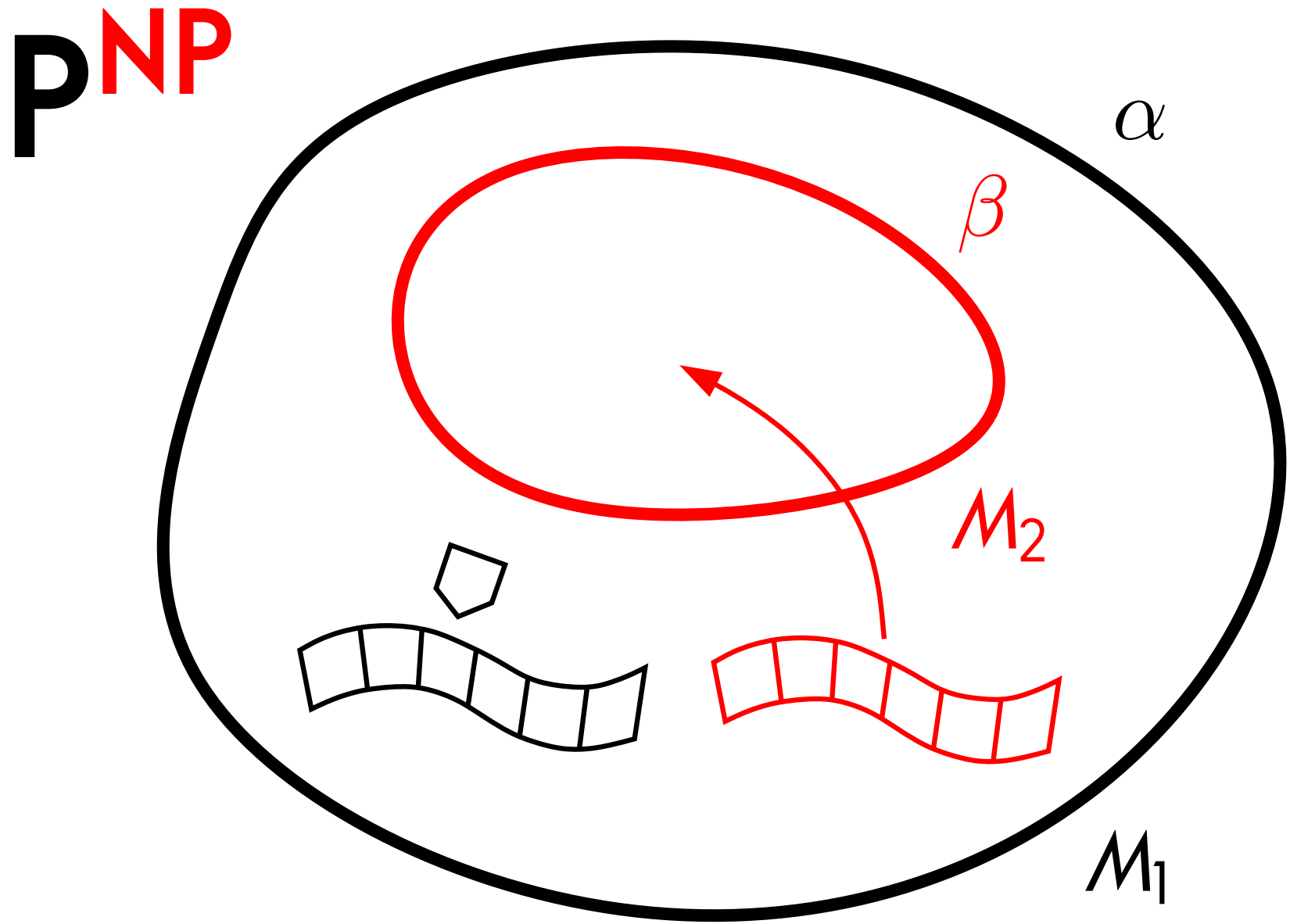

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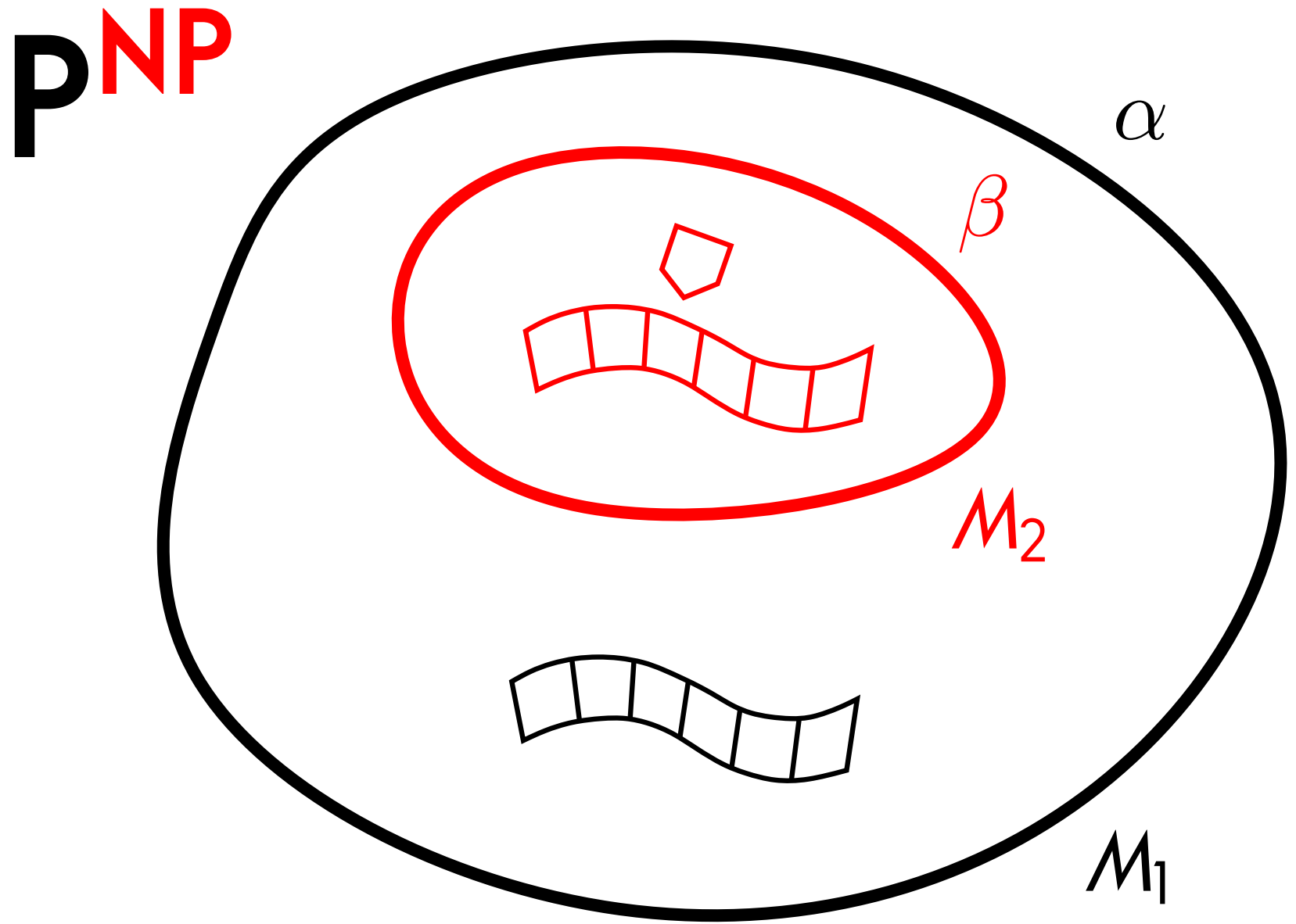

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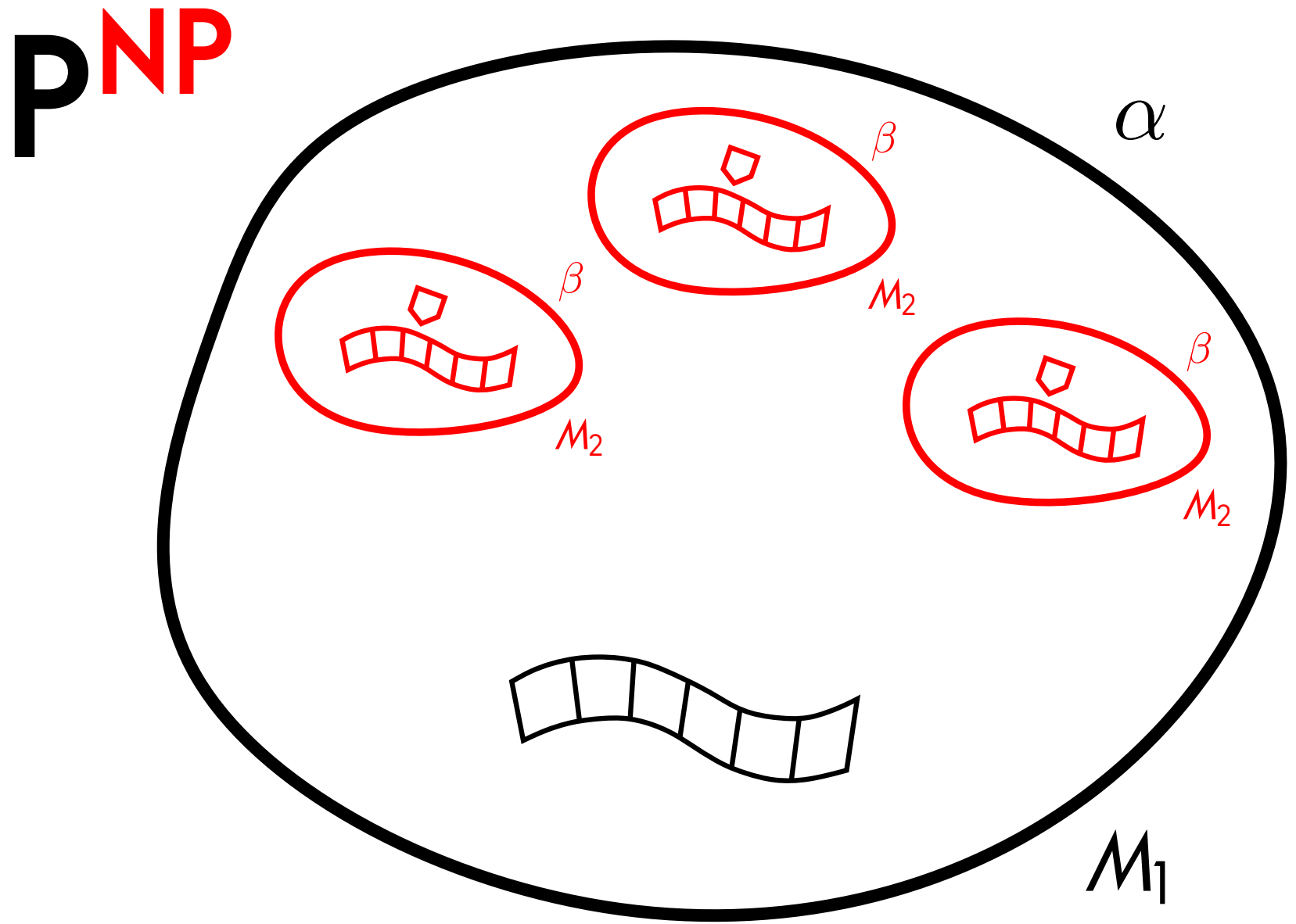

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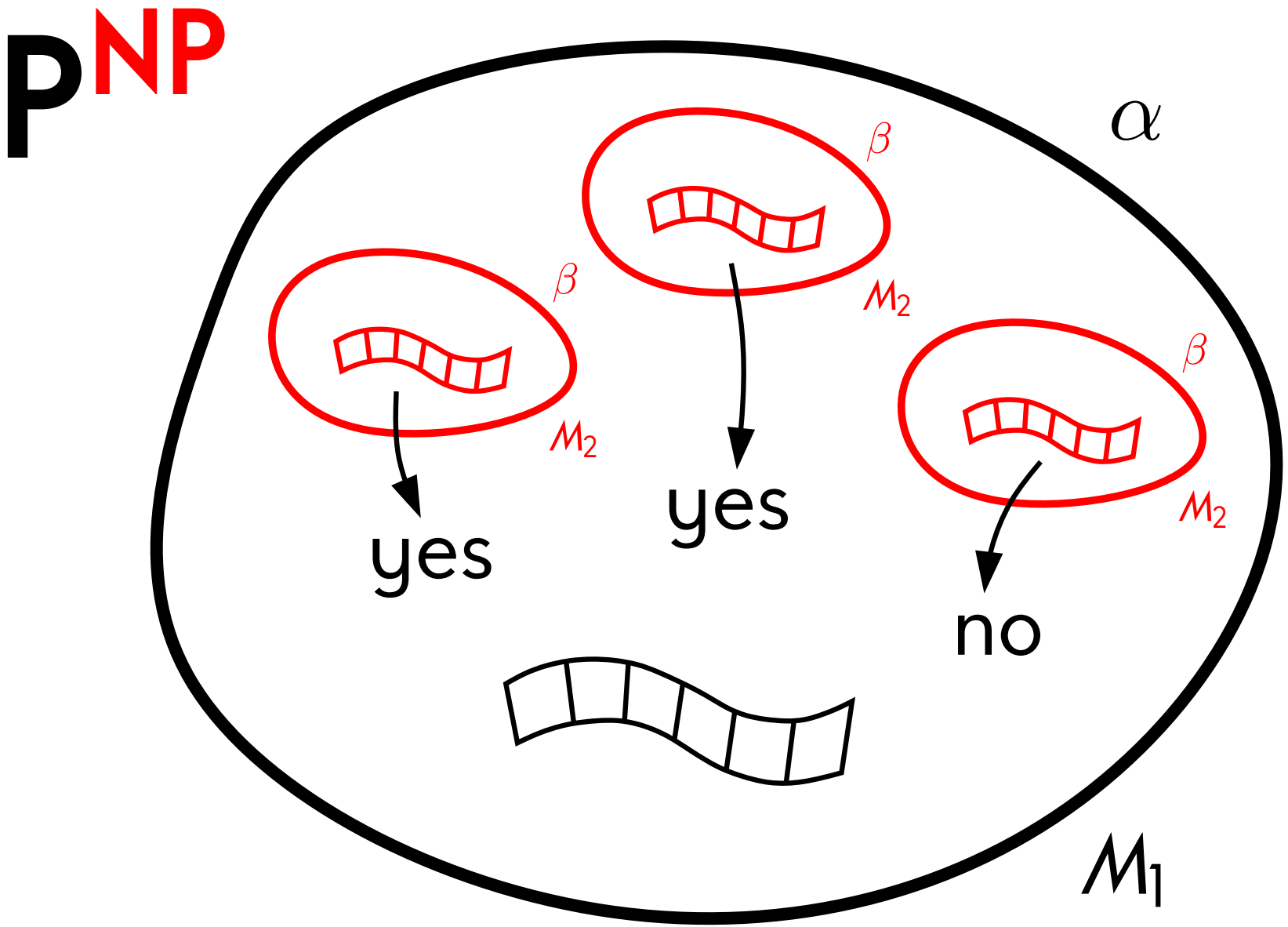

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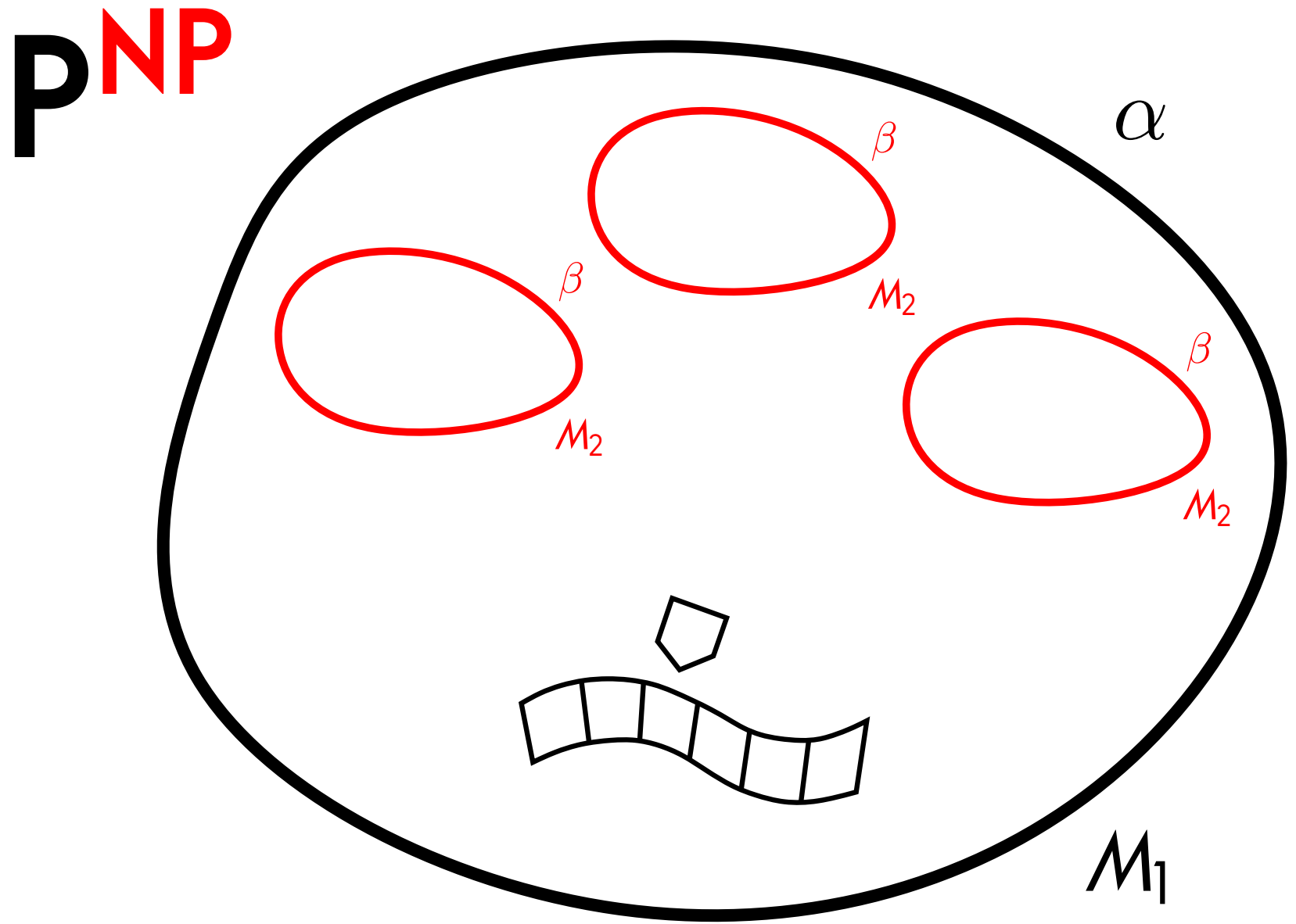
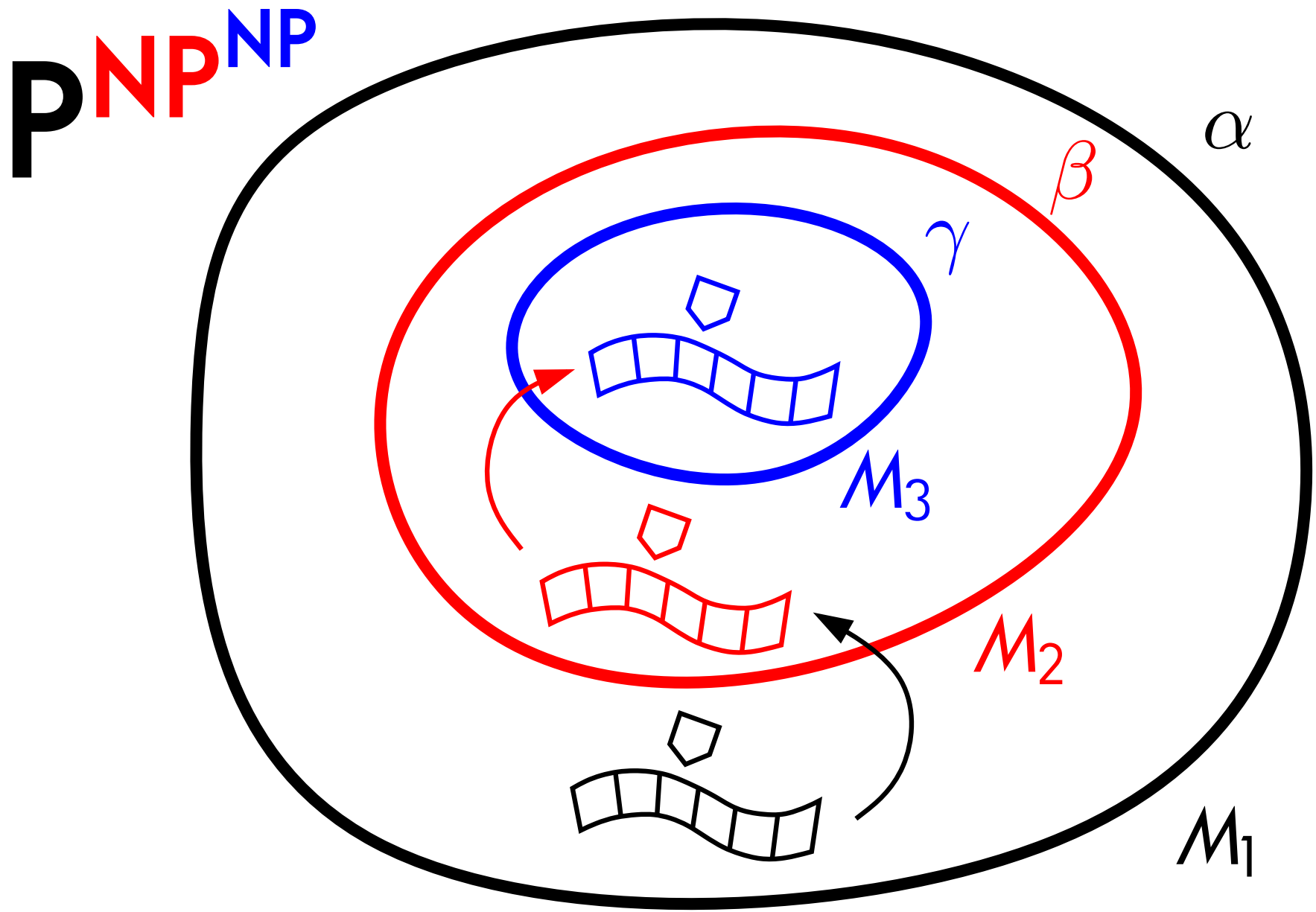


This can be iterated



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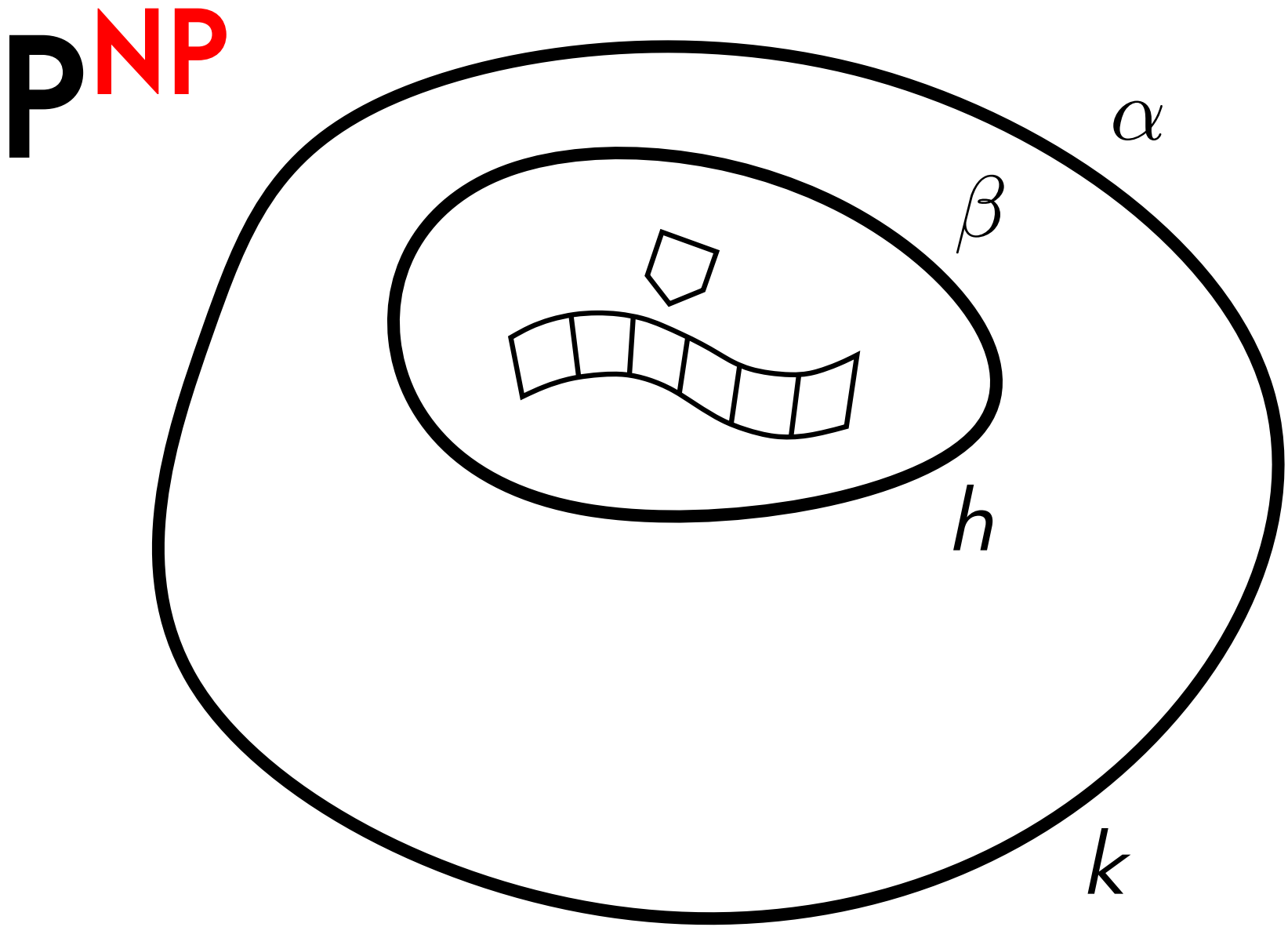

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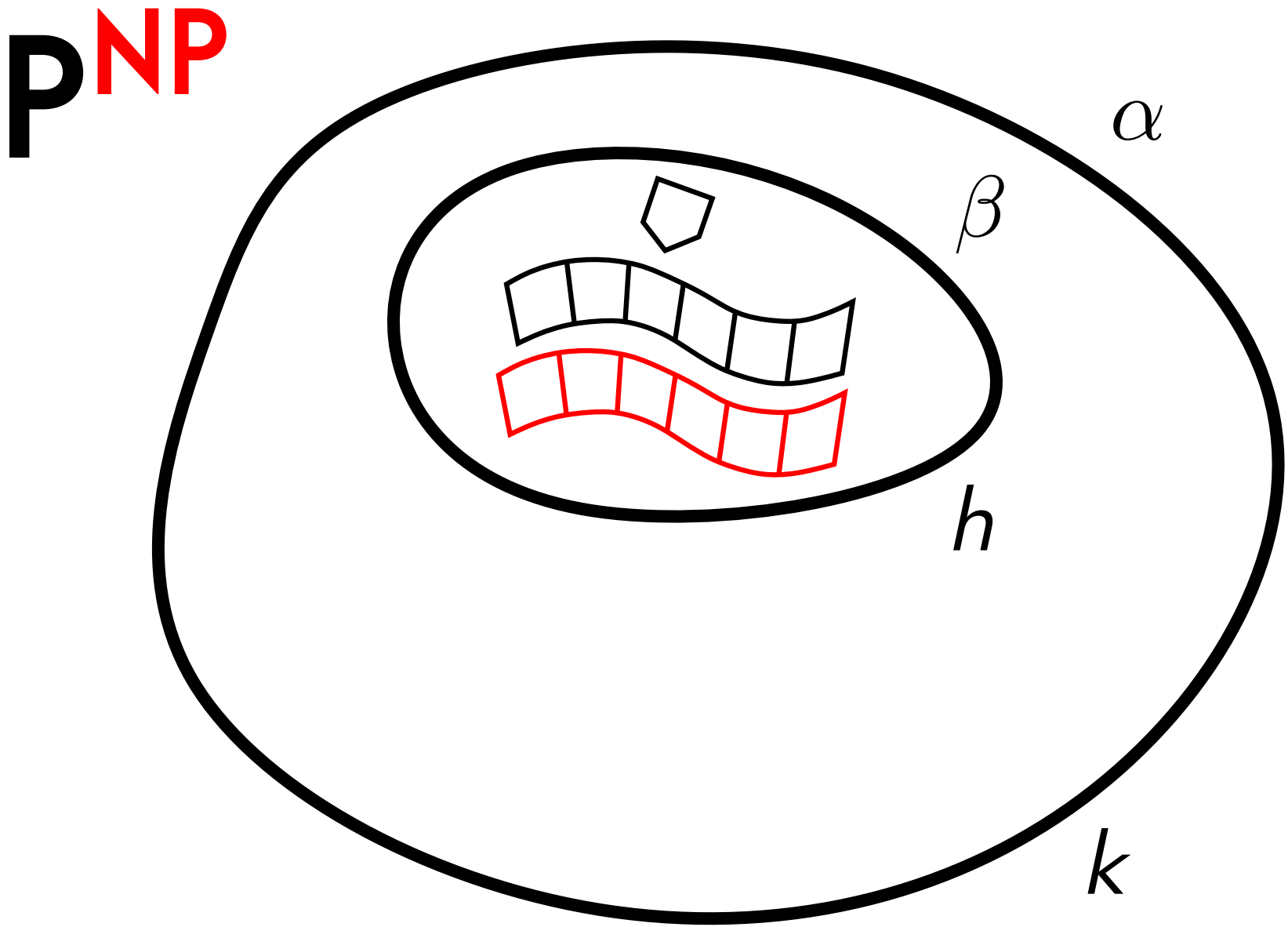

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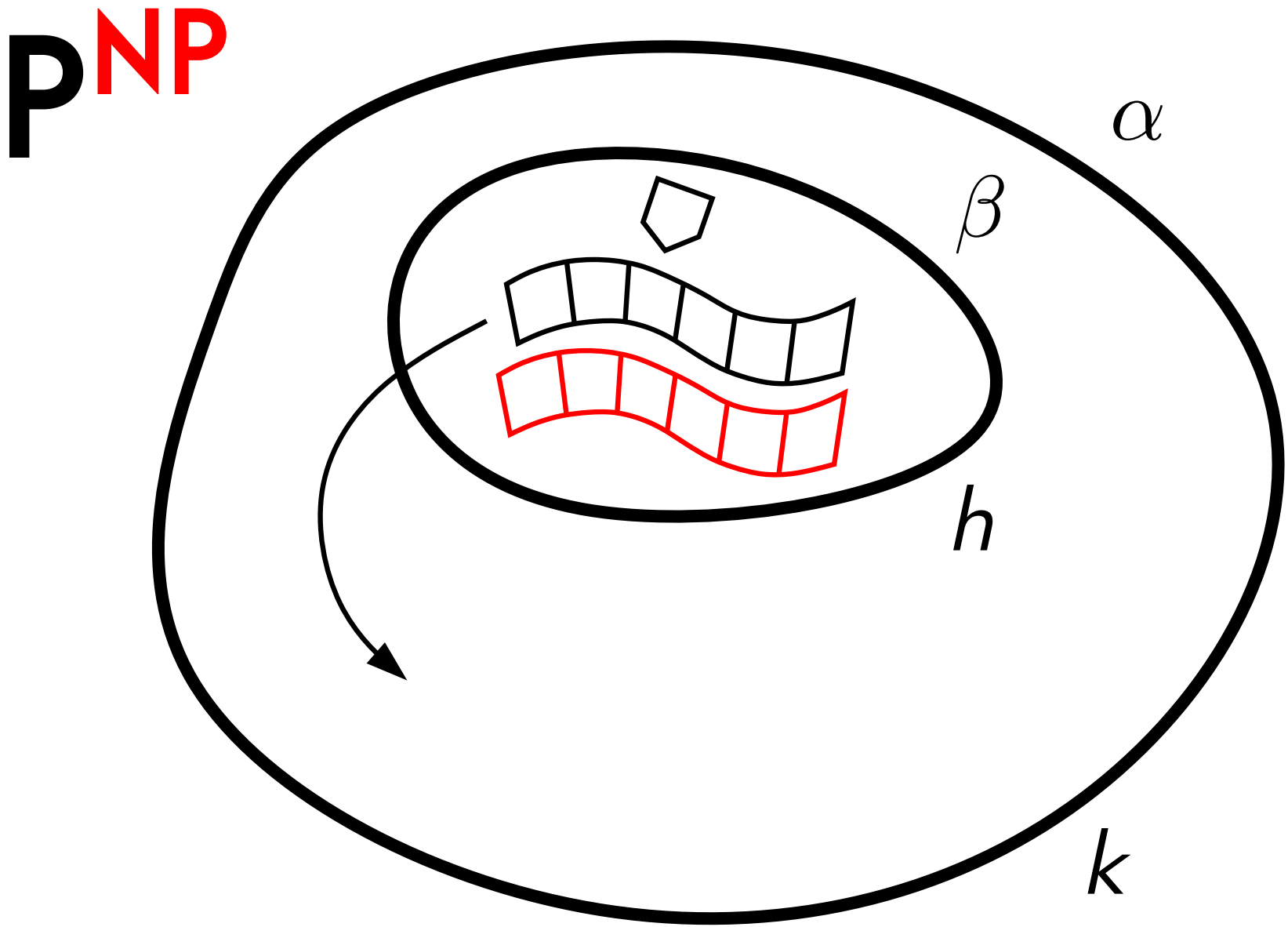

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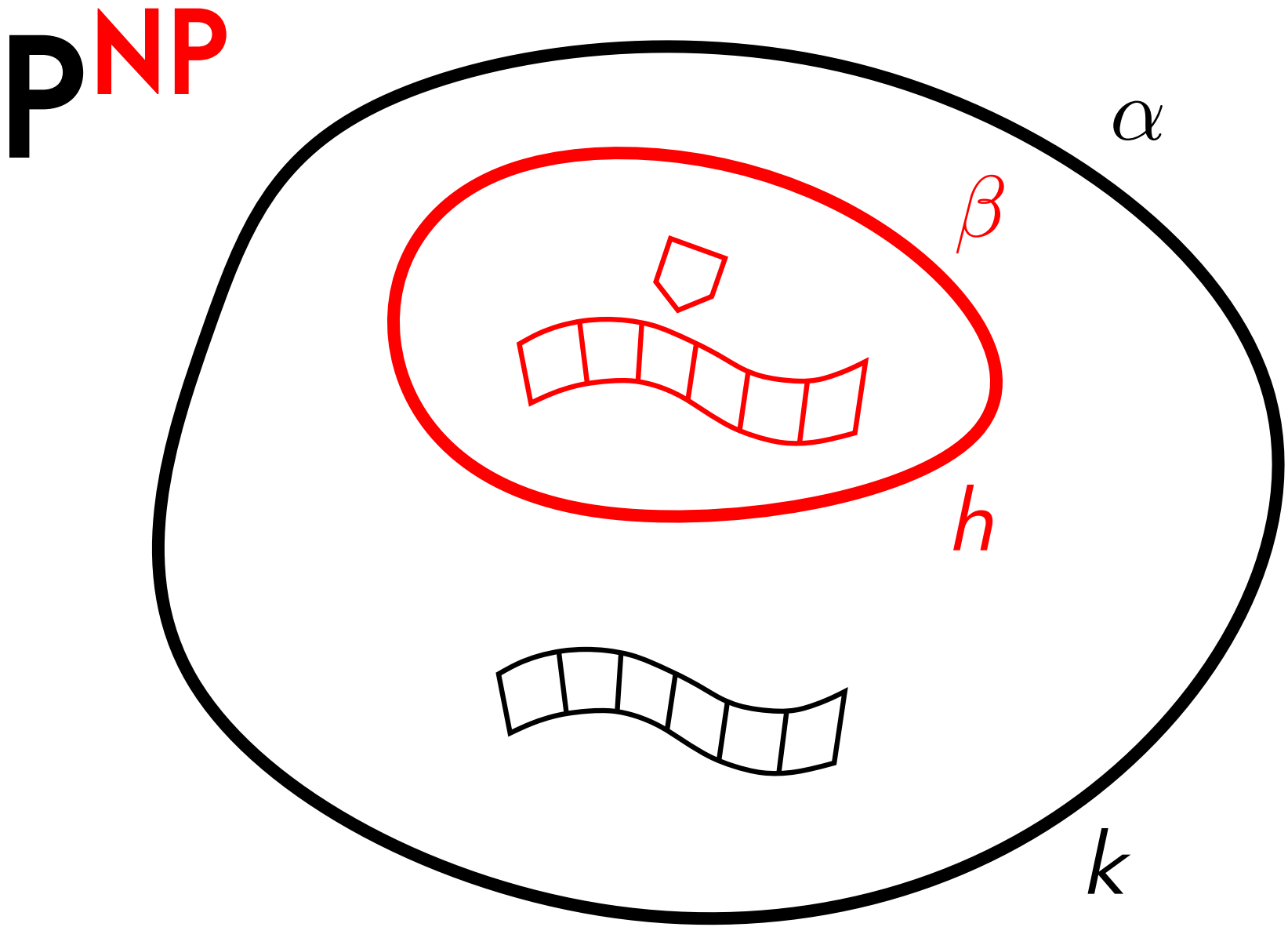

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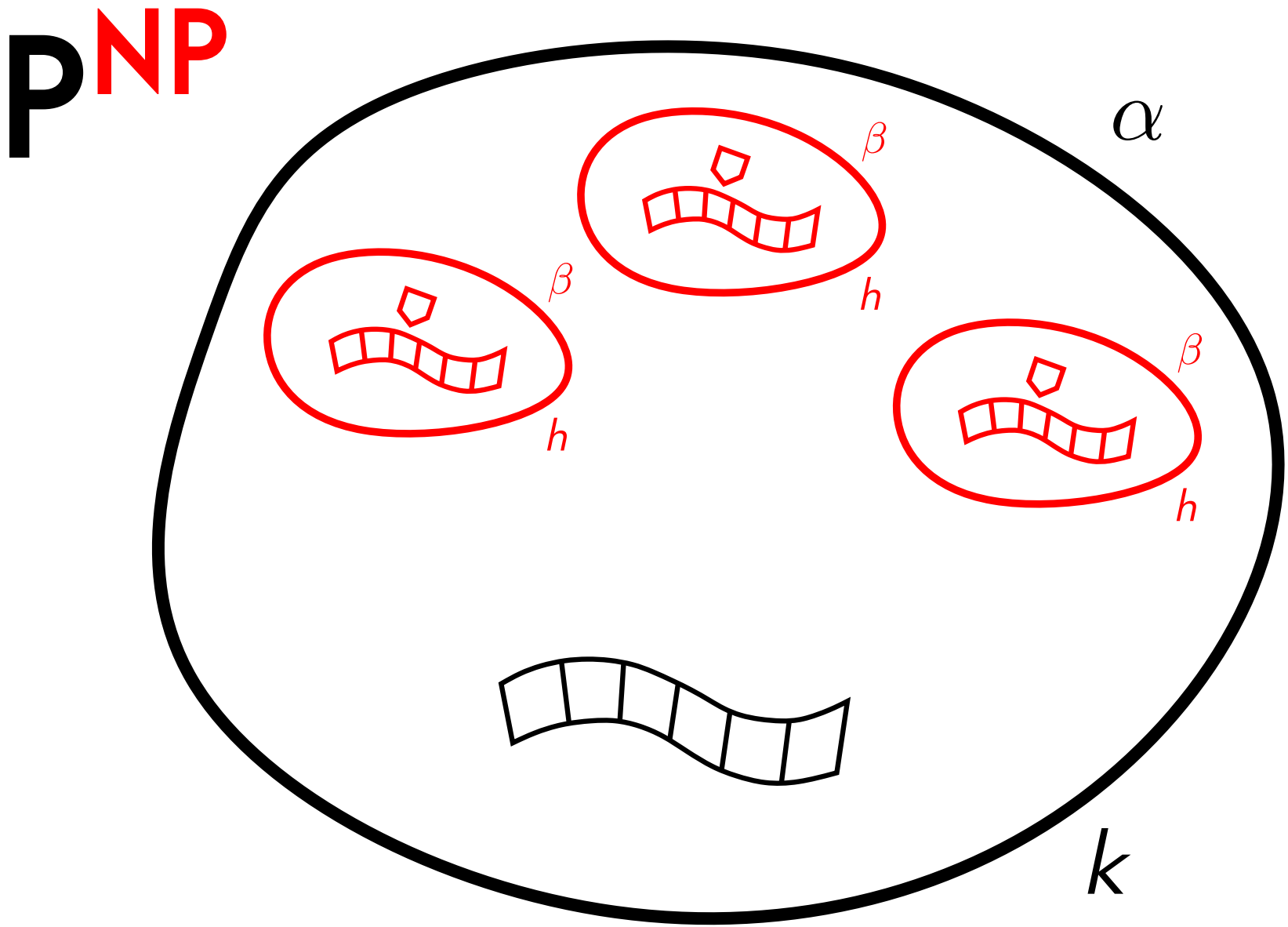

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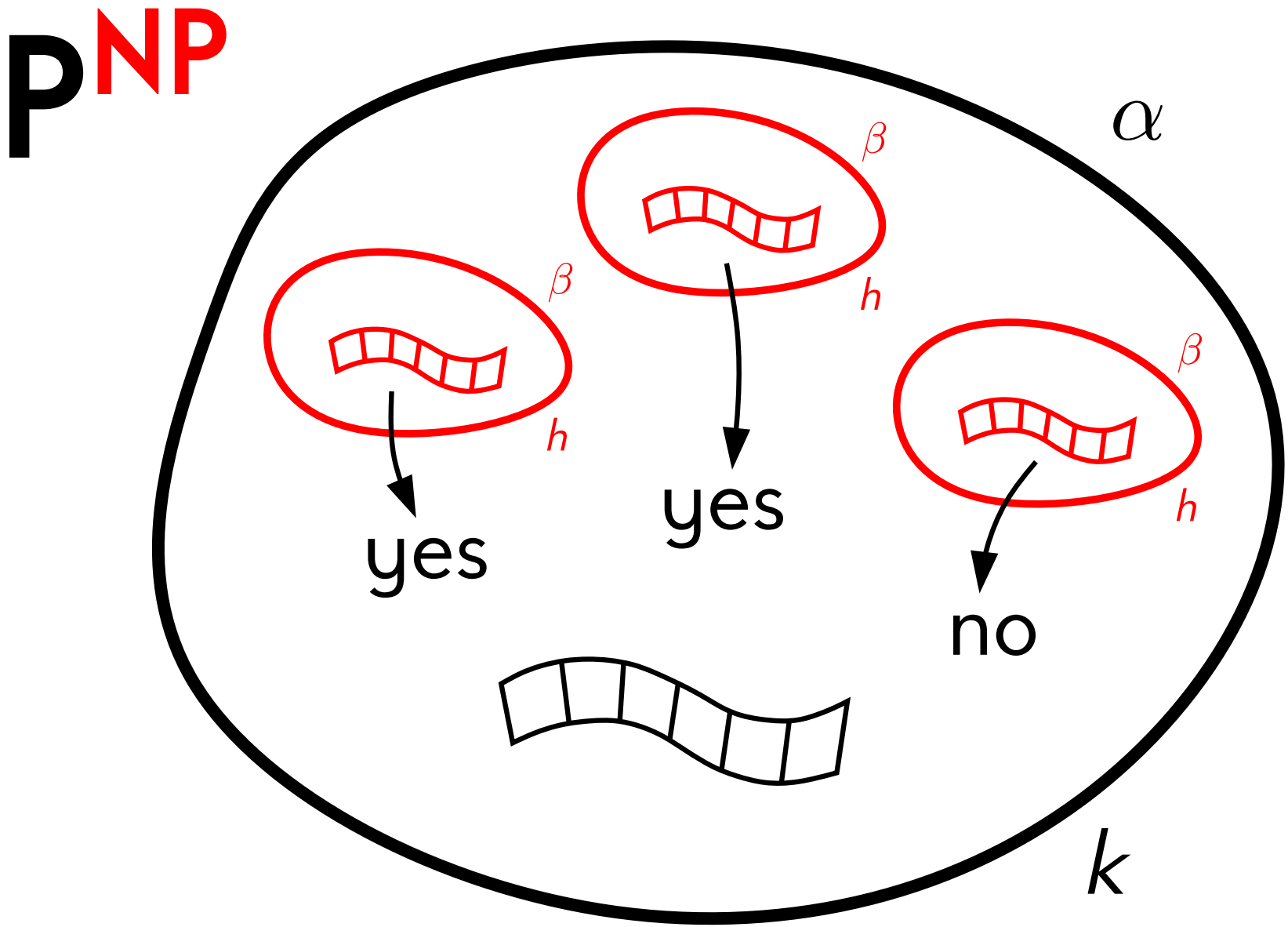

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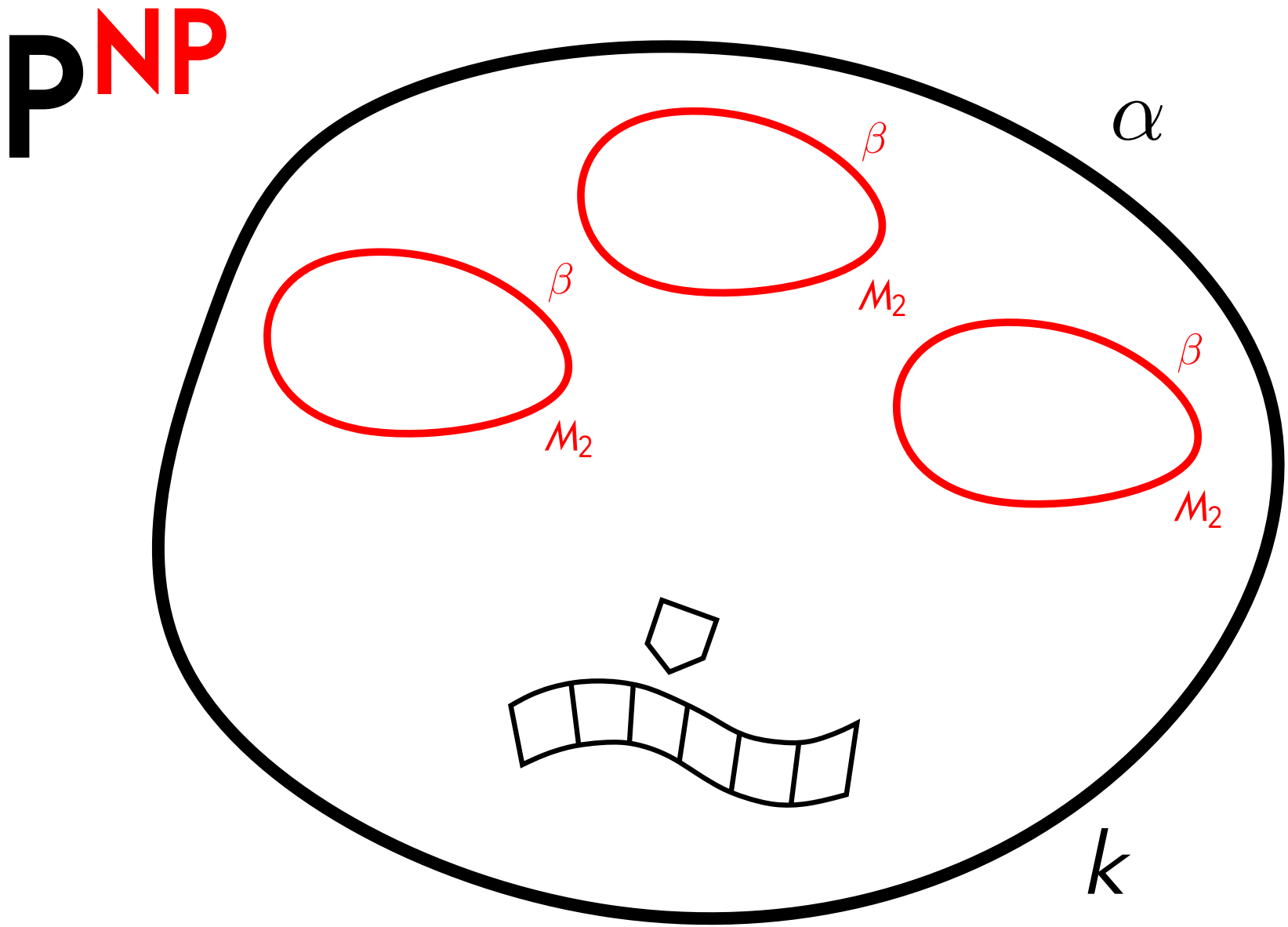
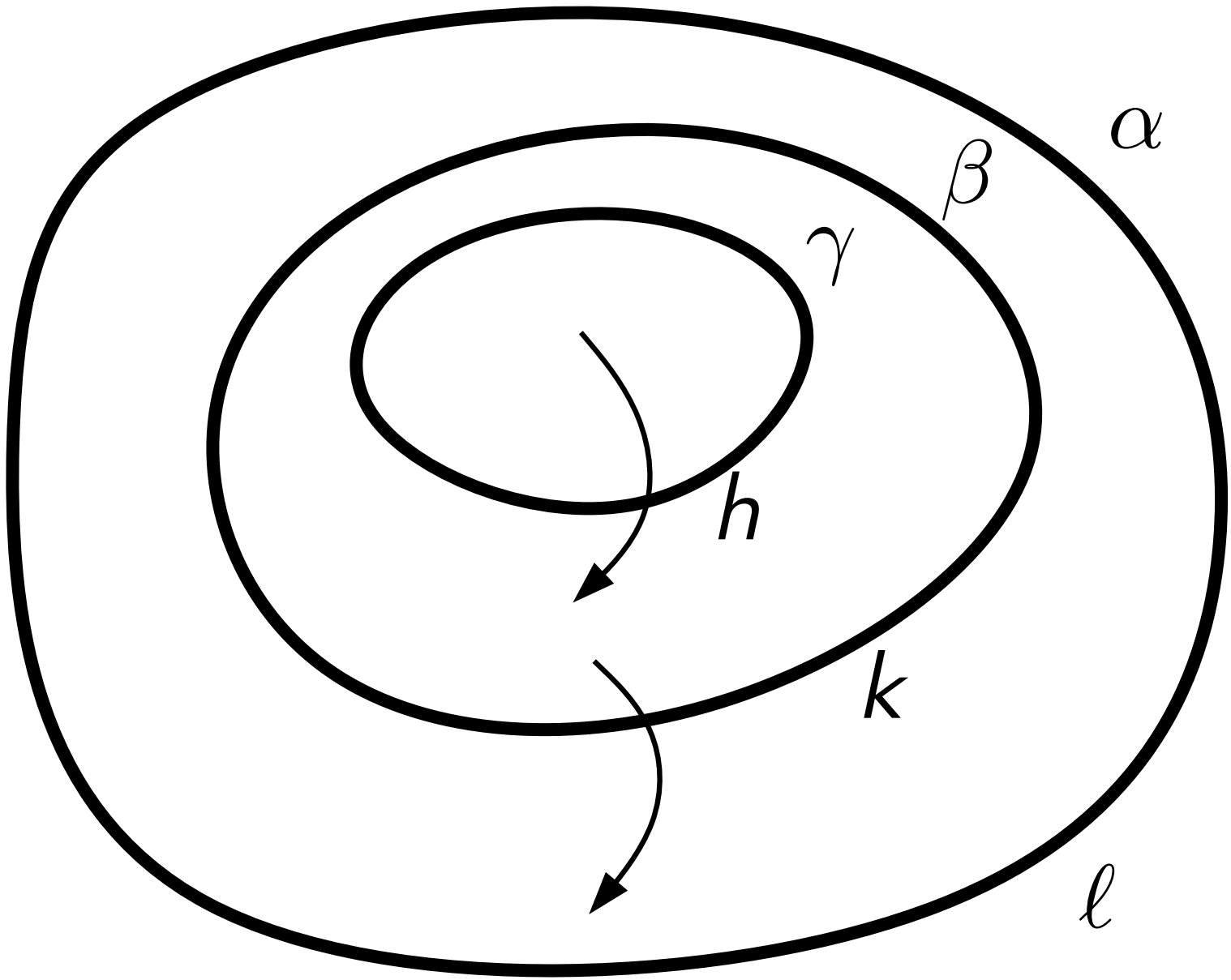


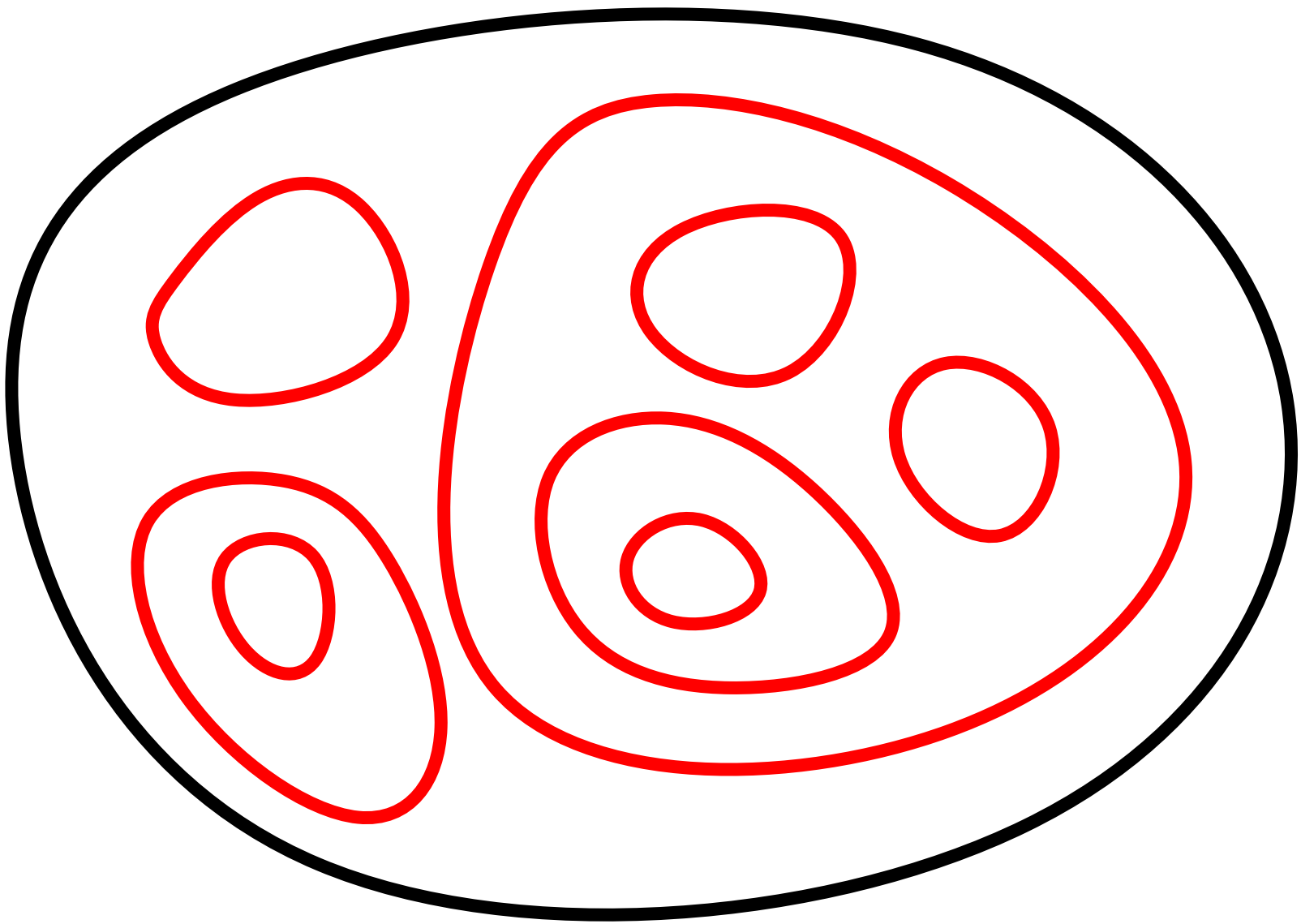
Each query “consumes” membrane depth



And the construction cannot be iterated

Theorem. For each family of P systems working in polynomial time there exists some polynomial p such that you don't really care if you have more than $p(n)$ copies of an object

Simulation of P systems without send-in



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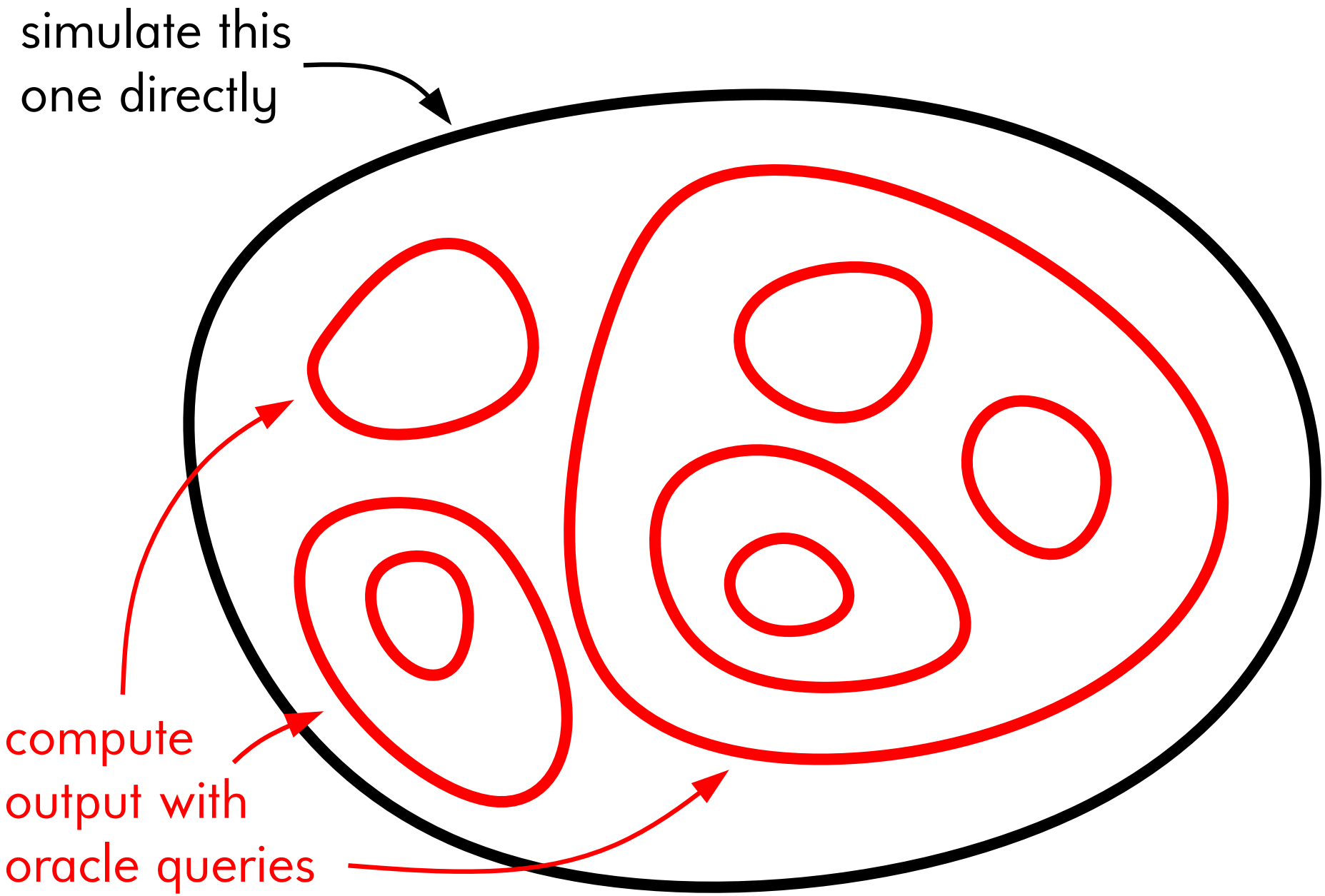

Which queries are needed?

Query. Hey, membranes with label h, how many copies of a do you send out at time t? (I don't care if it's more than $p(n)$)

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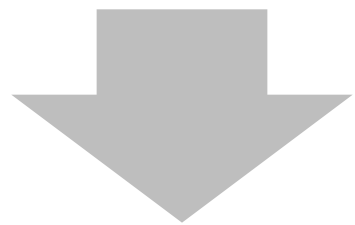
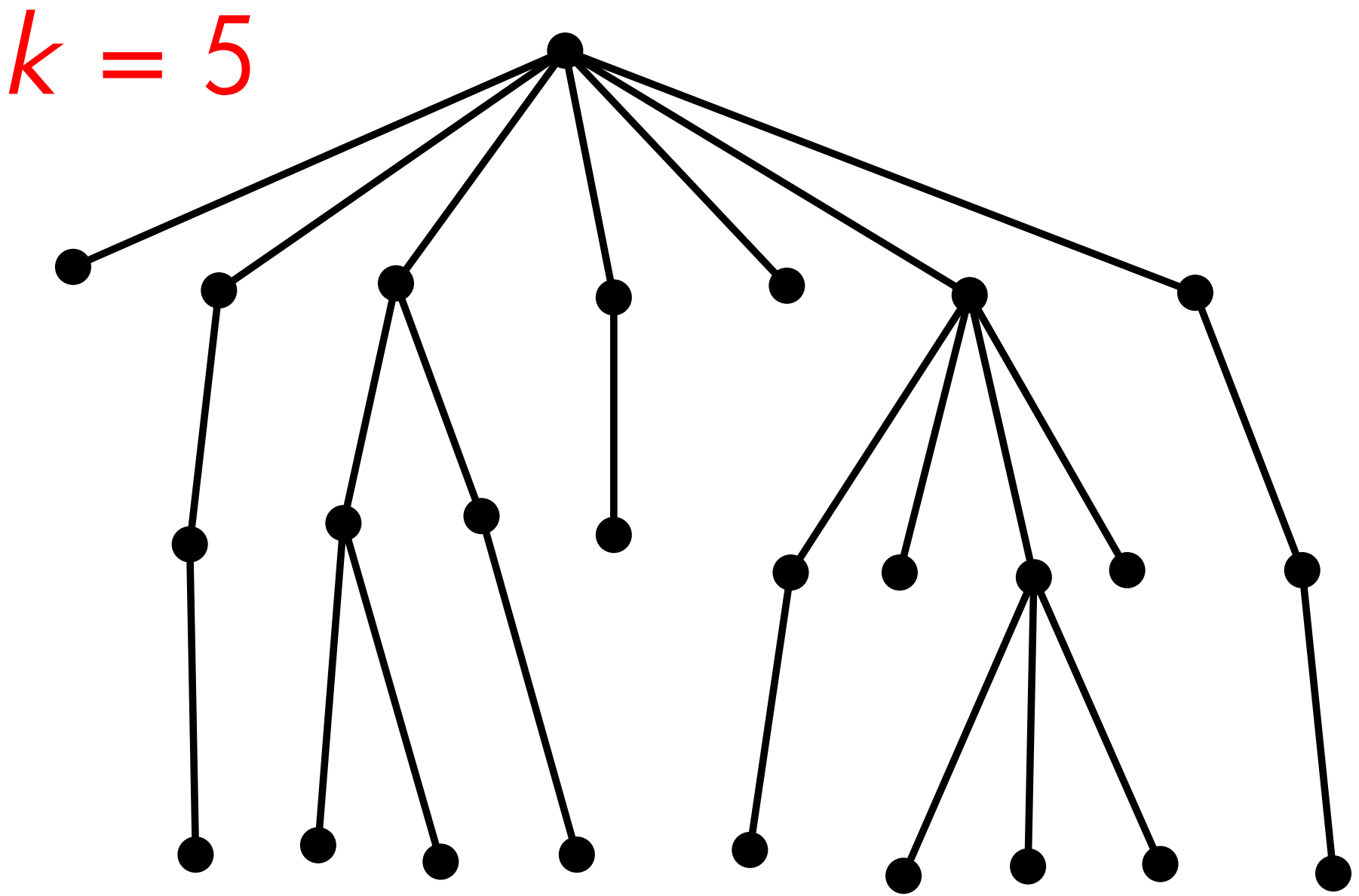
Query. Hey, membranes with label *h*, how many copies of *a* do you send out at time *t*? (I don't care if it's more than $p(n)$)

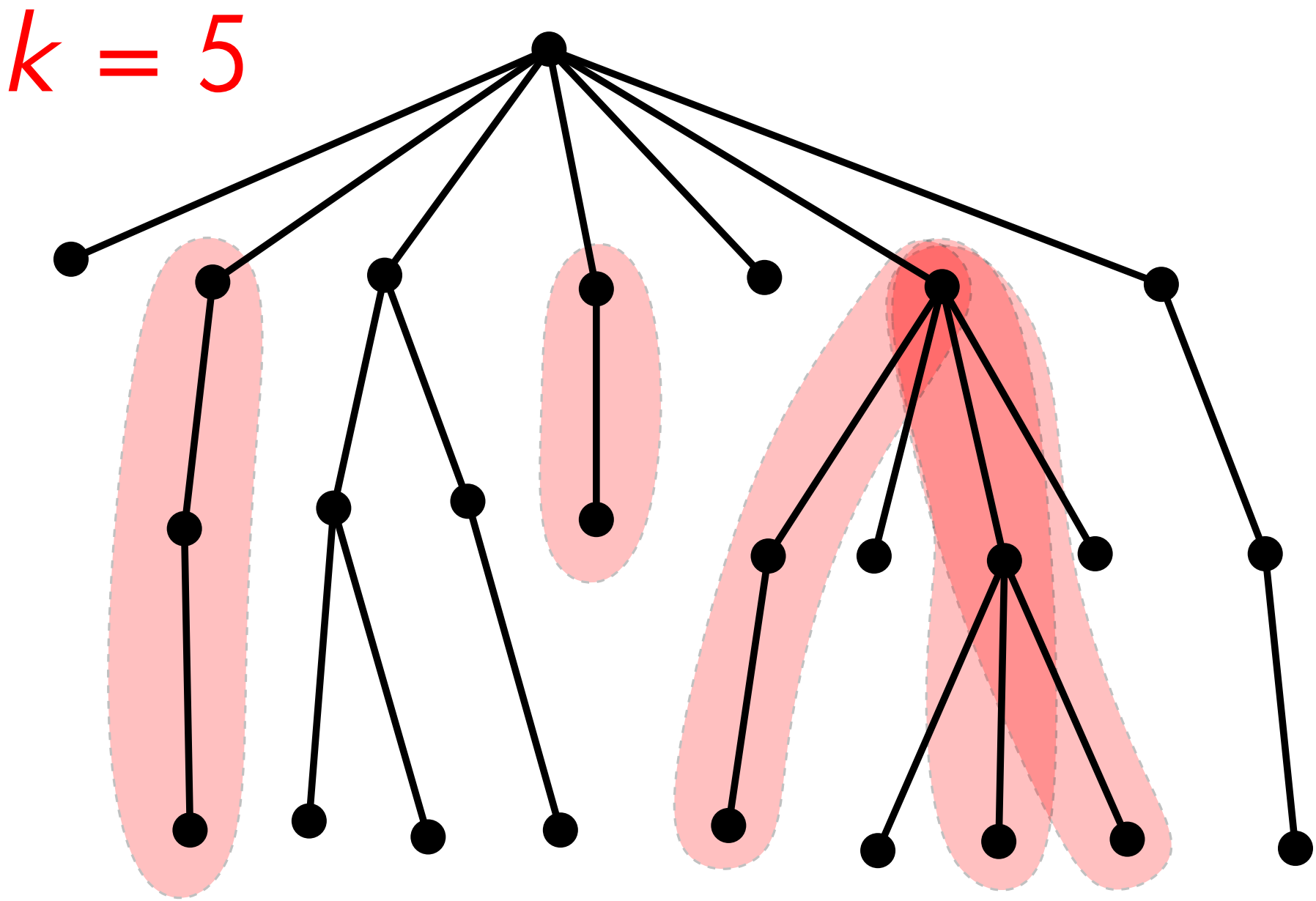


Query. Hey, membranes with label *h*, do you send out at least *k* copies of *a* at time *t*?

The queries can be answered by an **NP** oracle



The queries can be answered by an **NP** oracle



Main result

Theorem. P systems without send-in (and without "strong" nonelementary division) do $\mathbf{P}^{\mathbf{NP}}$ in polynomial time instead of **PSPACE**

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$$\left[\left[\right]^{+}_{h_1} \cdots \left[\right]^{+}_{h_m} \left[\right]^{-}_{h_{m+1}} \cdots \left[\right]^{-}_{h_n} \right]^{\alpha}_{h}$$

$$\downarrow$$

$$\left[\left[\right]^{\delta}_{h_1} \cdots \left[\right]^{\delta}_{h_m} \right]^{\beta}_{h} \left[\left[\right]^{\epsilon}_{h_{m+1}} \cdots \left[\right]^{\epsilon}_{h_n} \right]^{\gamma}_{h}$$

Other results

Only one between dissolution and “weak” nonelementary division is actually needed

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$$[a]_h^{\alpha} \rightarrow [b]_h^{\beta}\ [c]_h^{\gamma}$$

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$$[a]_h^{\alpha} \to [b]_h^{\beta}\ [c]_h^{\gamma}$$

Theorem. Without send-in, strong and weak nonelementary division, and dissolution you "just" do $\mathbf{P}_{\|}^{\mathbf{NP}}$ aka $\mathbf{P}^{\mathbf{NP}[\log n]}$ in polynomial time

¡Thanks for your attention!
¡Gracias por su atención!