

Protein inspired knot theory

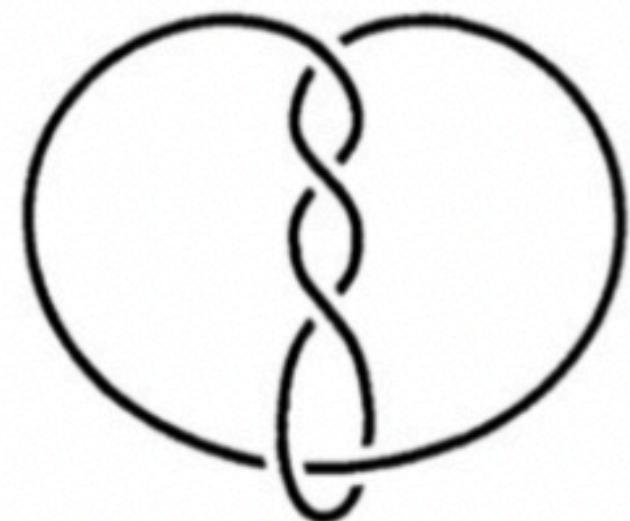
Can proteins help us to derive interesting knot projections?

Knots are like a necklace, without ends.

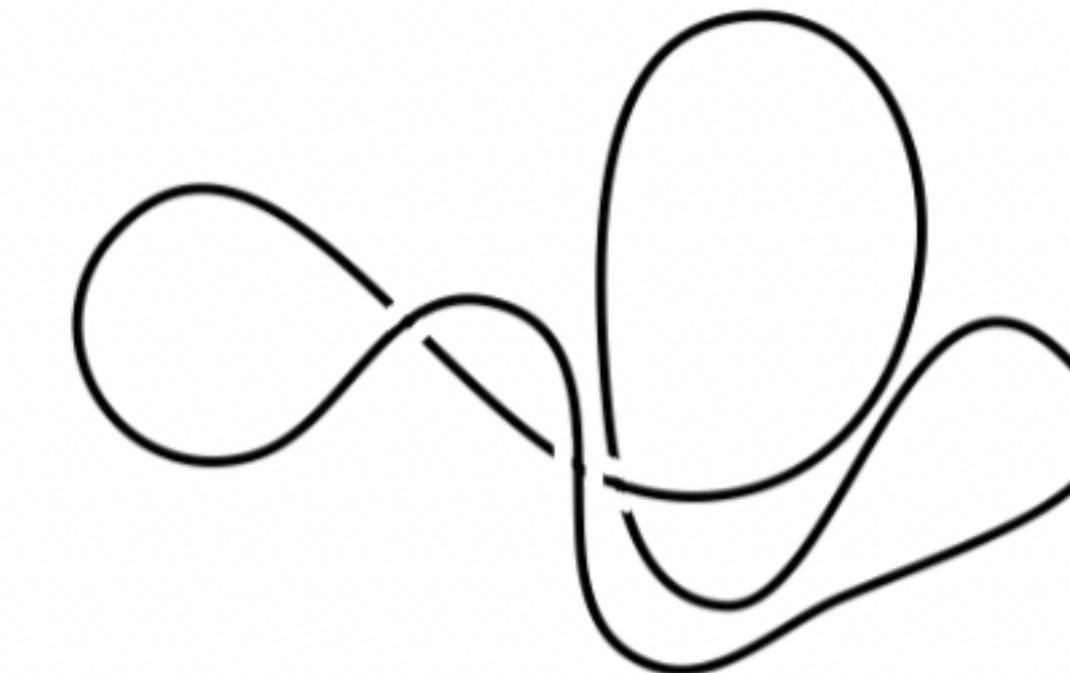
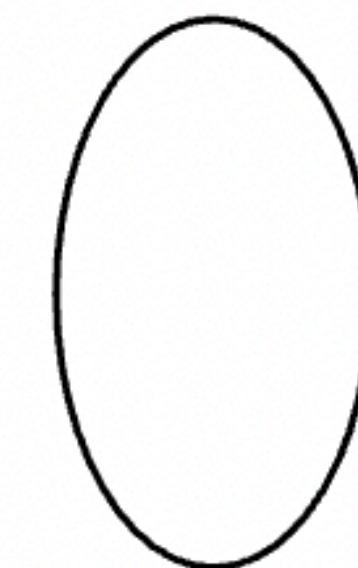
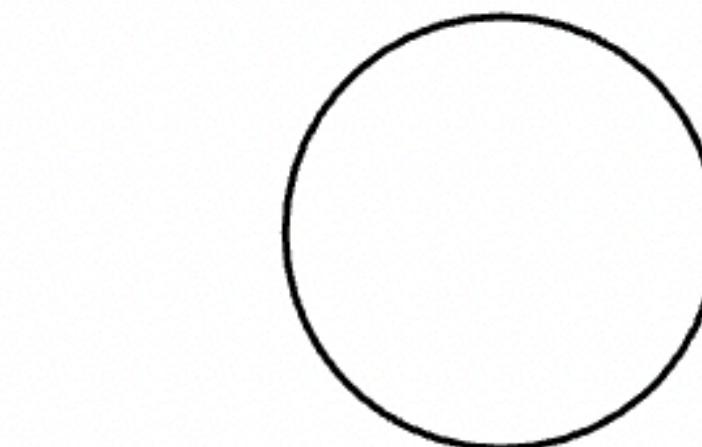
A knot is a 3D object.

Knot diagrams show "shadows" of the knot, with information on over/under crossings.

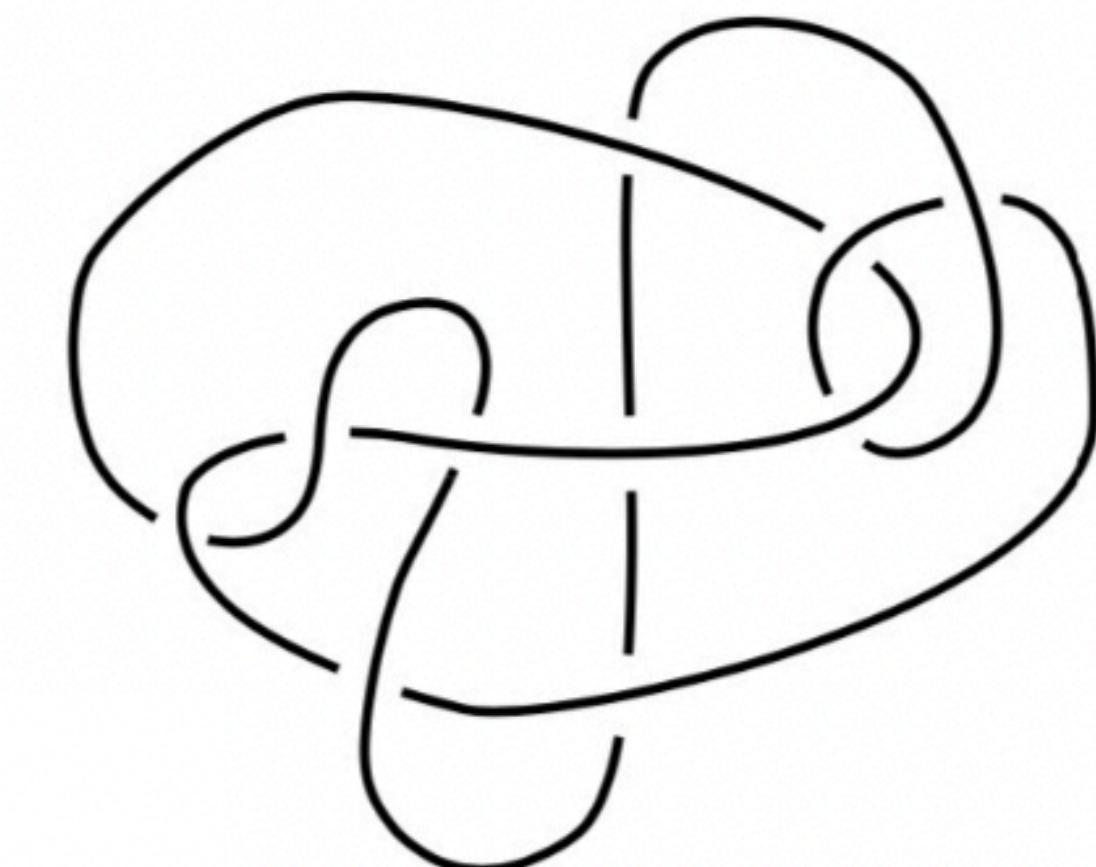
knotted



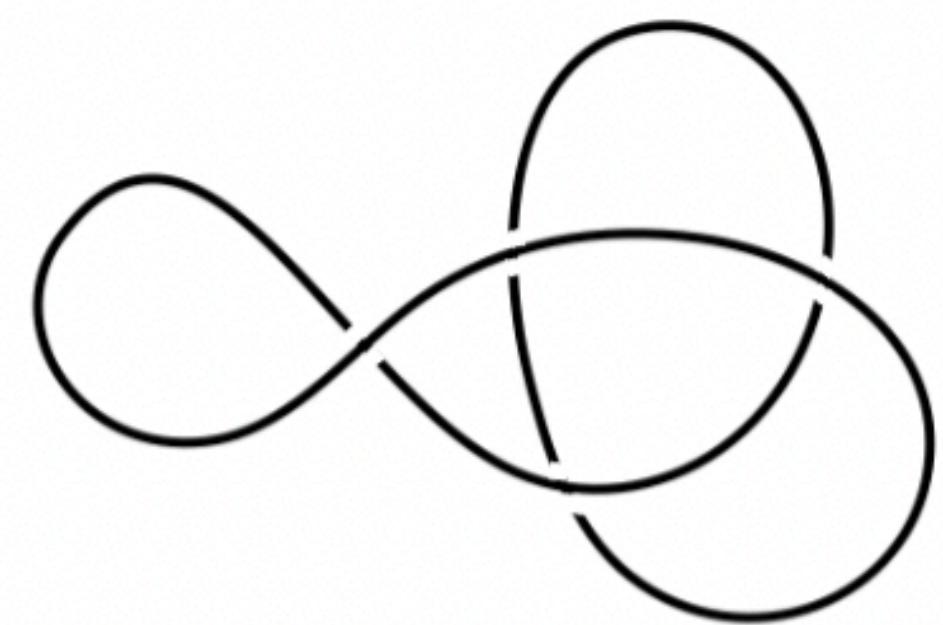
unknotted



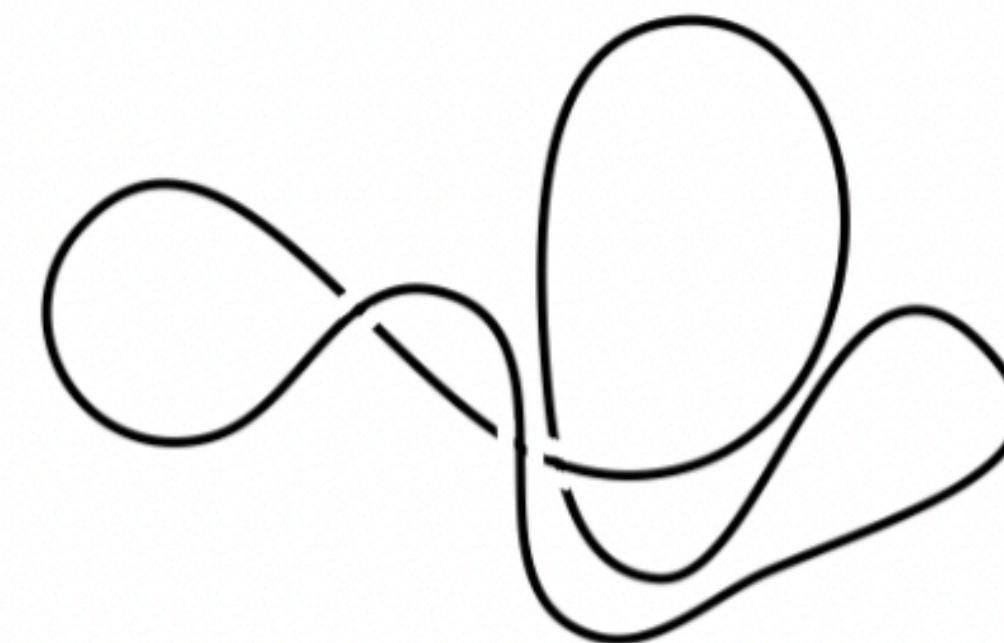
Knotted??



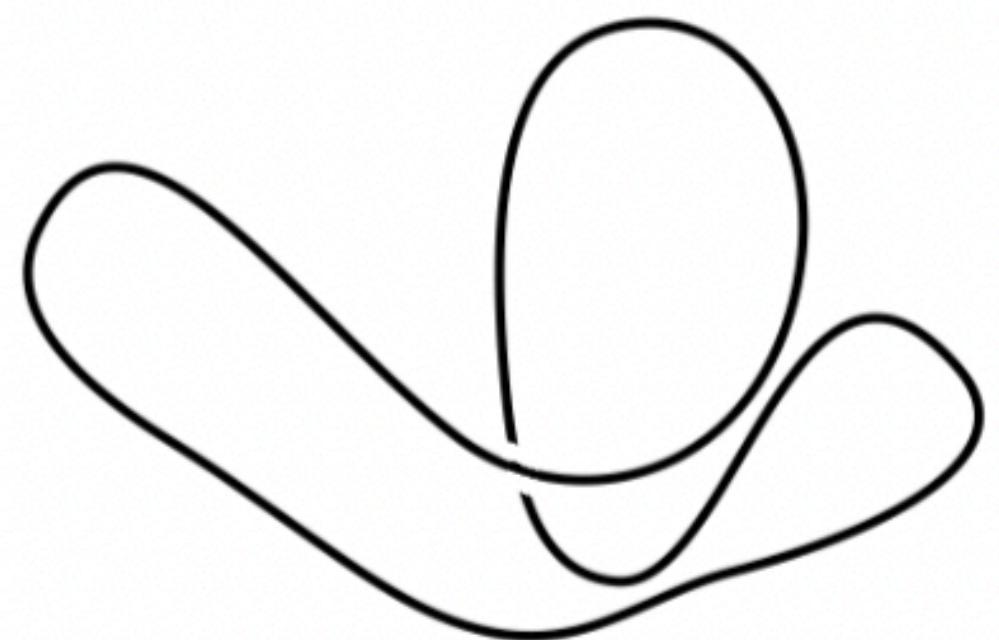
This figure is unknotted, as we can see by performing knot moves



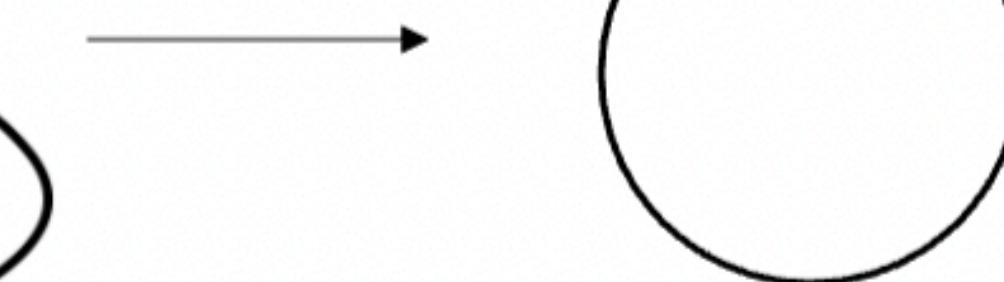
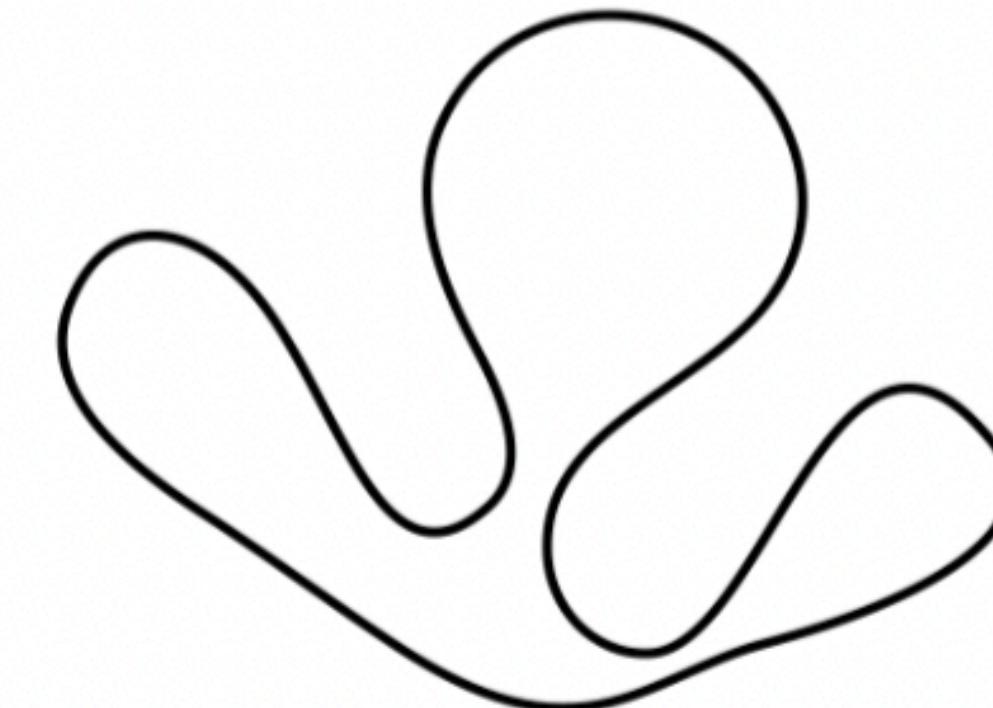
slide
→



unpoke
→

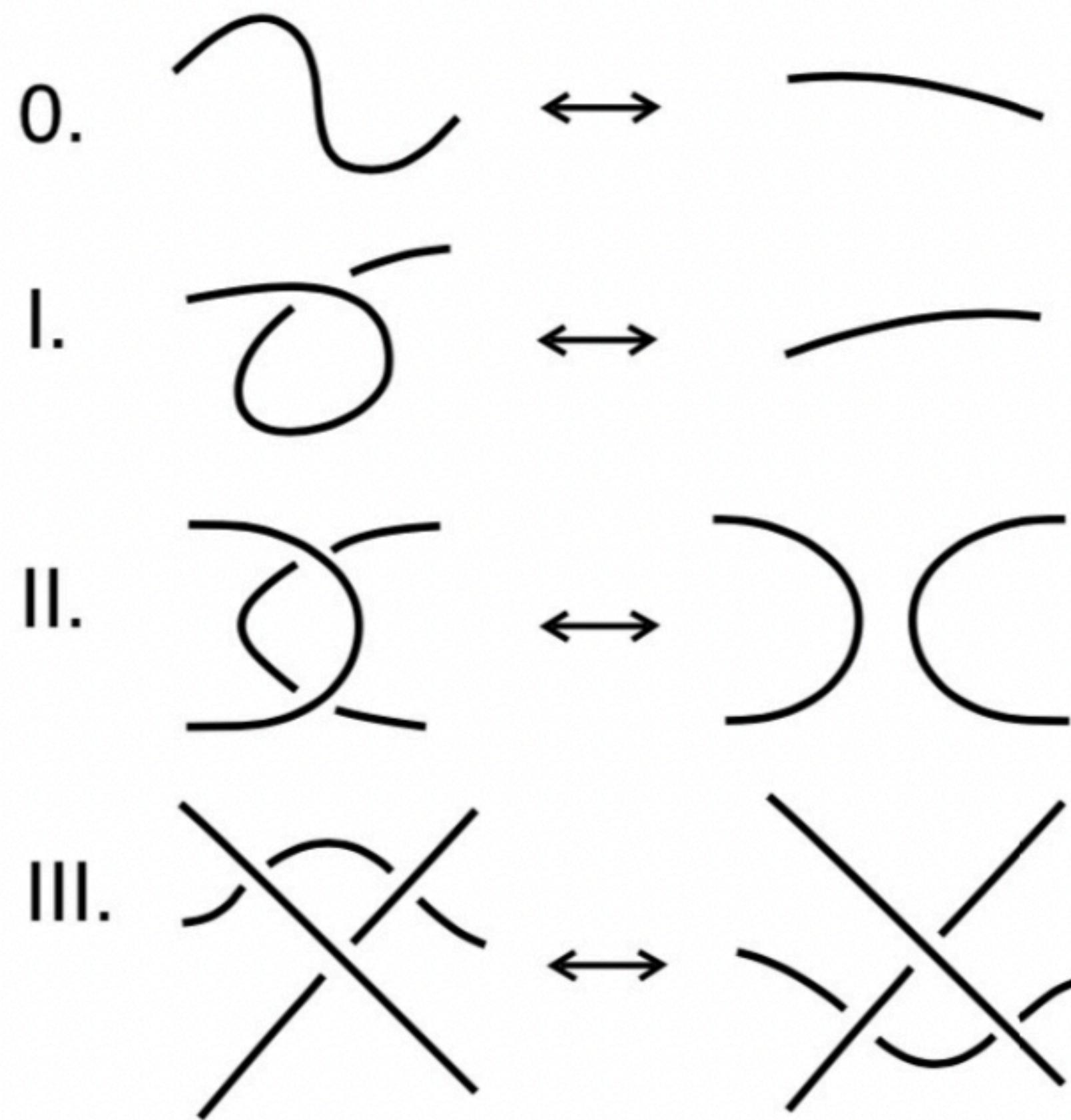


untwist
→



Reidemeister moves

Preserve knot type

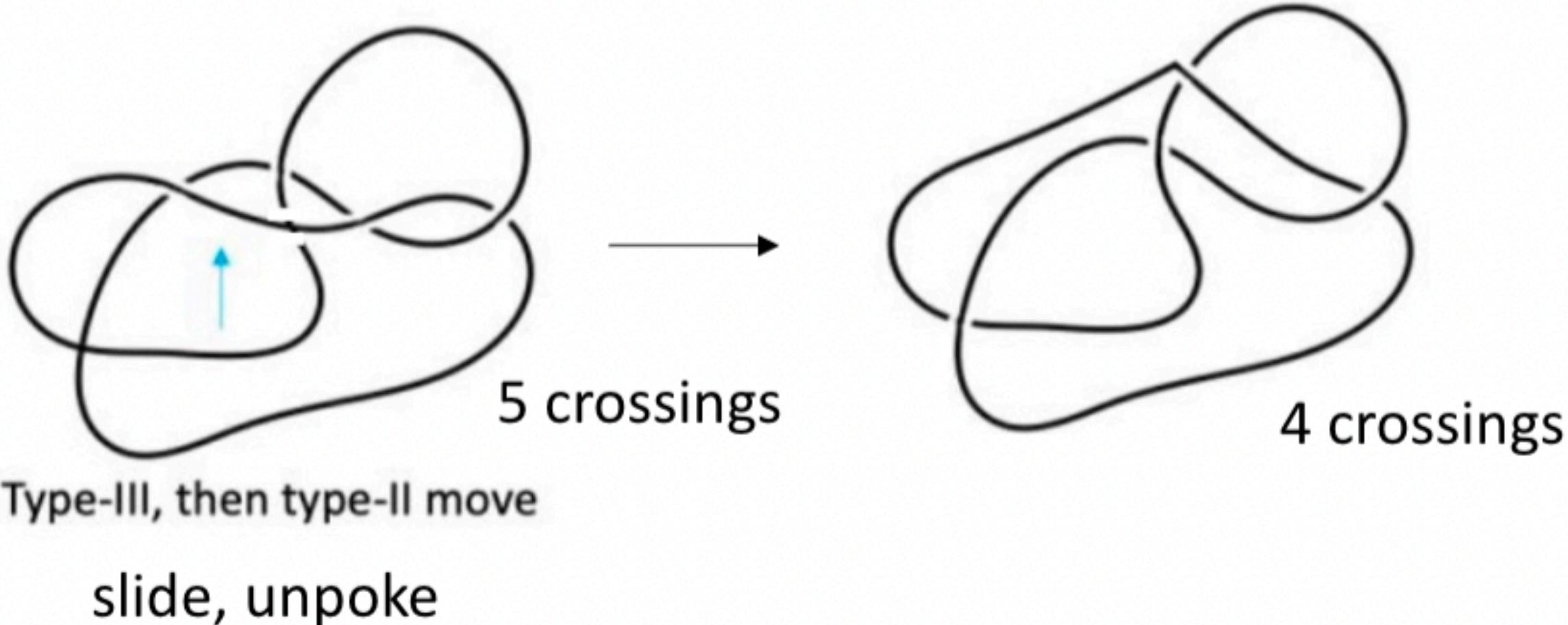
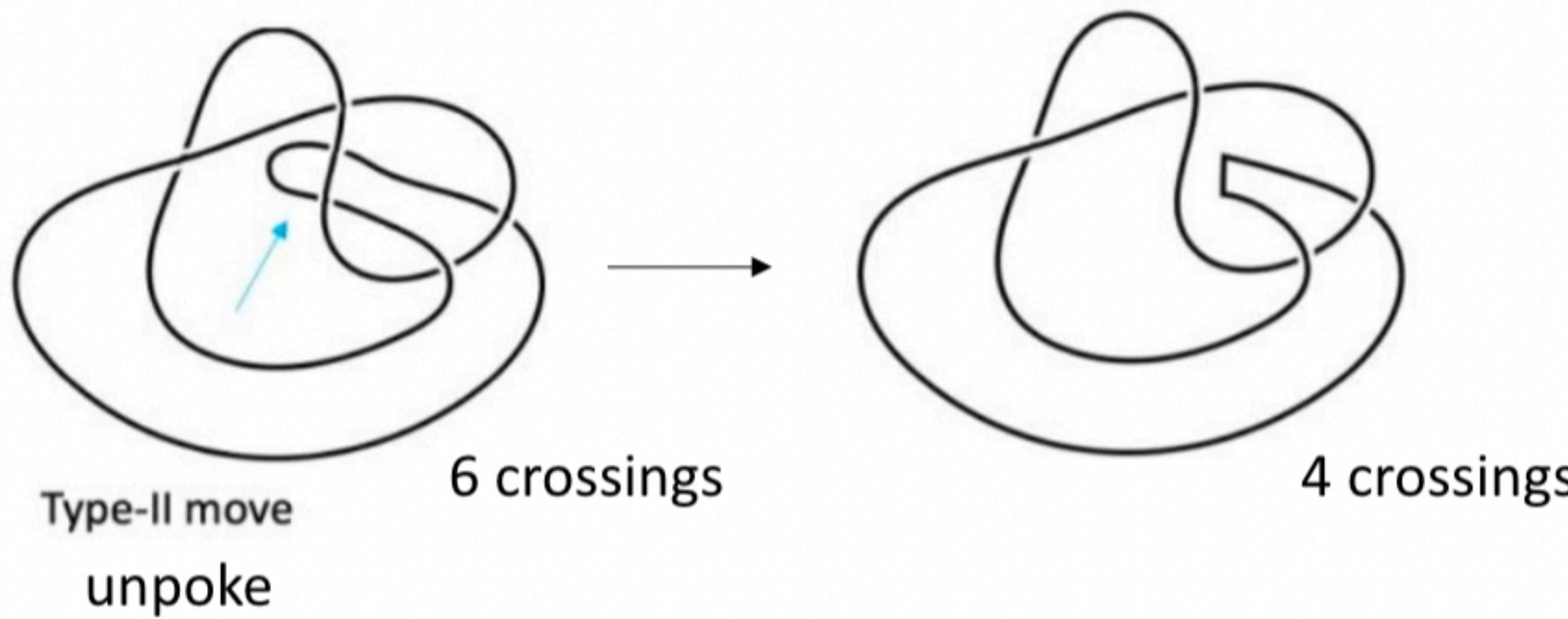


twist

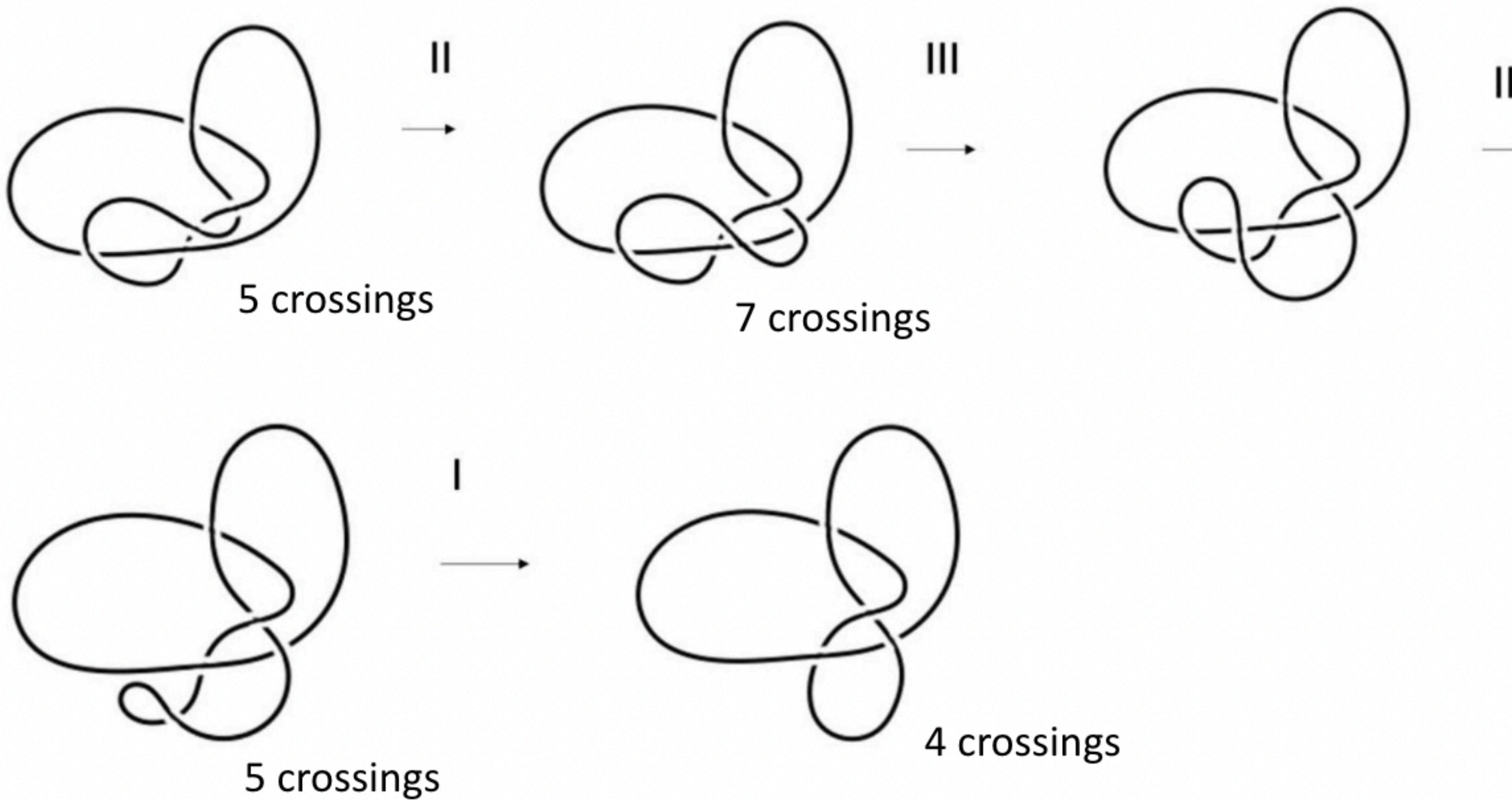
poke

slide

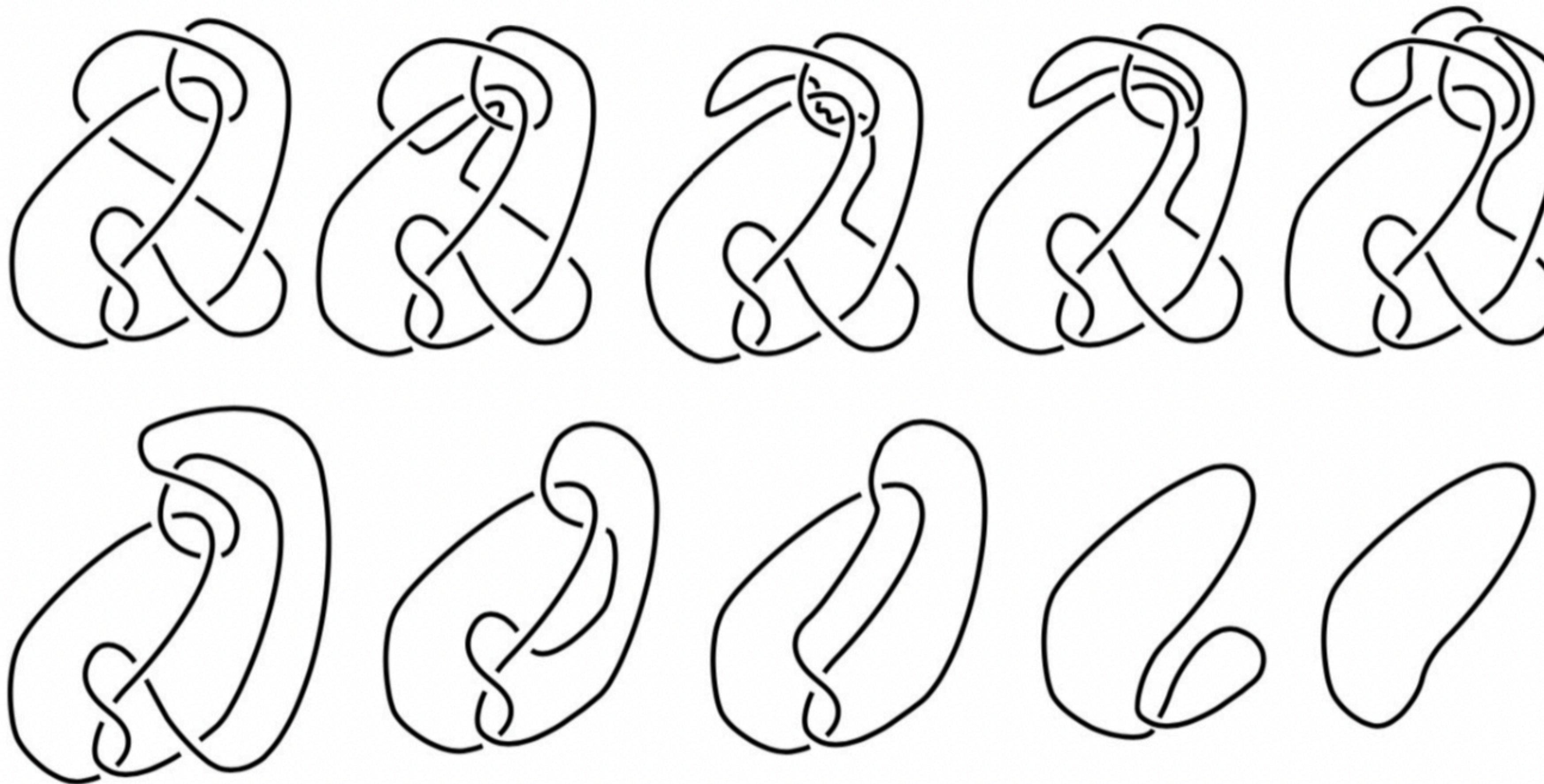
We simplify a knot by reducing the number of crossings to the minimal number



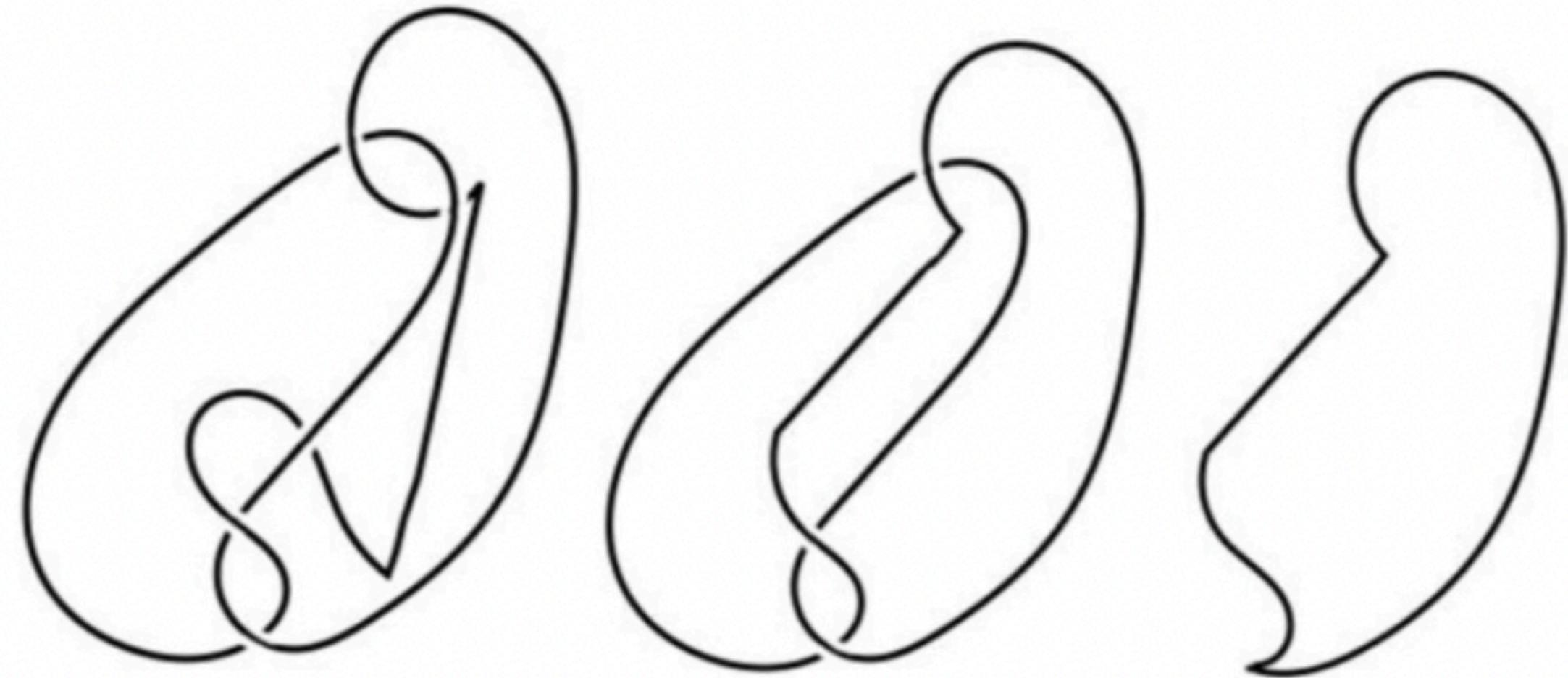
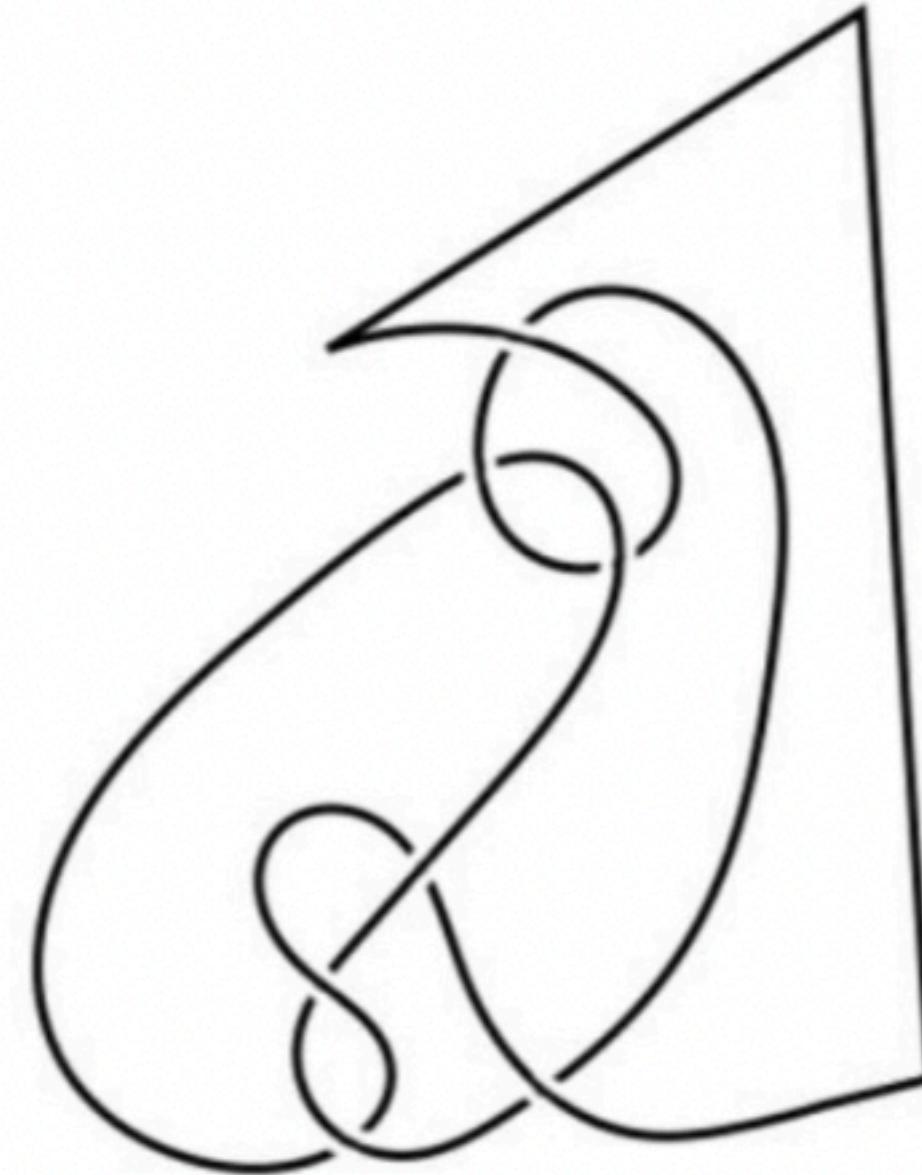
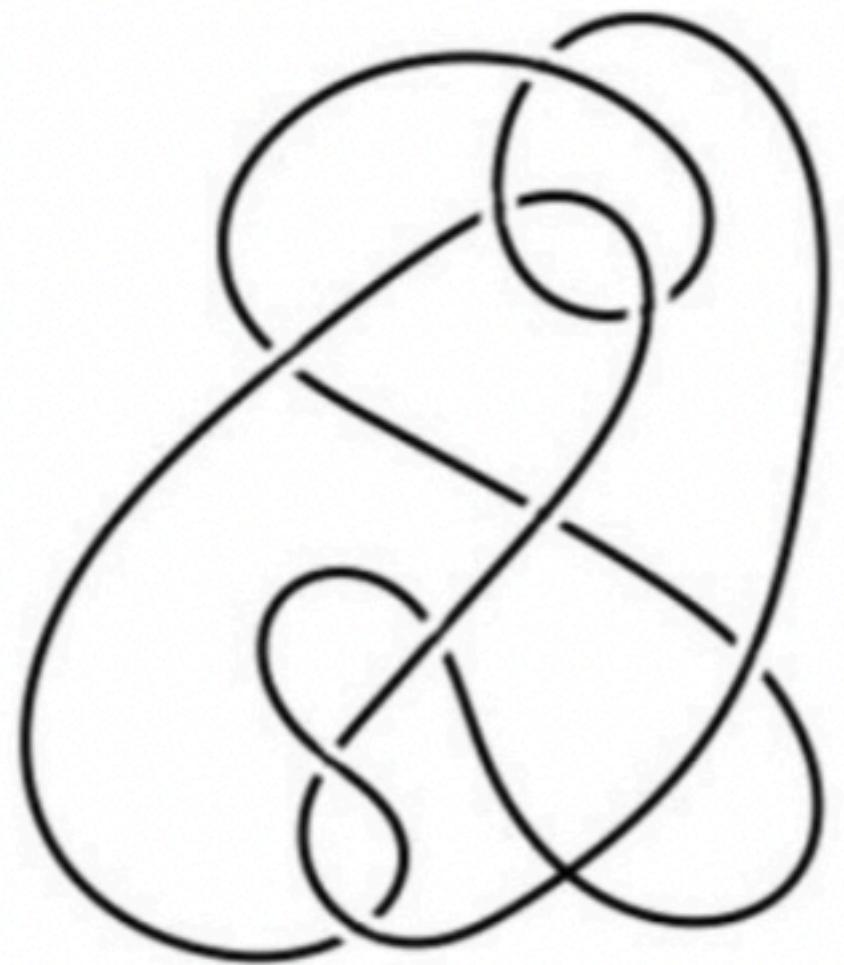
This knot requires increasing the number of crossings before it can decrease



The knot from the first page is unknotted. Reidemeister moves approach:



Another approach (multiple moves per step, but easy to understand visually)

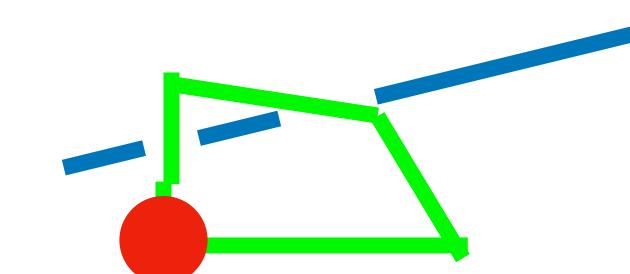


Kauffman-Lambropoulou definition of a **hard unknot**

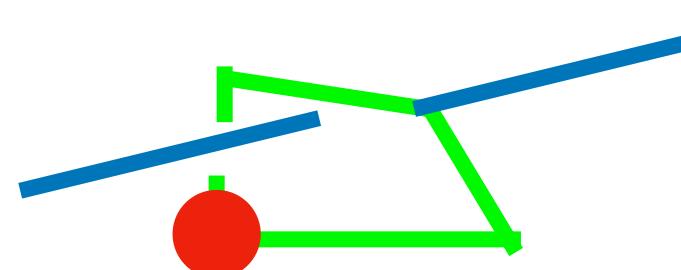
We shall call a diagram of the unknot *hard* if it has the following three properties:

1. There are no simplifying Type I moves on the diagram.
2. There are no simplifying Type II moves on the diagram.
3. There are no Type III moves on the diagram.

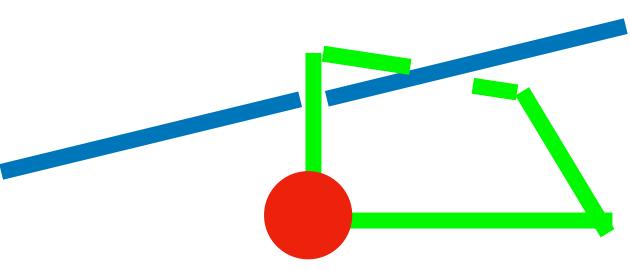
Foreground loop deletion represents an isomorphism of the knot



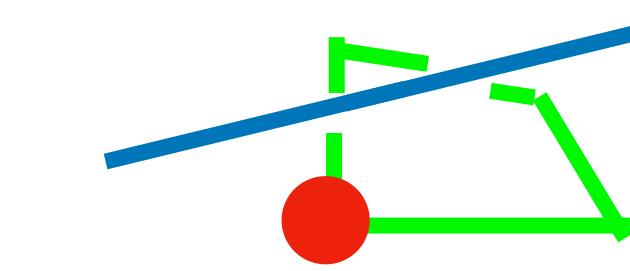
Foreground loop



Not a Foreground loop



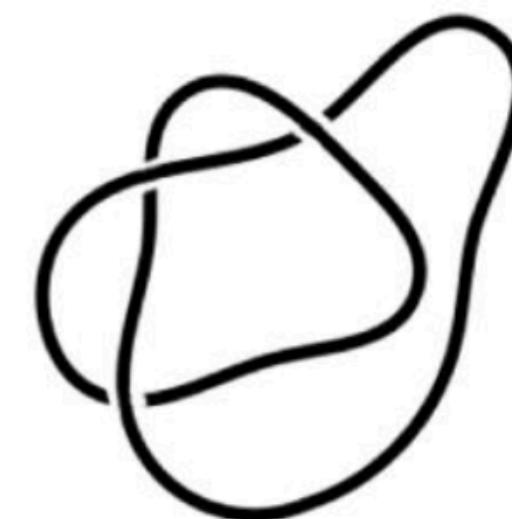
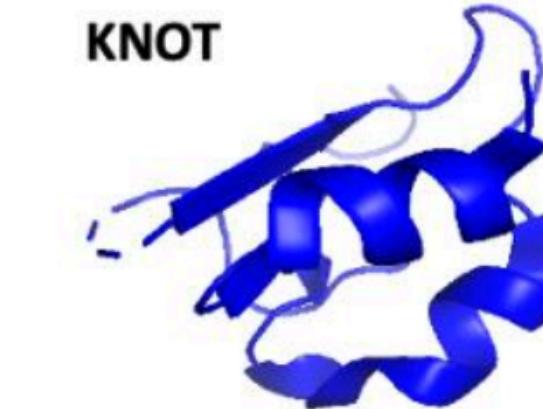
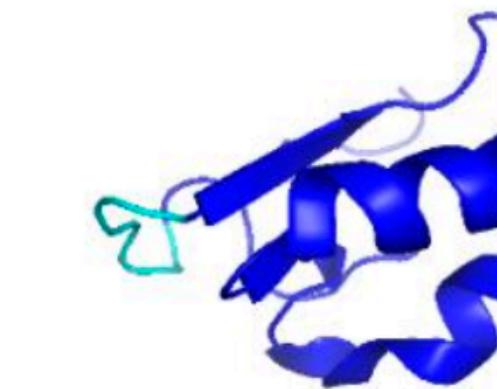
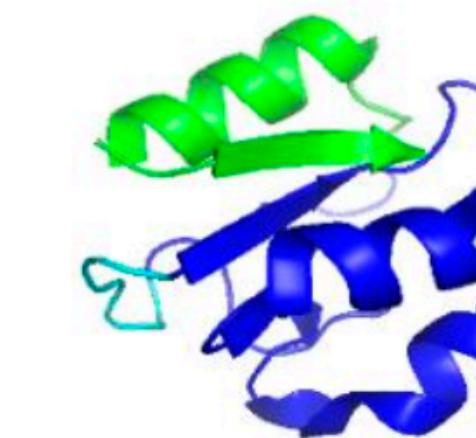
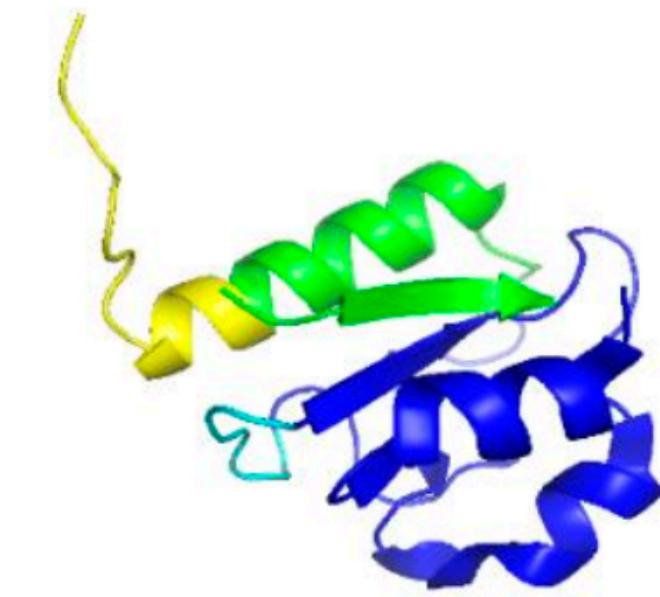
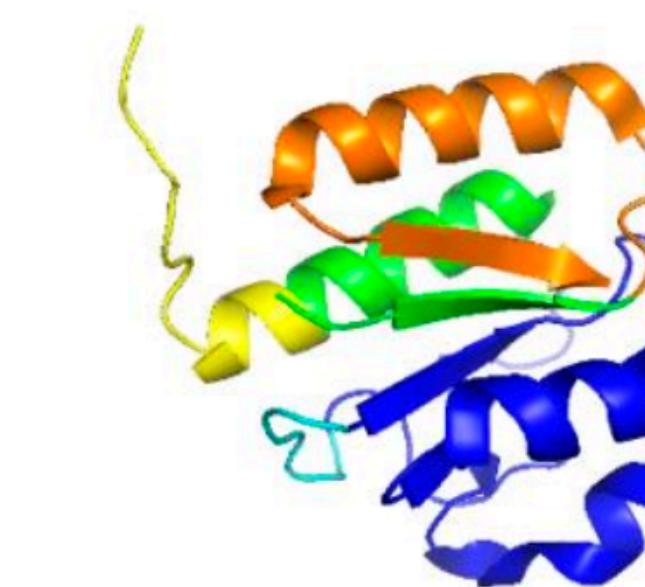
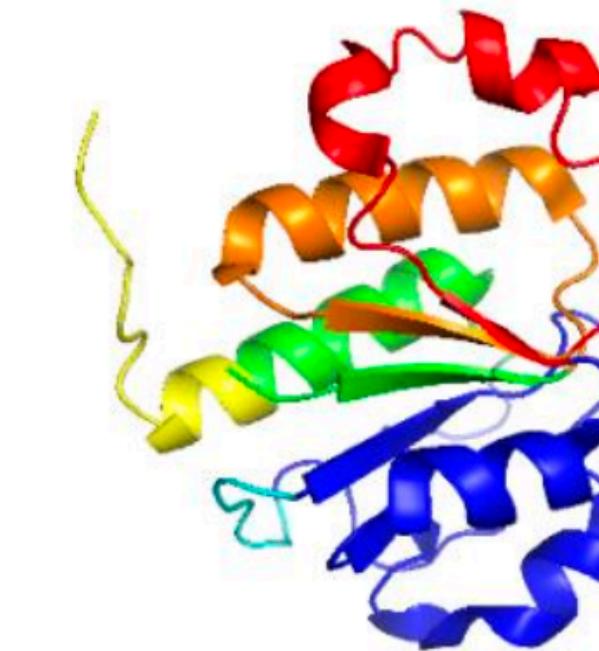
Not a Foreground loop



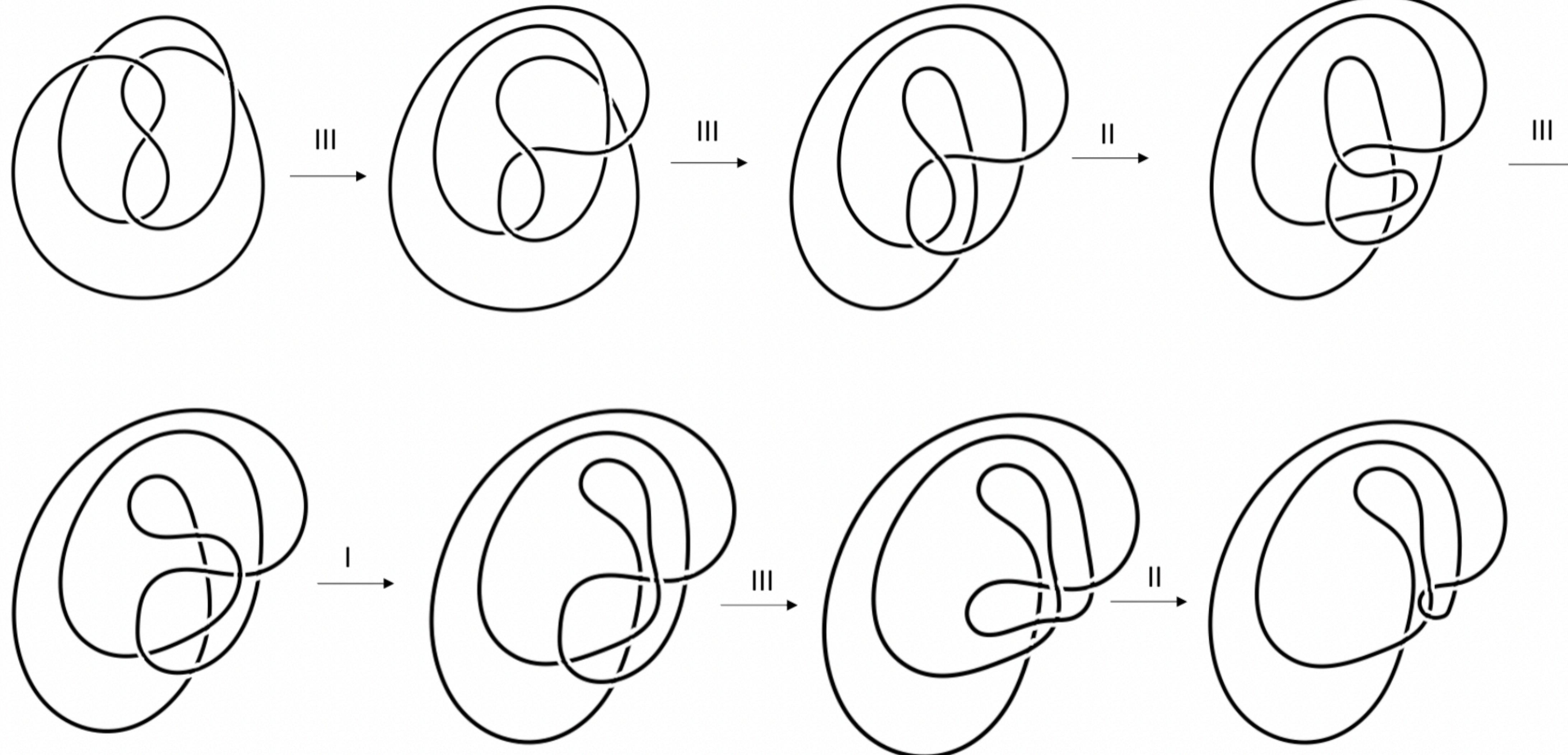
Don't count as a
Foreground loop
But when rotated 180
degrees, would be a
Foreground loop

YibK example

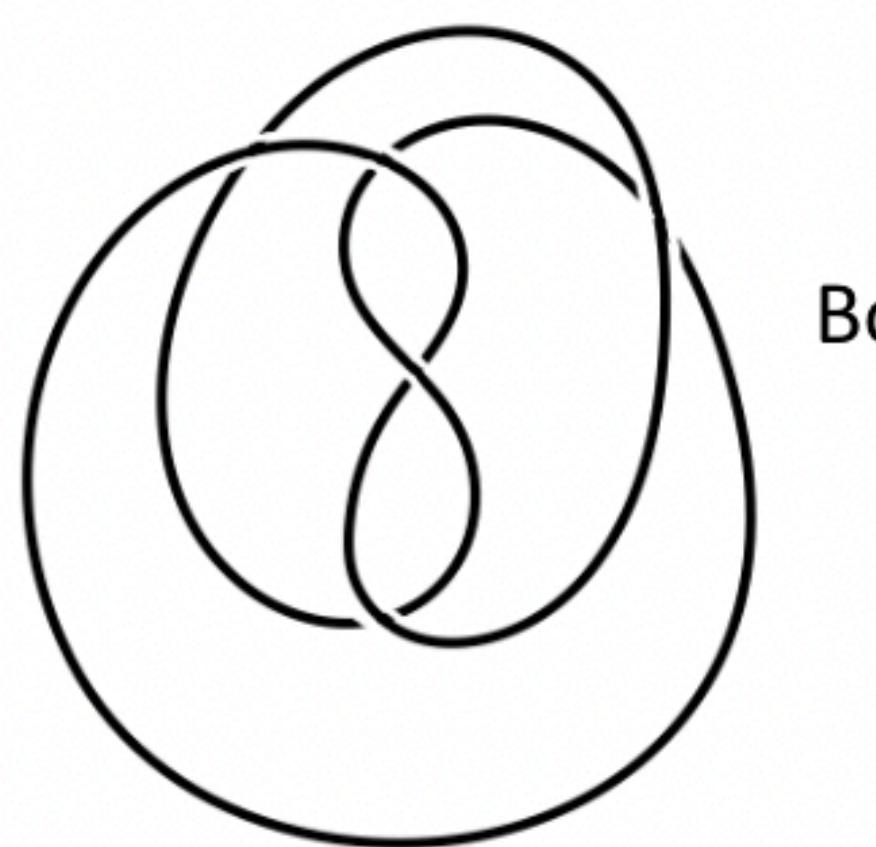
Full protein



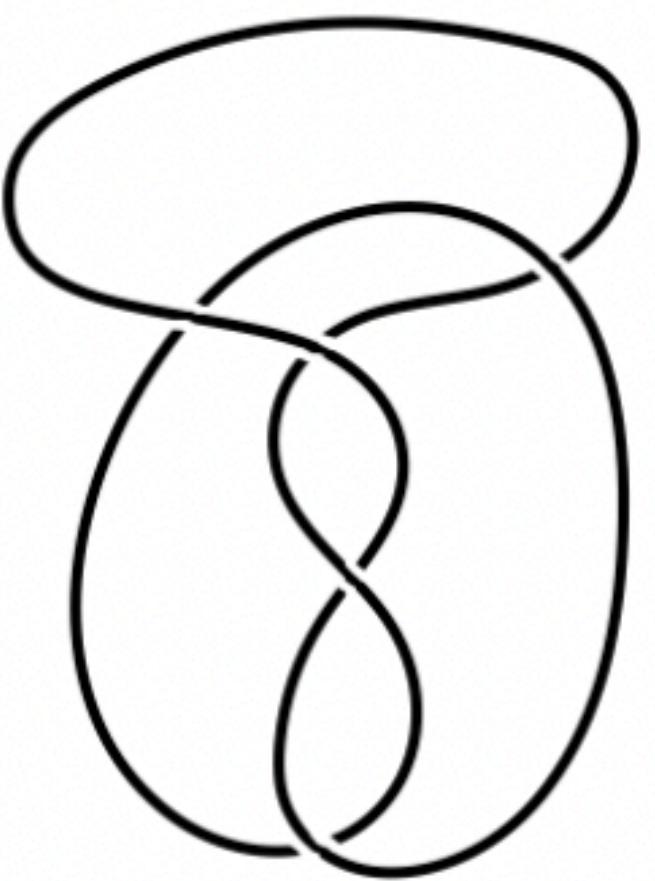
This knot projection was derived from foreground loop deletions + rotations of a protein knot (first connecting every fourth alpha carbon)
This knot is not Kauffman-Lambropoulou hard because it first requires a type-III move.
However, increase in complexity is still required before complexity can be decreased.
We suggest extending the definition of a hard (un)knot.



3D approach



Bottom to top
→



untwist
→

