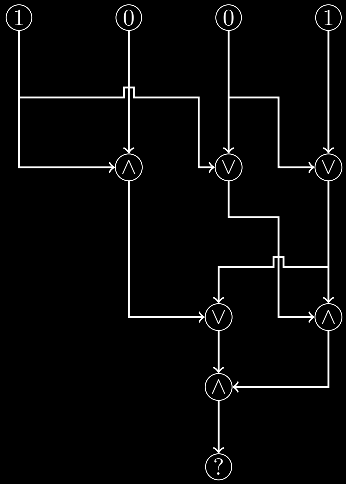
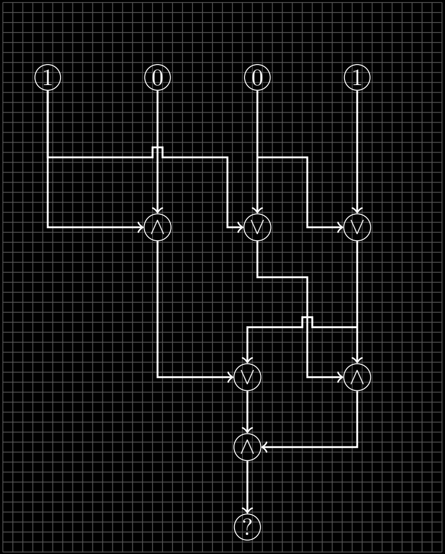
Complexity of prediction: proving P-completeness

Monotone Circuit Value Problem $\leq_{\text{logspace}}$ **Fuze circuits**



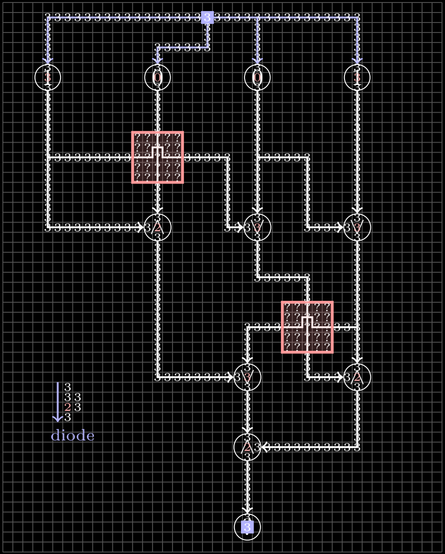
Complexity of prediction: proving P-completeness

Monotone Circuit Value Problem $\leq_{\text{logspace}}$ **Fuze circuits**



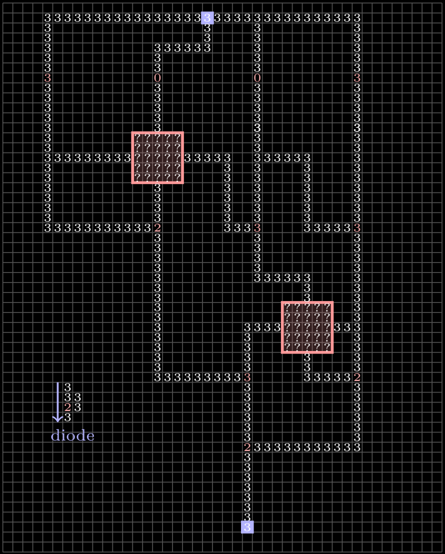
Complexity of prediction: proving P-completeness

Monotone Circuit Value Problem $\leq_{\text{logspace}}$ **Fuze circuits**



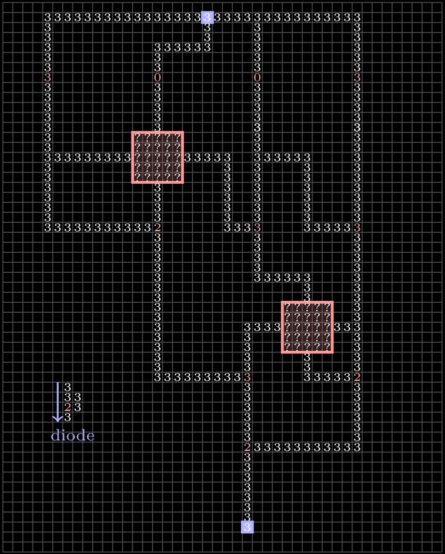
Complexity of prediction: proving P-completeness

Monotone Circuit Value Problem $\leq_{\text{logspace}}$ **Fuze circuits**



Complexity of prediction: proving P-completeness

Monotone Circuit Value Problem $\leq_{\text{logspace}}$ **Fuze circuits**



But **Planar Monotone CVP** is in NC [Yang, 1991].

Planar ⇝ Monotone

Crossover gate ?

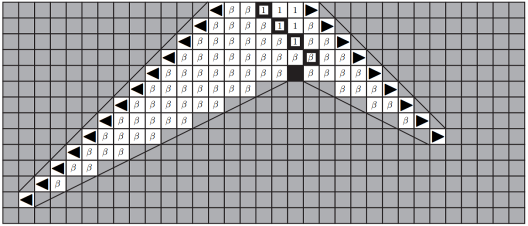
Computing with sand

Theorem. Chip Firing Games on arbitrary infinite graphs (of small degree) are Turing-complete (infinite configurations).

Theorem. Sandpiles on $\mathbb{Z}^d$ with dimension $d \geq 3$ are Turing-complete (infinite ultimately periodic configurations). Even on $\{1,2,3\} \times \mathbb{Z}^2$.

Corollary. Undecidable problems on ultimately periodic configurations.

Sandpile Halting Problem: fuze circuits simulating a lazy CA



Goles, Margenstern: “Universality of the chip-firing game”, 1995.

Cairns: “Some halting problems for abelian sandpiles are undecidable in dimension three”, 2018.