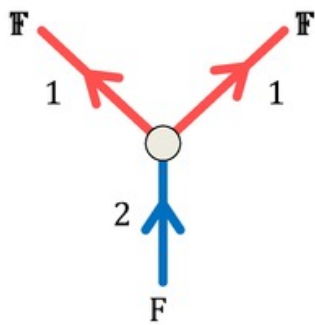


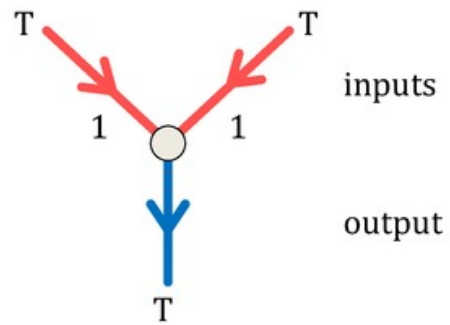
# Gadget Framework

Hypersurreal • 9 Dec 2023

## AND vertex

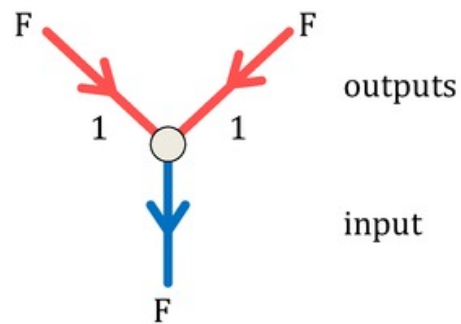
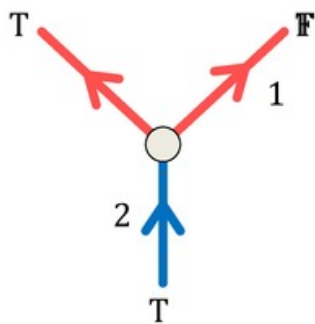


not your usual  
AND gate!



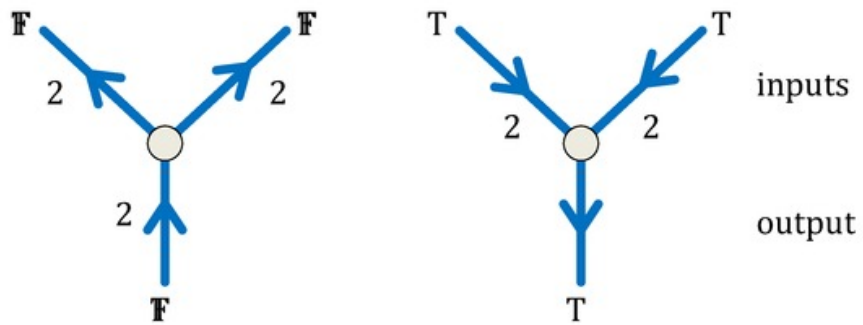
**Rule:** at least 2 units  
incoming at a vertex

## SPLIT vertex



**Rule:** at least 2 units  
incoming at a vertex

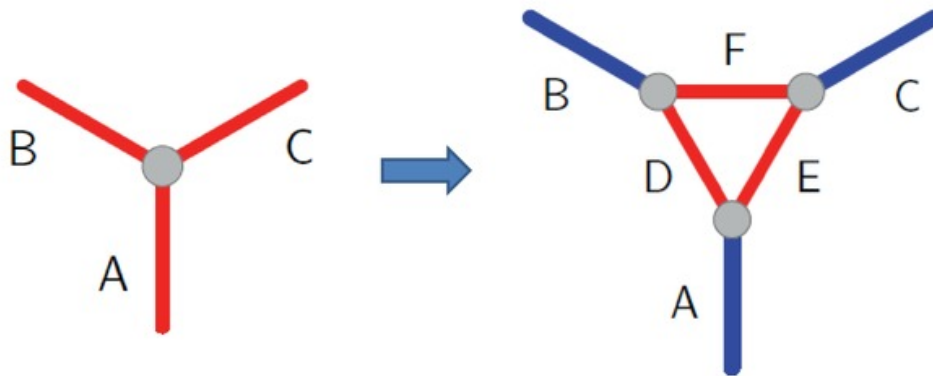
## OR vertex



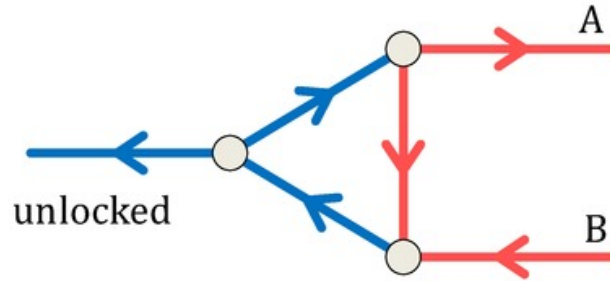
not your usual  
OR gate!

**Rule:** at least 2 units  
incoming at a vertex

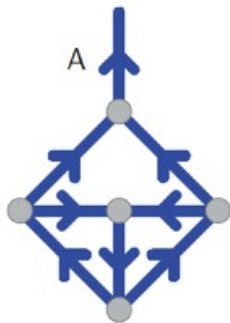
## CHOICE vertex



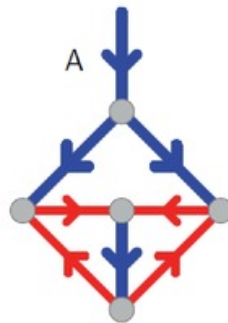
# Latch



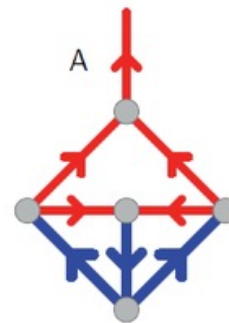
# Wire Terminators



unconstrained blue terminator

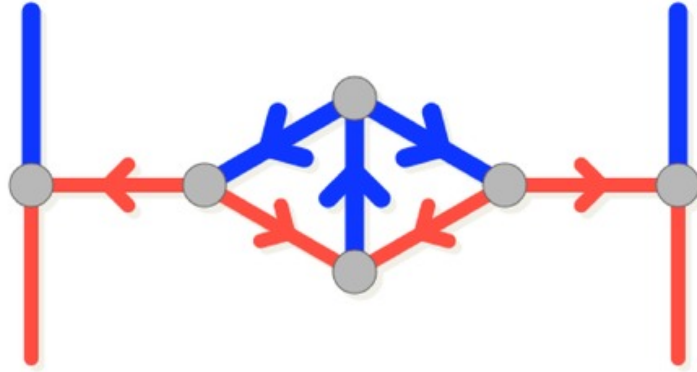


forced-inward blue terminator



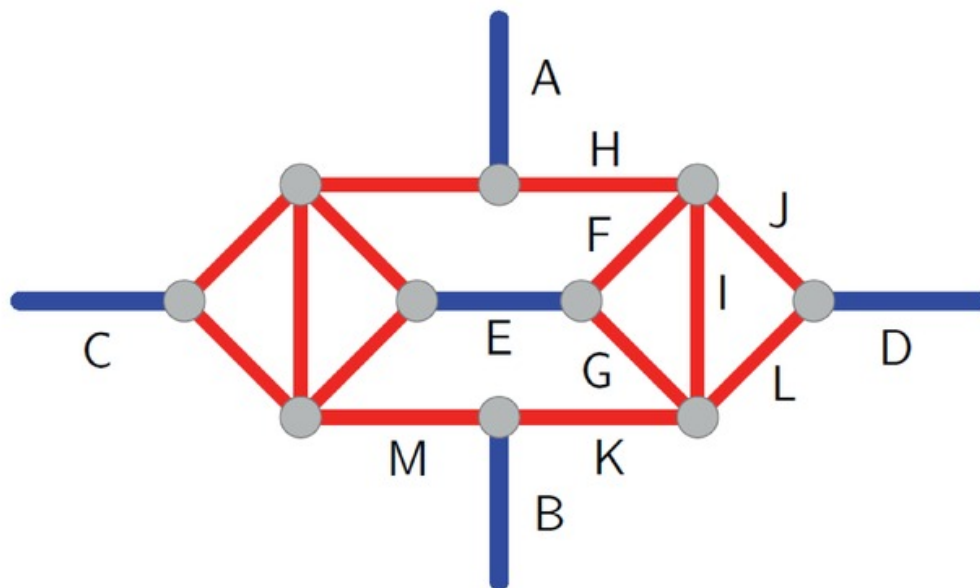
unconstrained red terminator

## Red-Blue Conversion

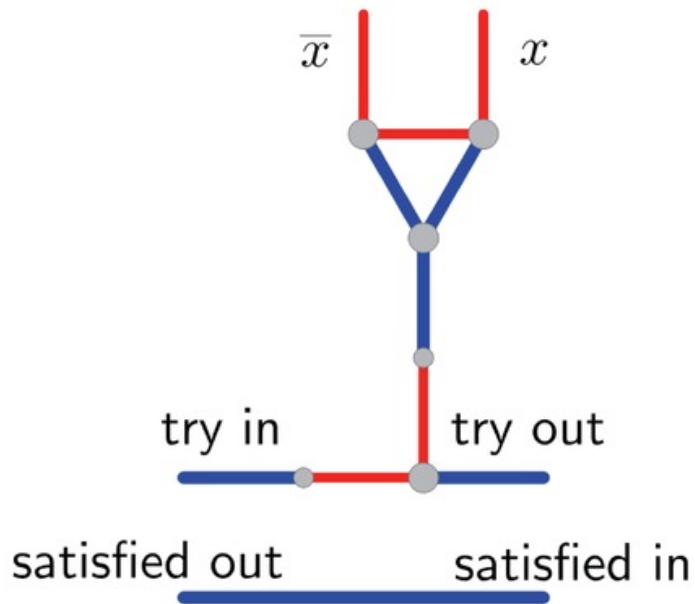


assume an even number of conversions

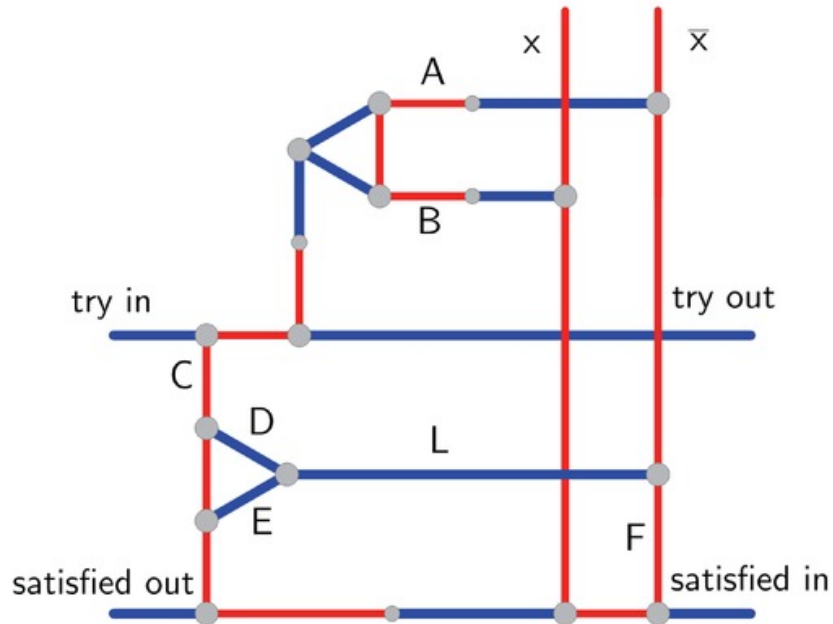
## Crossover Gadget



## Existential Quantifier

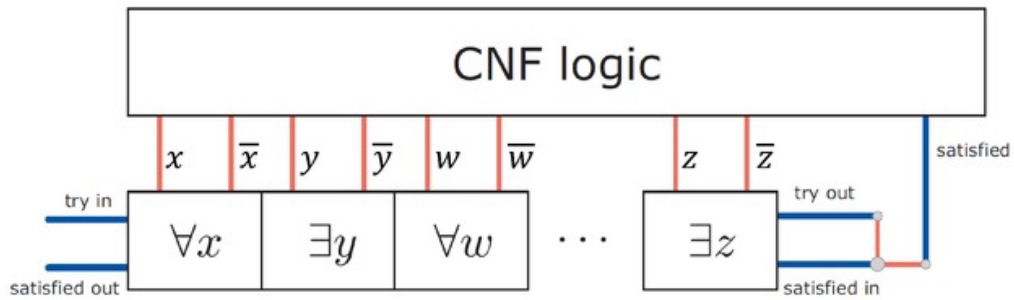


## Universal Quantifier



# Quantified Boolean Formulas (QBF/QSAT)

$$\forall x \exists y \forall w \dots \exists z [(x \vee y) \wedge \dots \wedge (\bar{z} \vee x \vee \bar{w})]$$



Source: [Visual Overview of Algorithmic Lower Bounds - Demaine](#)