A Comparison of Various Backward Analyzers for Parametrized Concurrent Systems

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Plan of the talk

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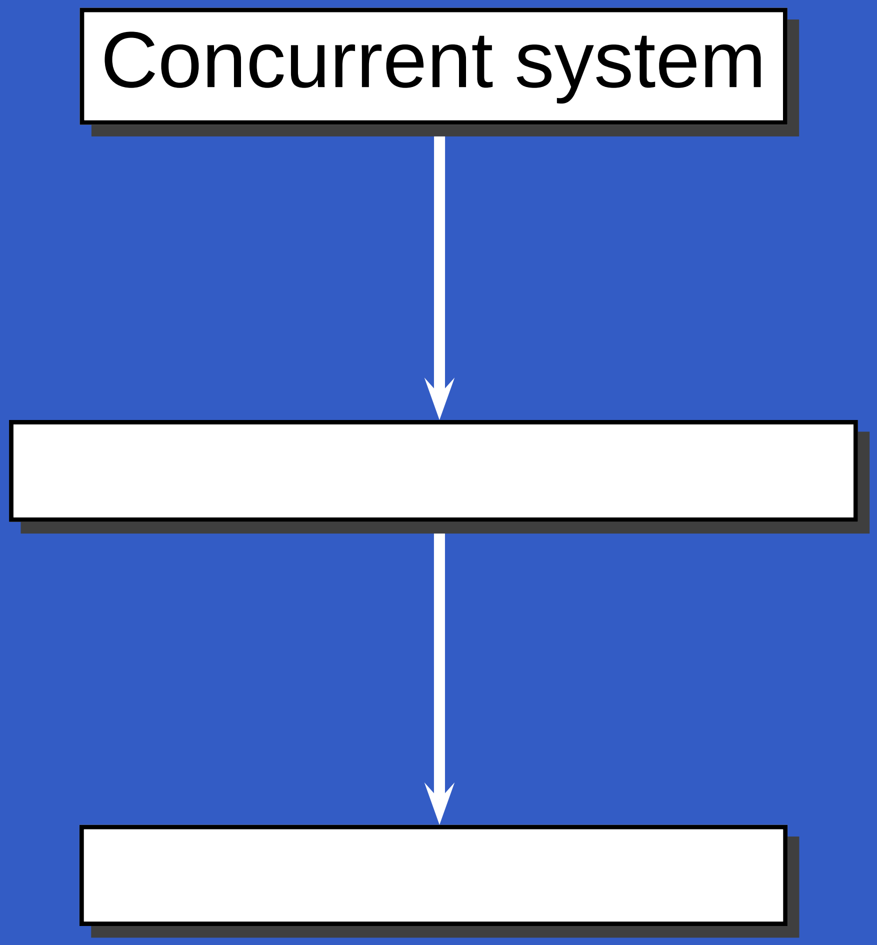
- Parametrized approach: Verify the property for any value of the parameter.

The verification process



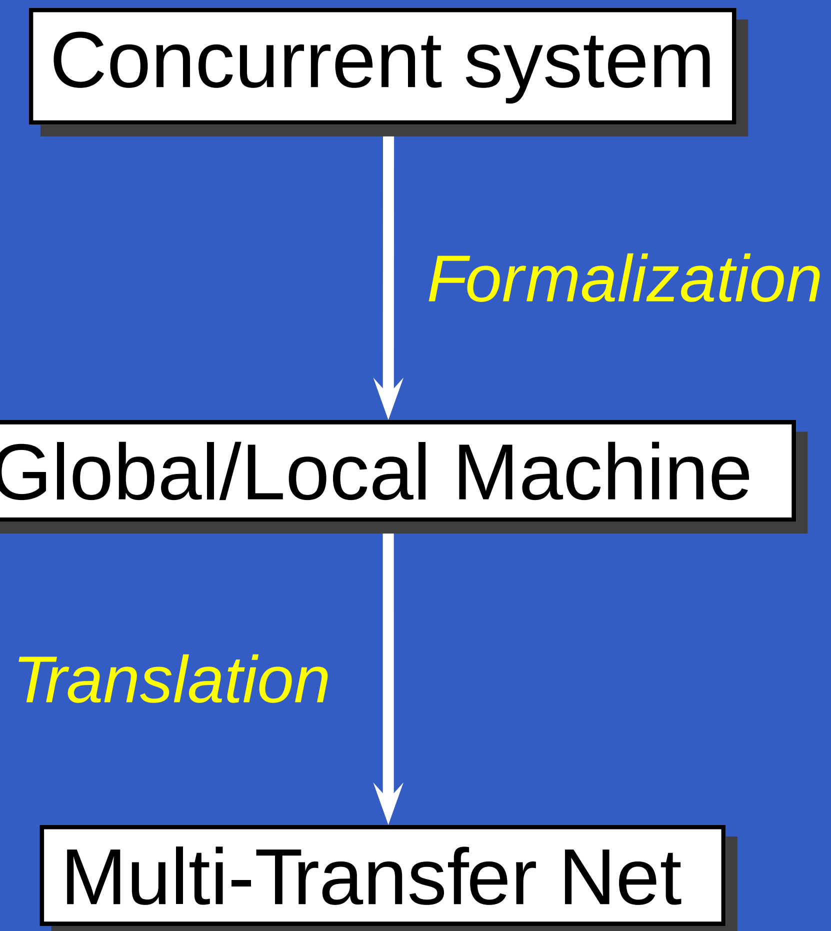
The verification process

Concurrent system

Formalization

Global/Local Machine

The verification process



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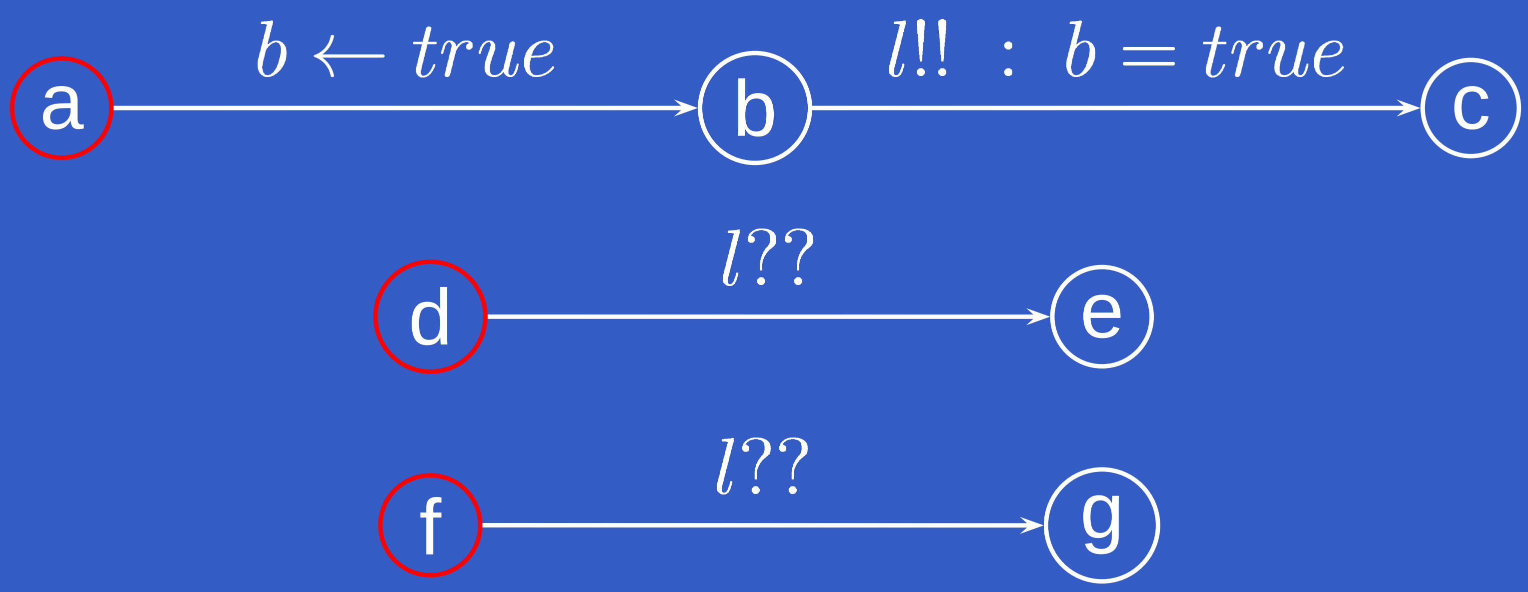

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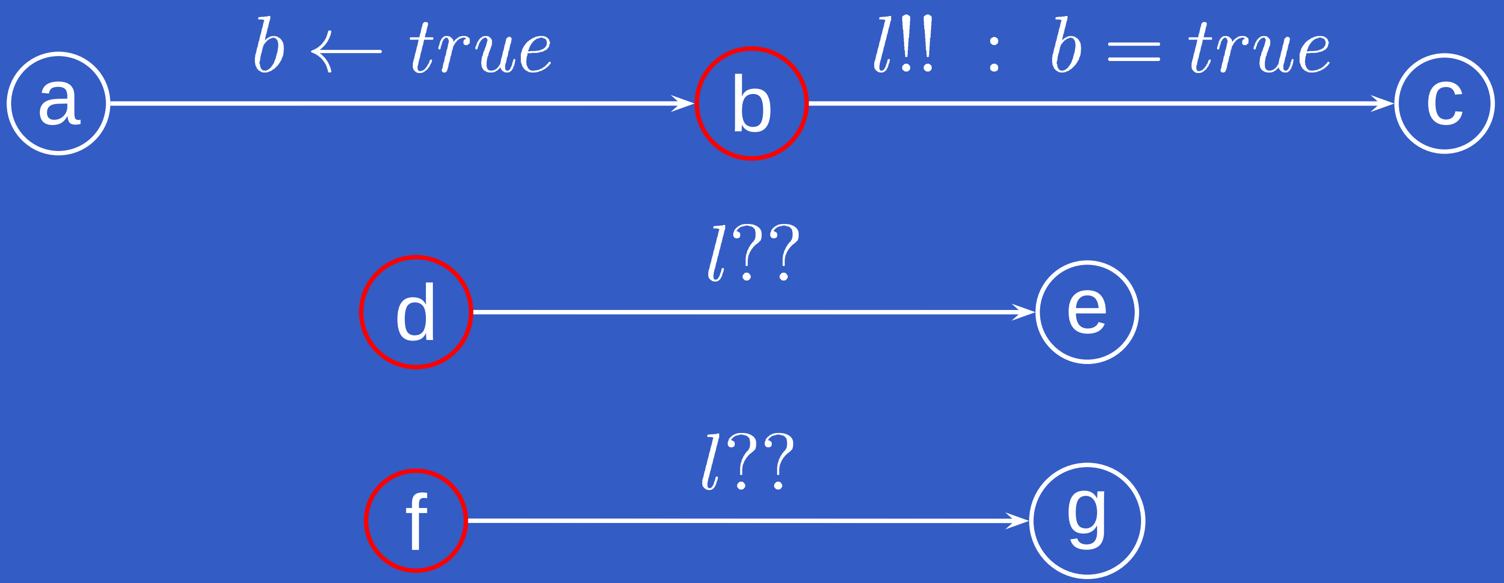

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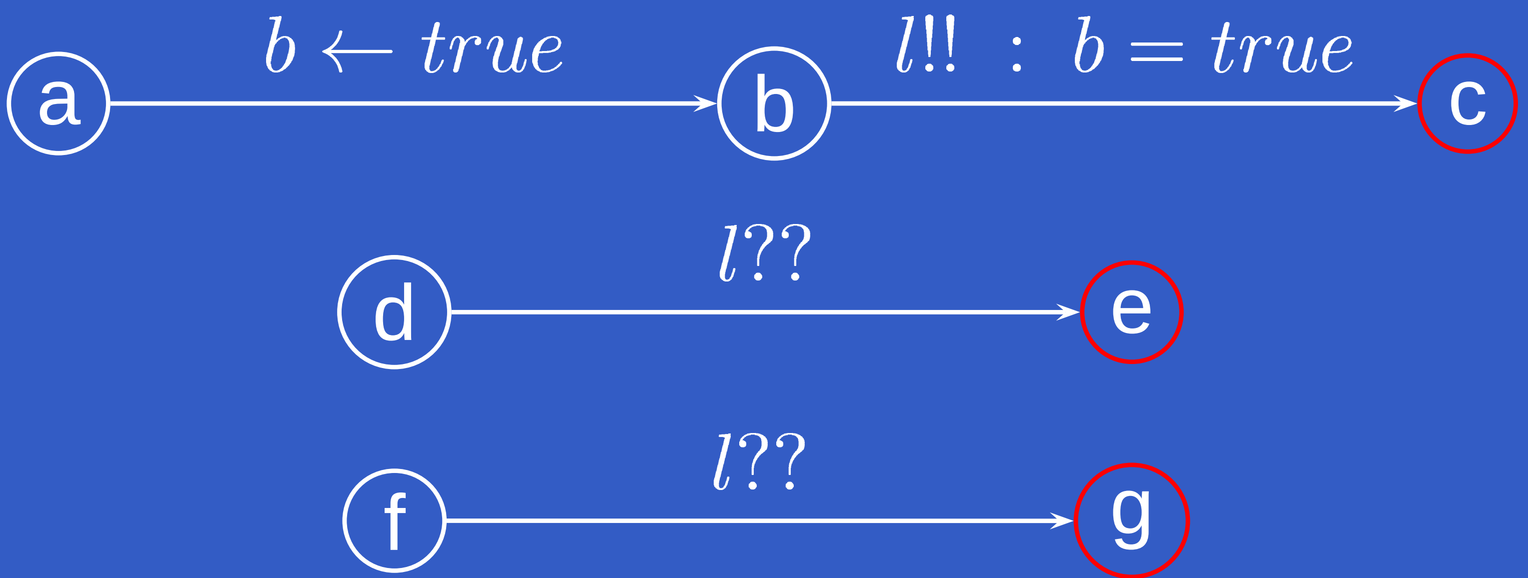
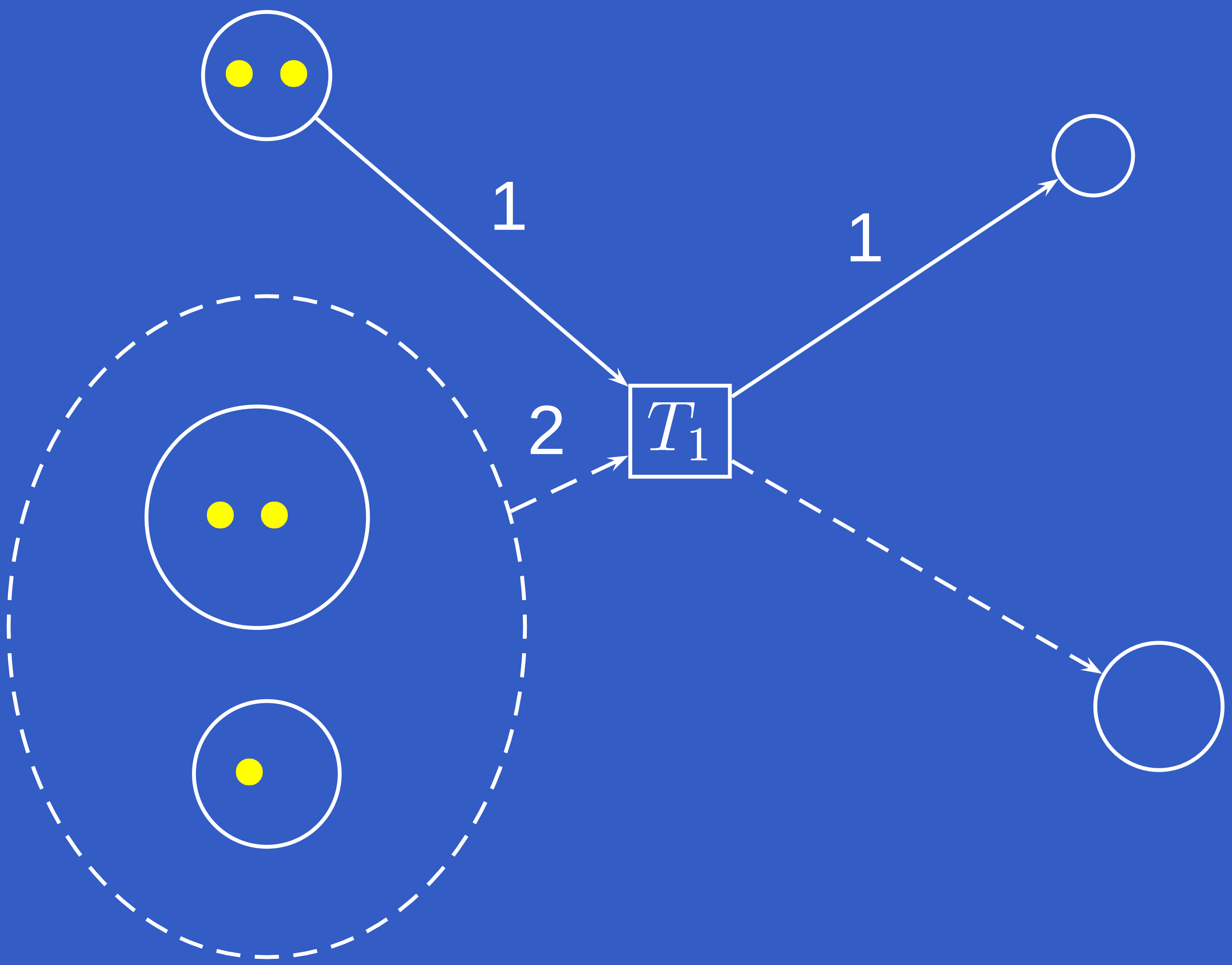


Multi-transfer nets



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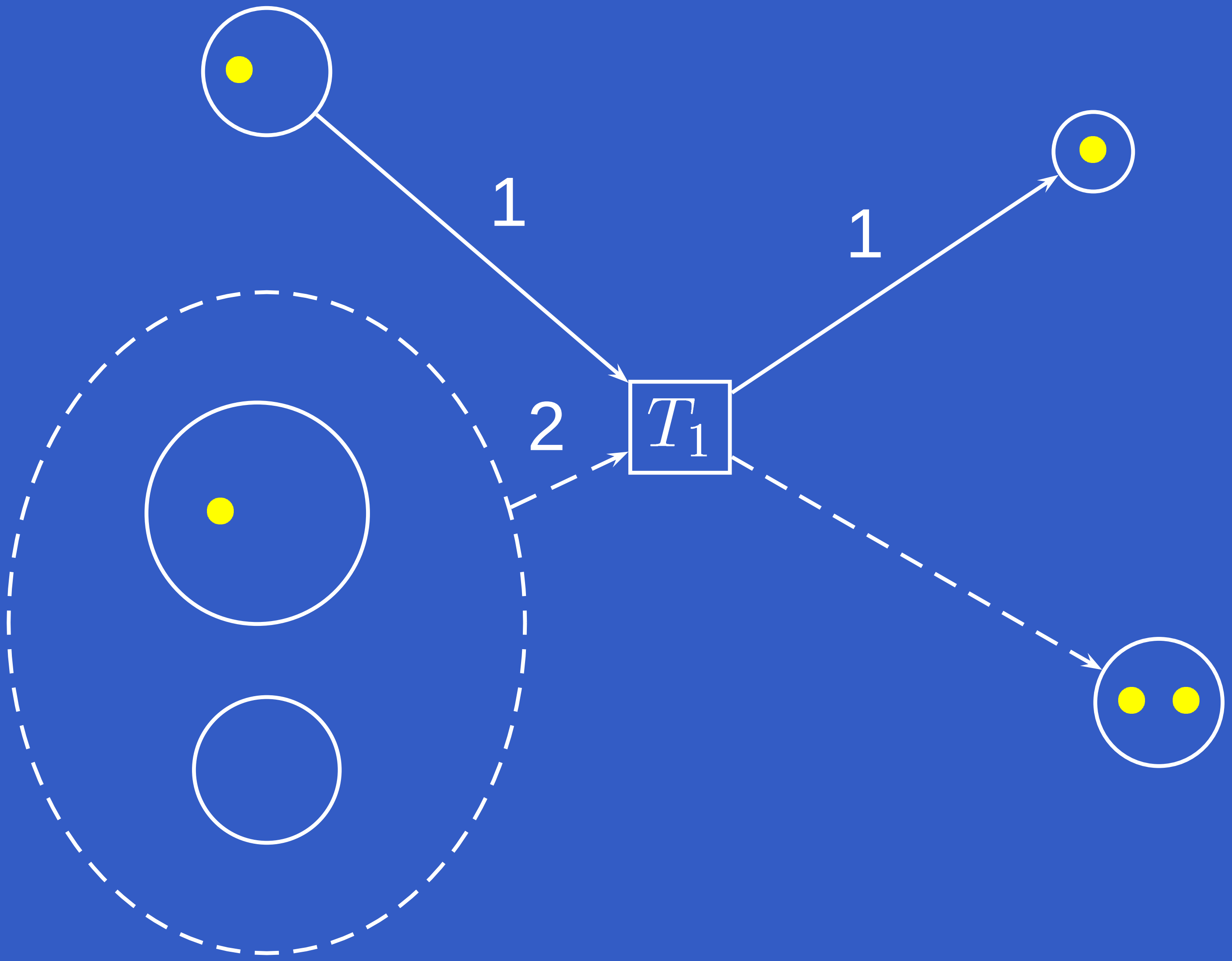

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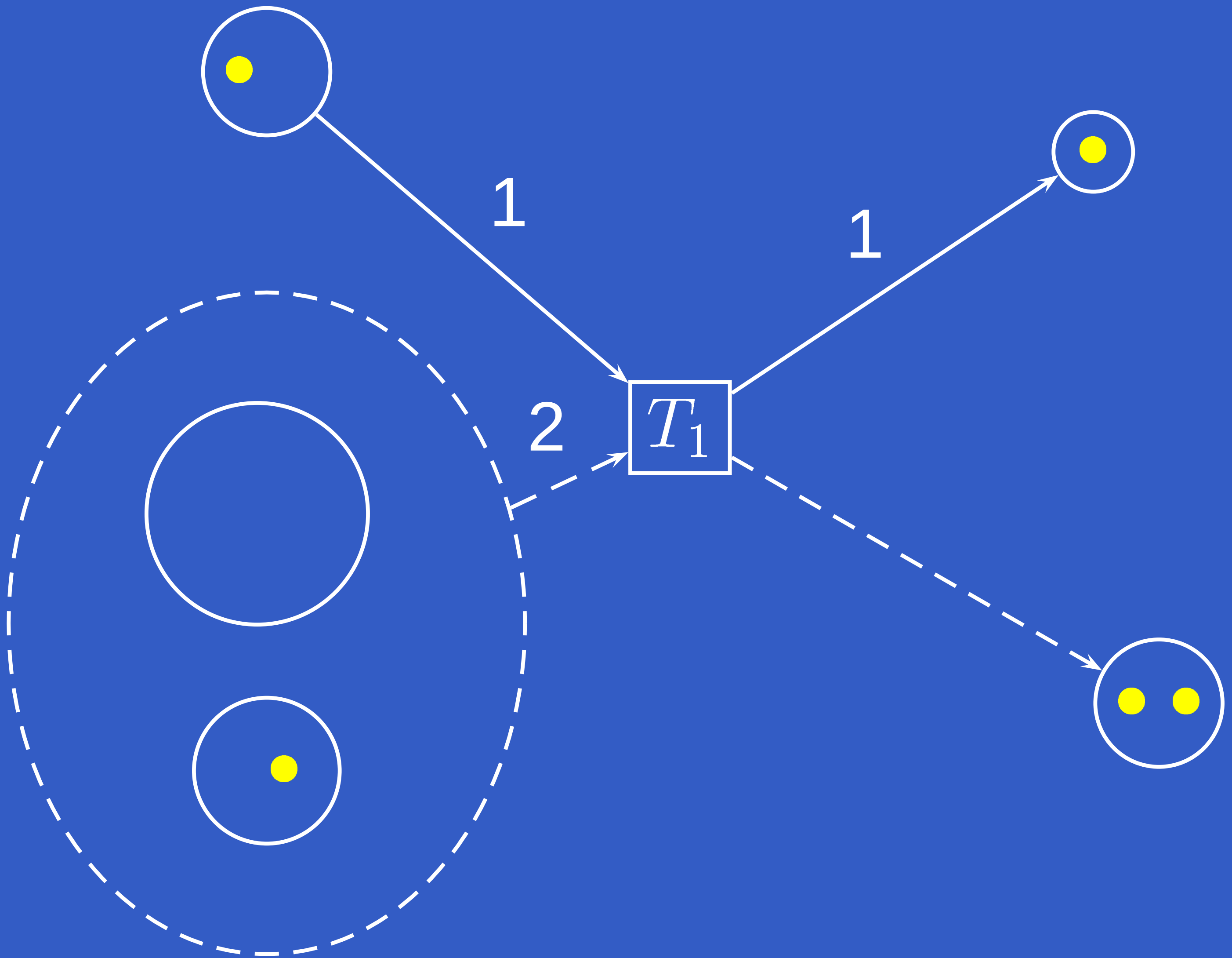

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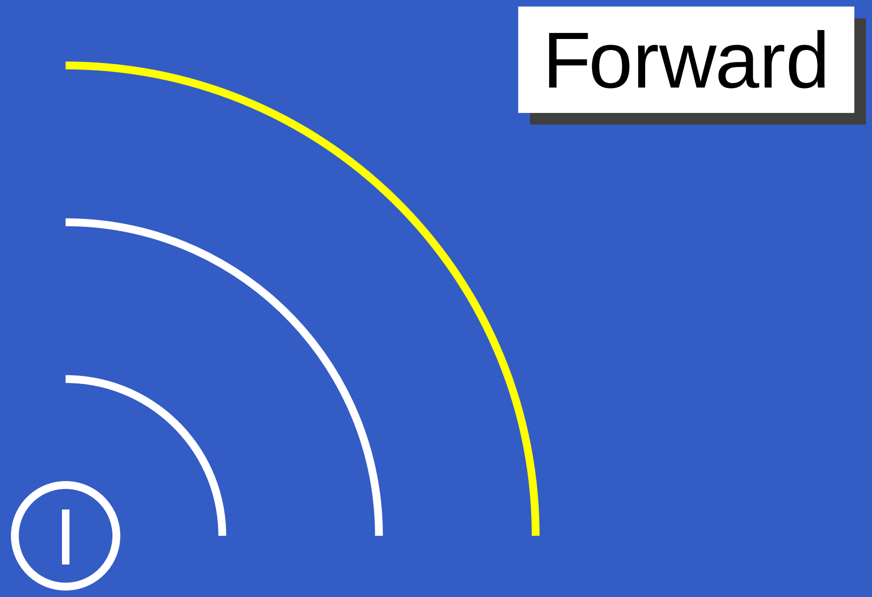

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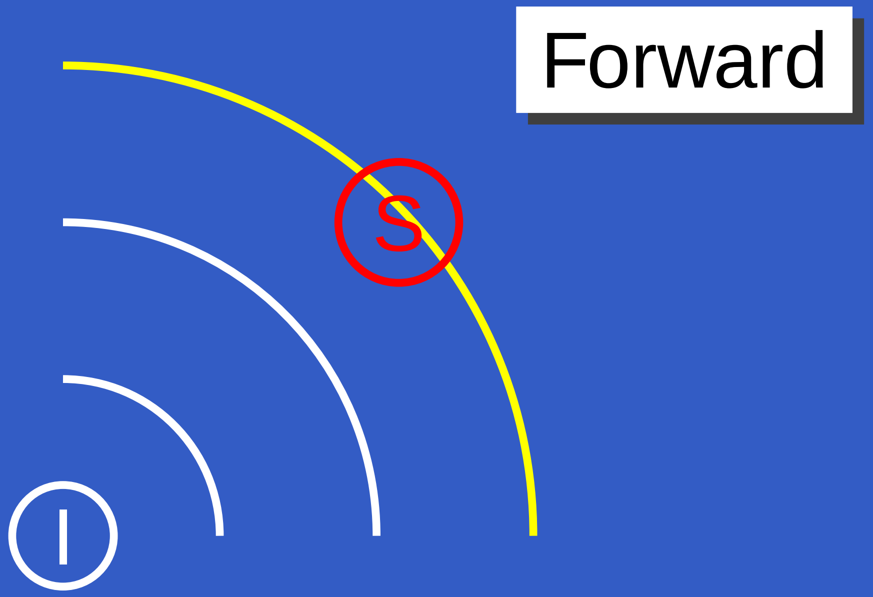

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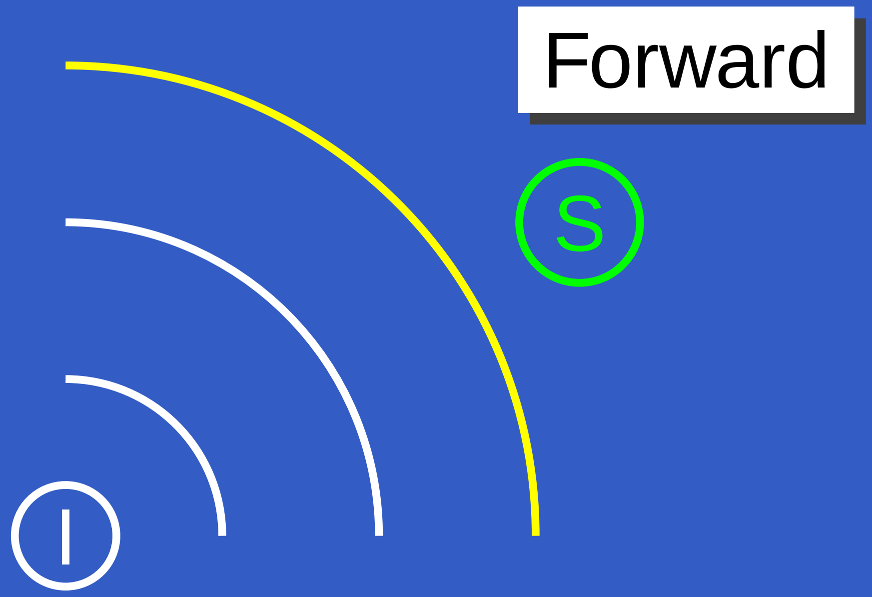

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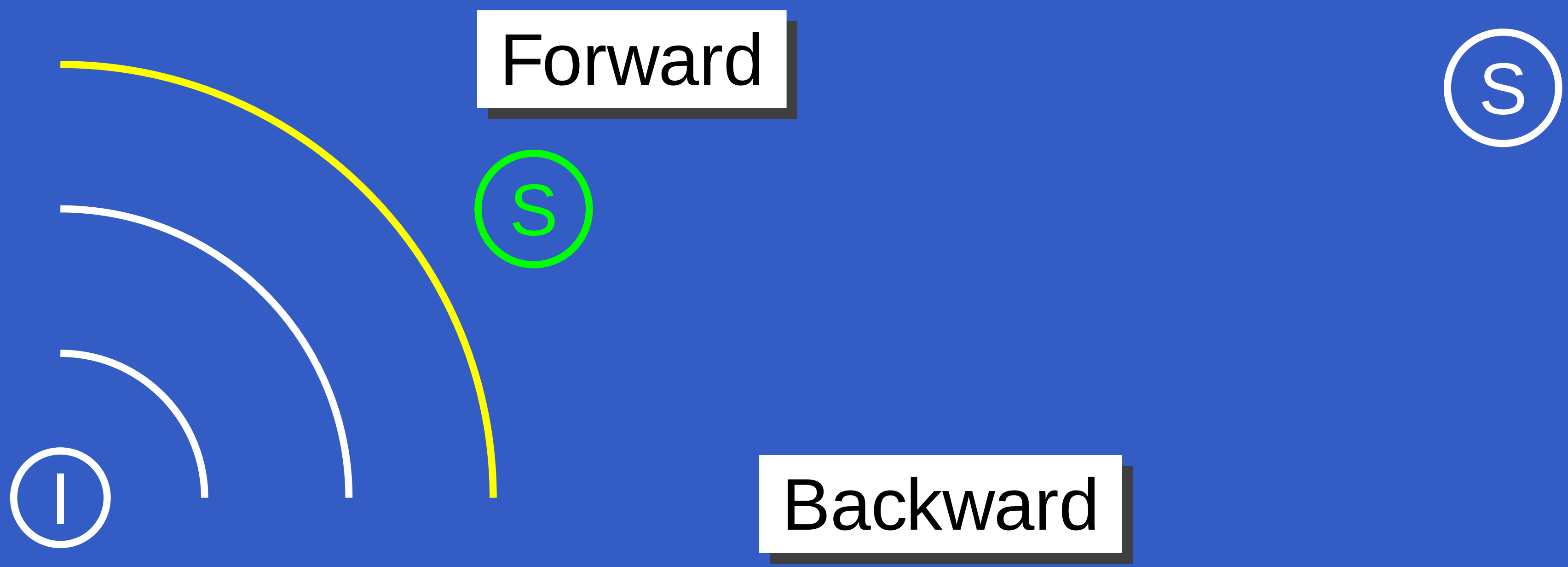

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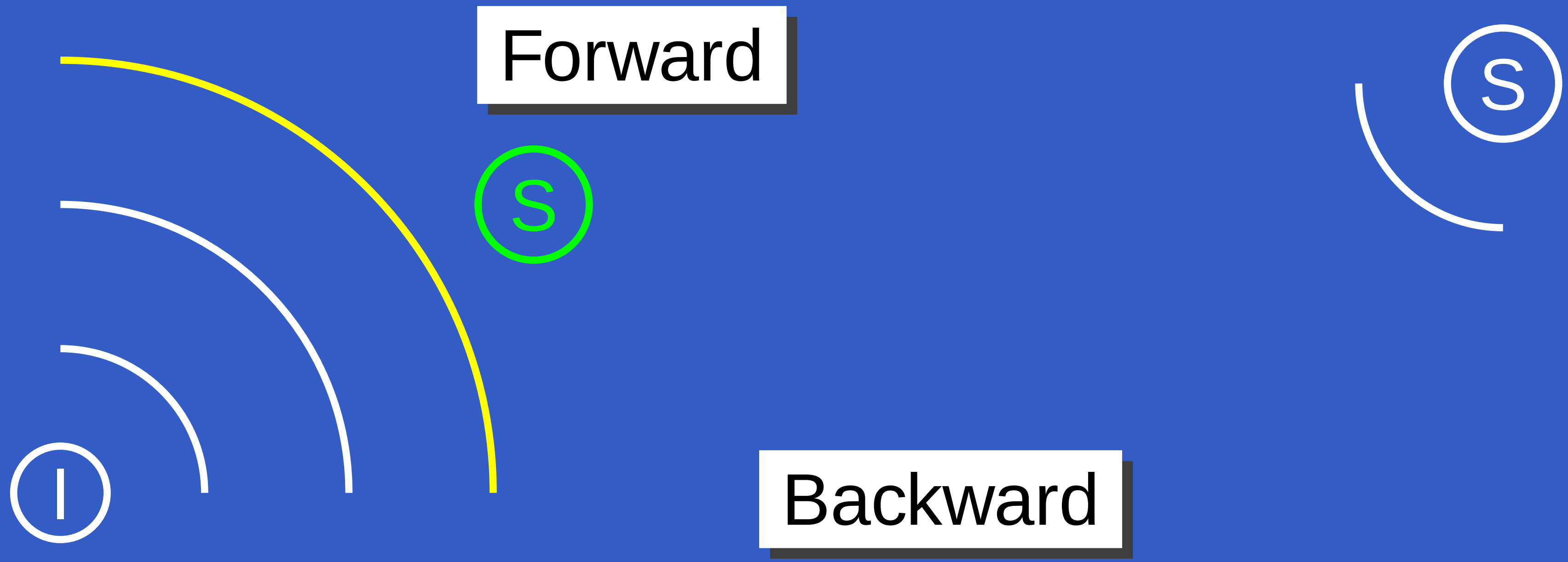

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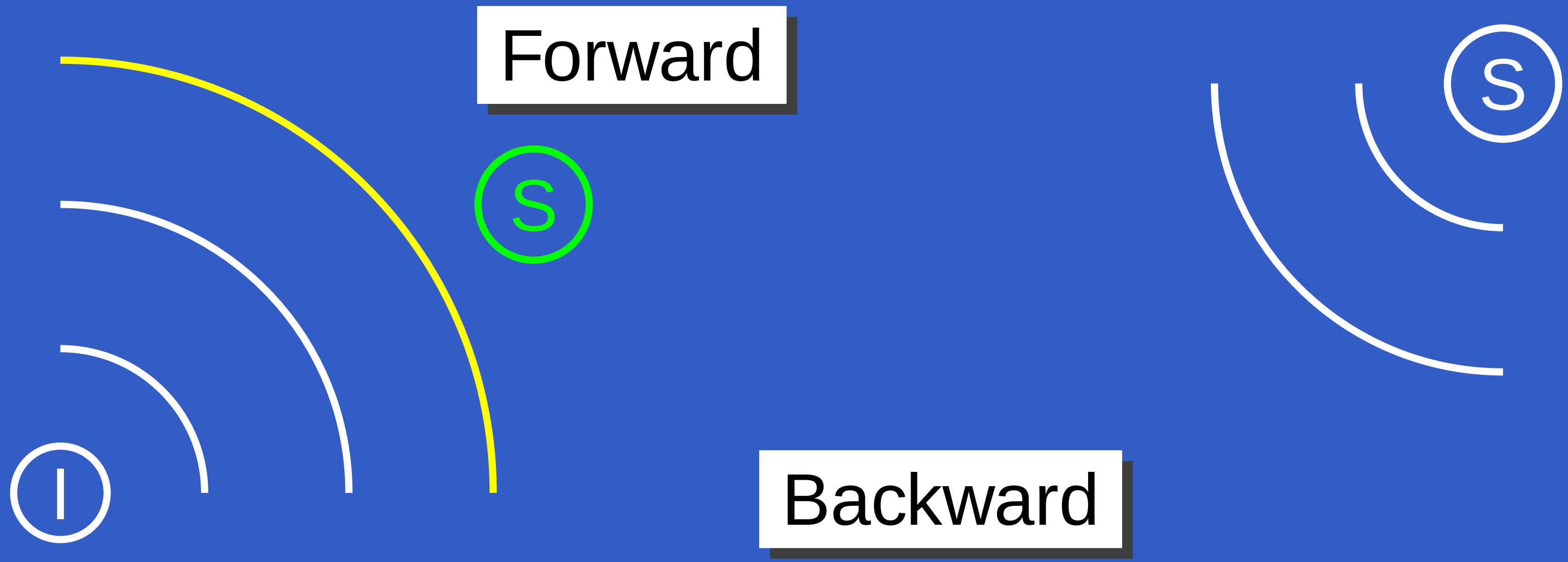

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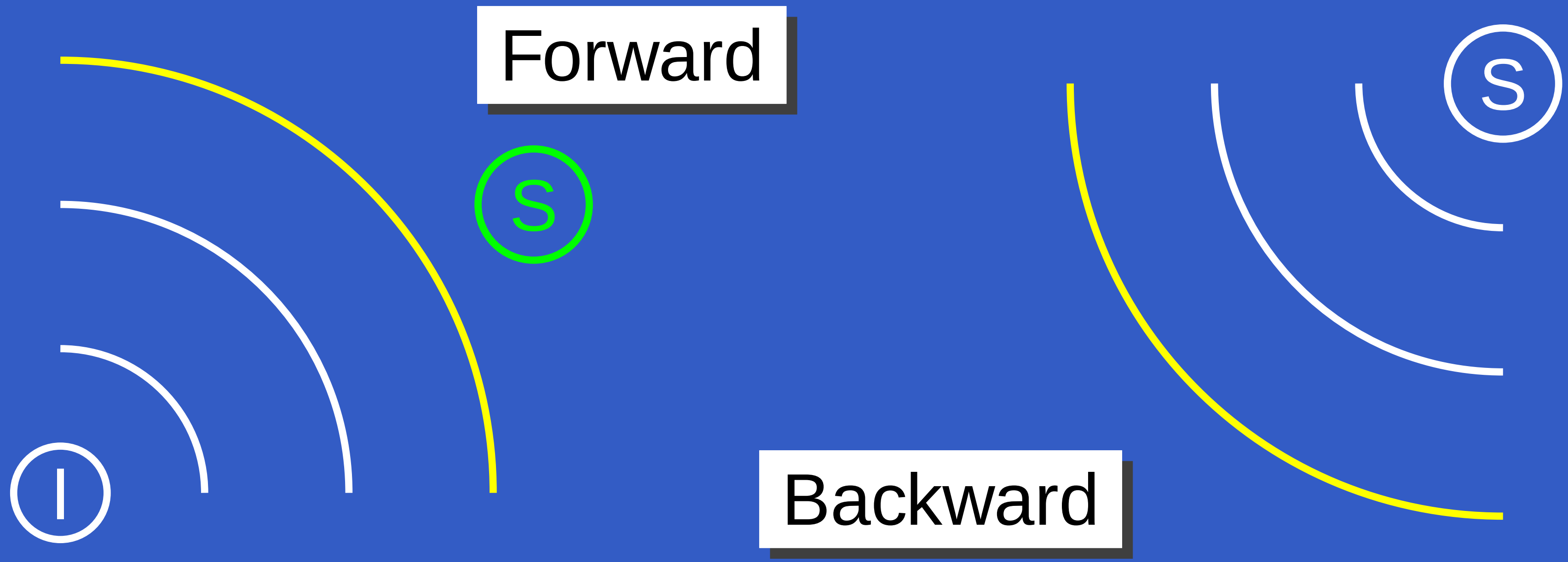

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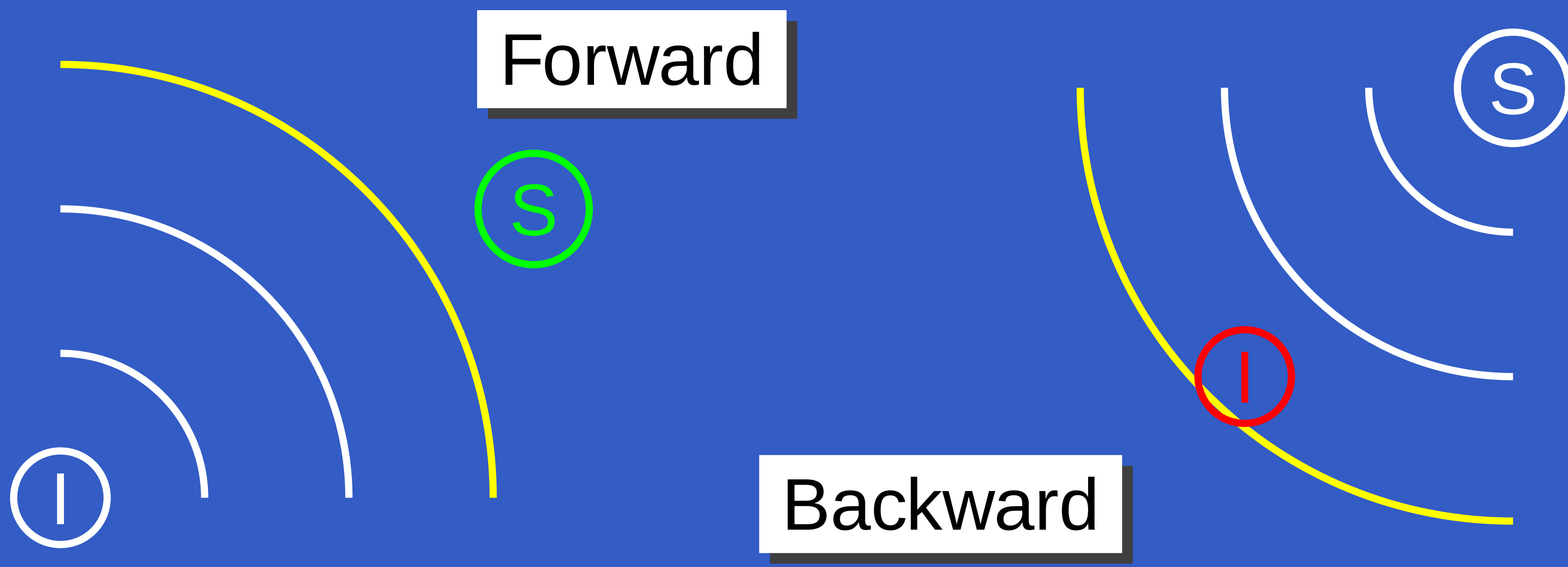

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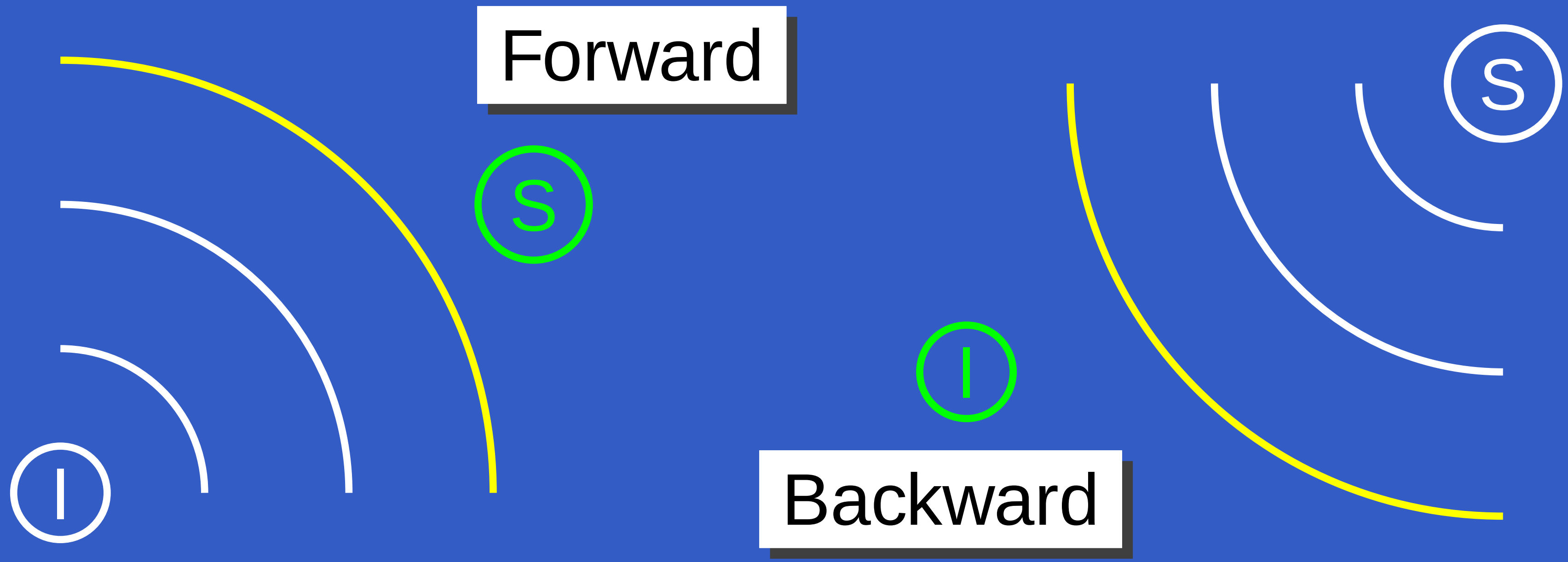
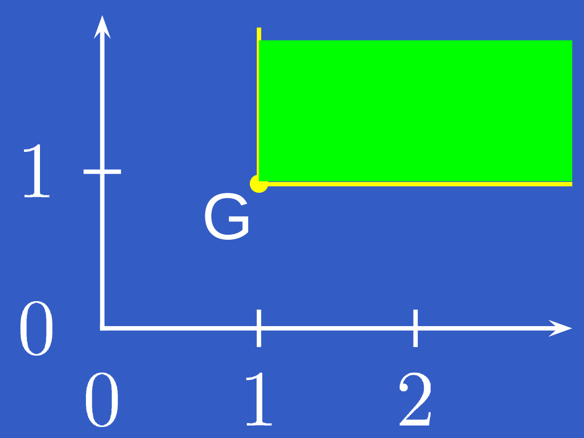


Decidability

- The fixed-point algorithm working backwards will finish if the set of unsafe points is upward-closed [Abdulla, Cerans, . . .].
- An upward-closed set of points (markings) is caracterized by its generator.



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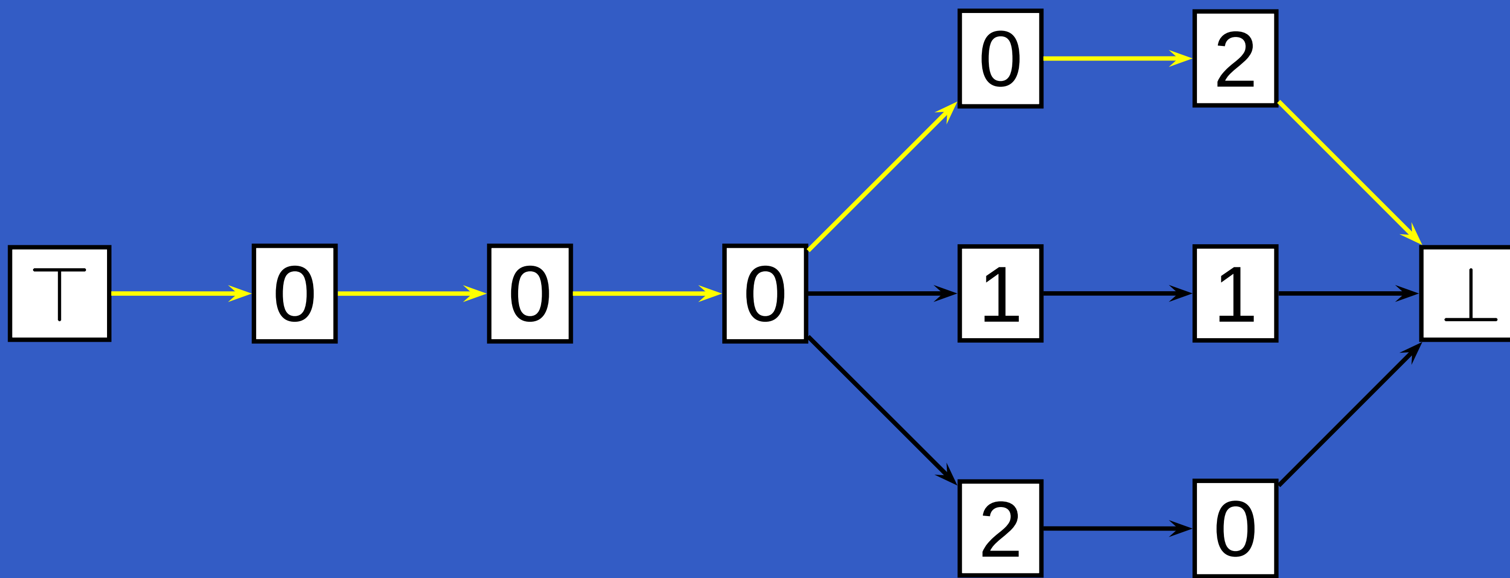
- Let's compare the practical preformances of four of them: CST, IST, DDD, NDD !

Covering Sharing Trees



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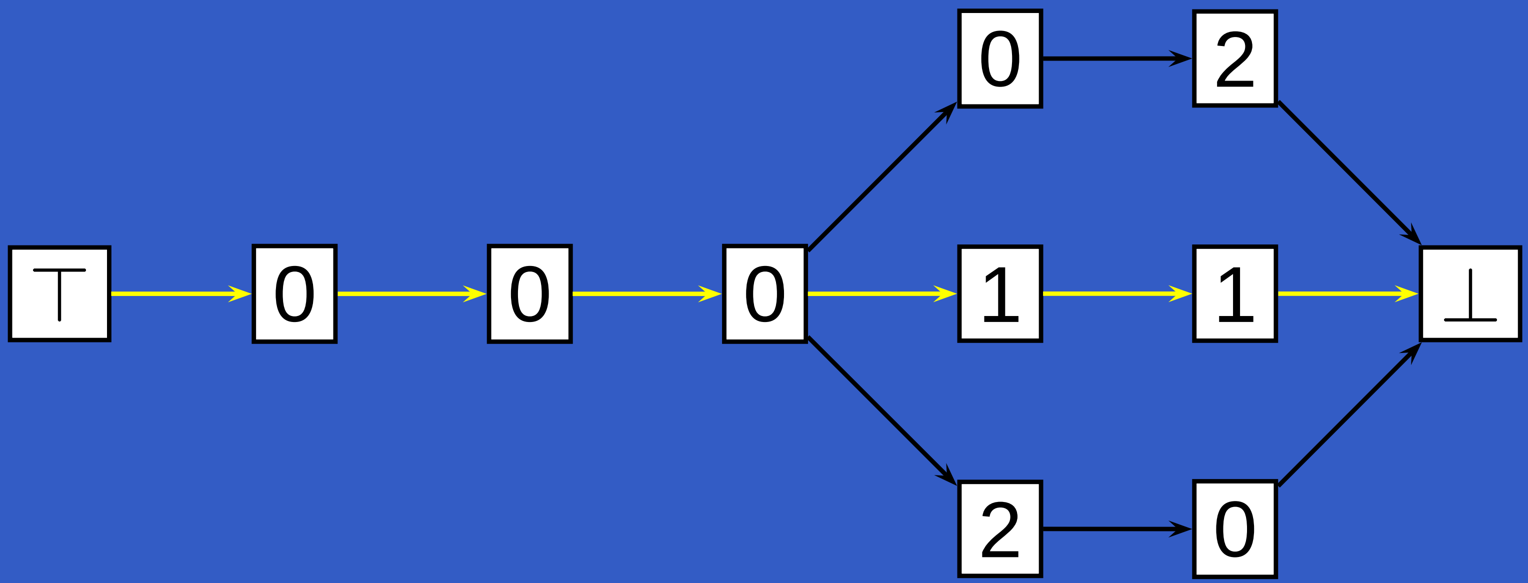

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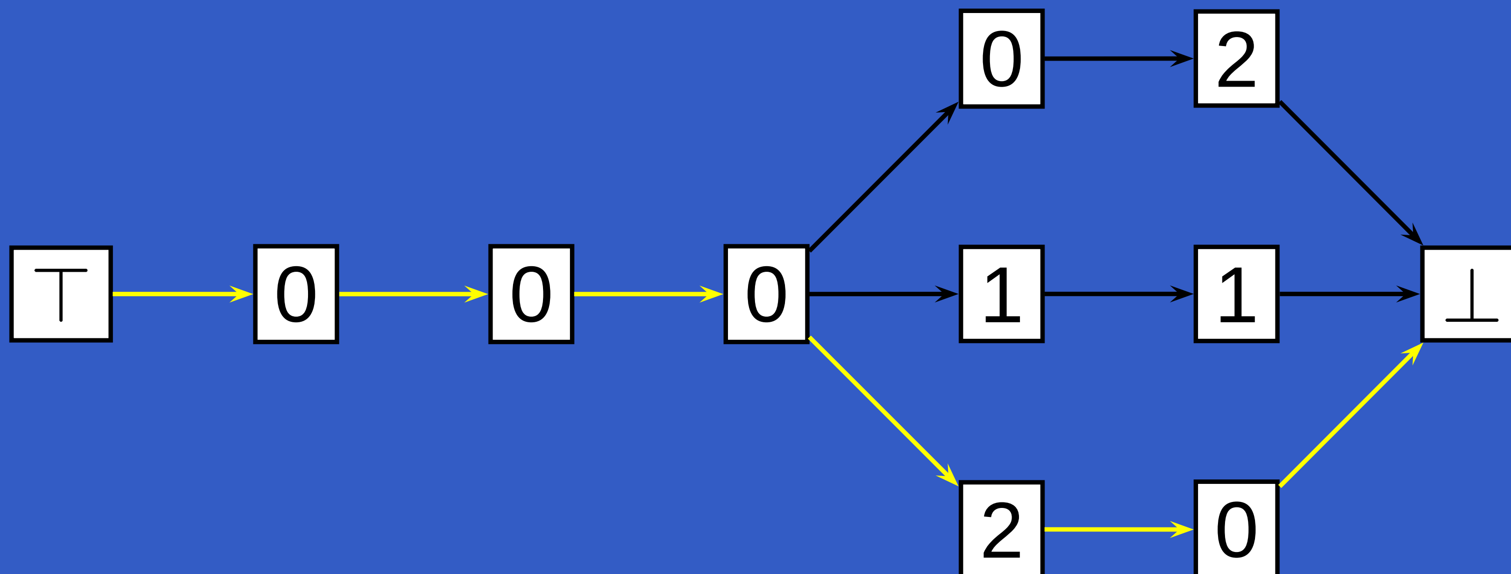

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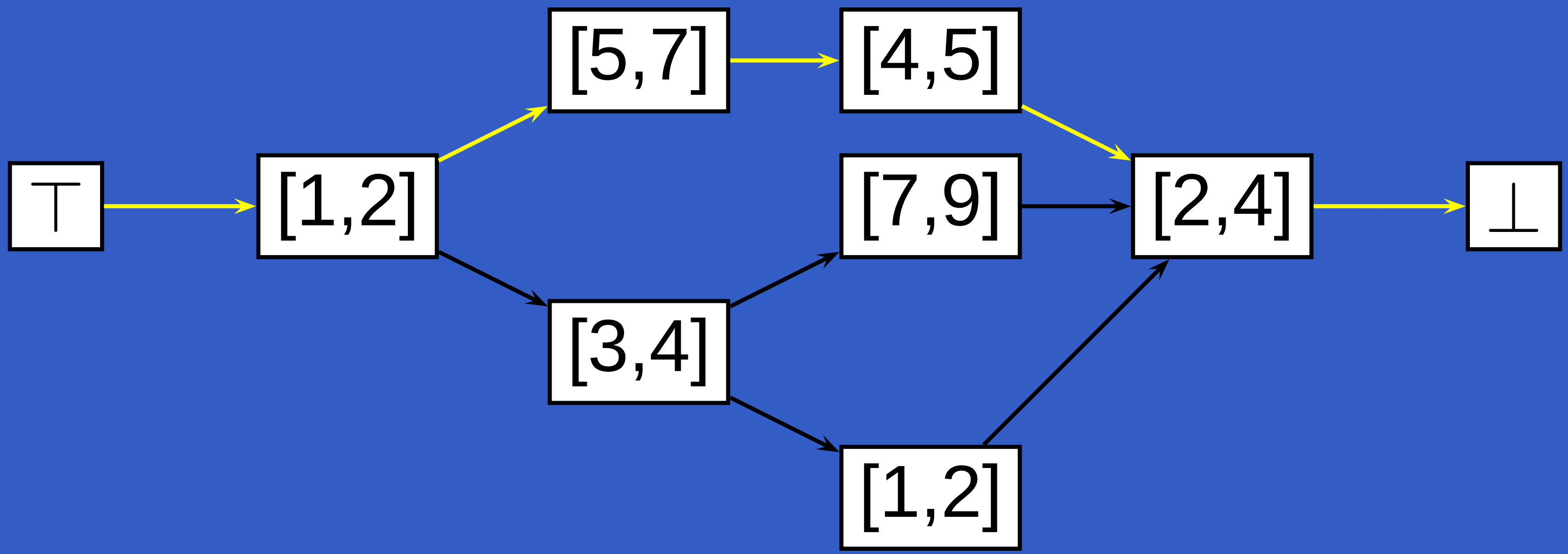

$$(1 \leq m_1 \leq 2) \wedge (5 \leq m_2 \leq 7) \wedge (4 \leq m_3 \leq 5) \wedge (2 \leq m_4 \leq 4)$$

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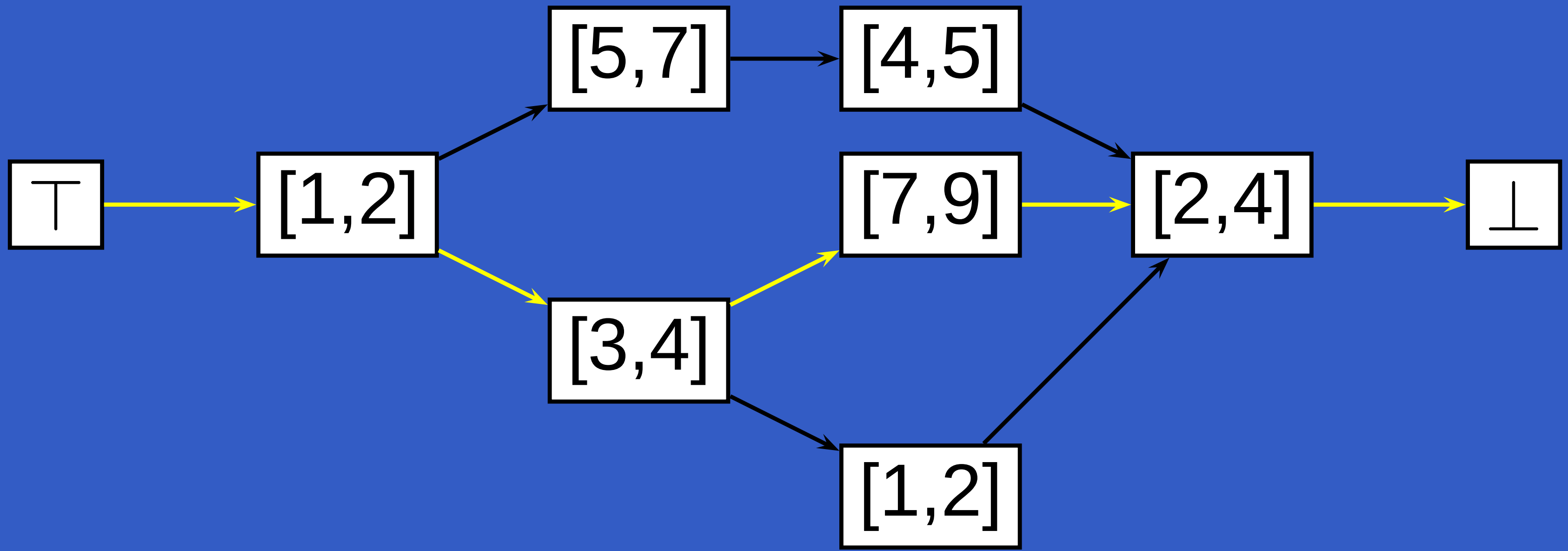

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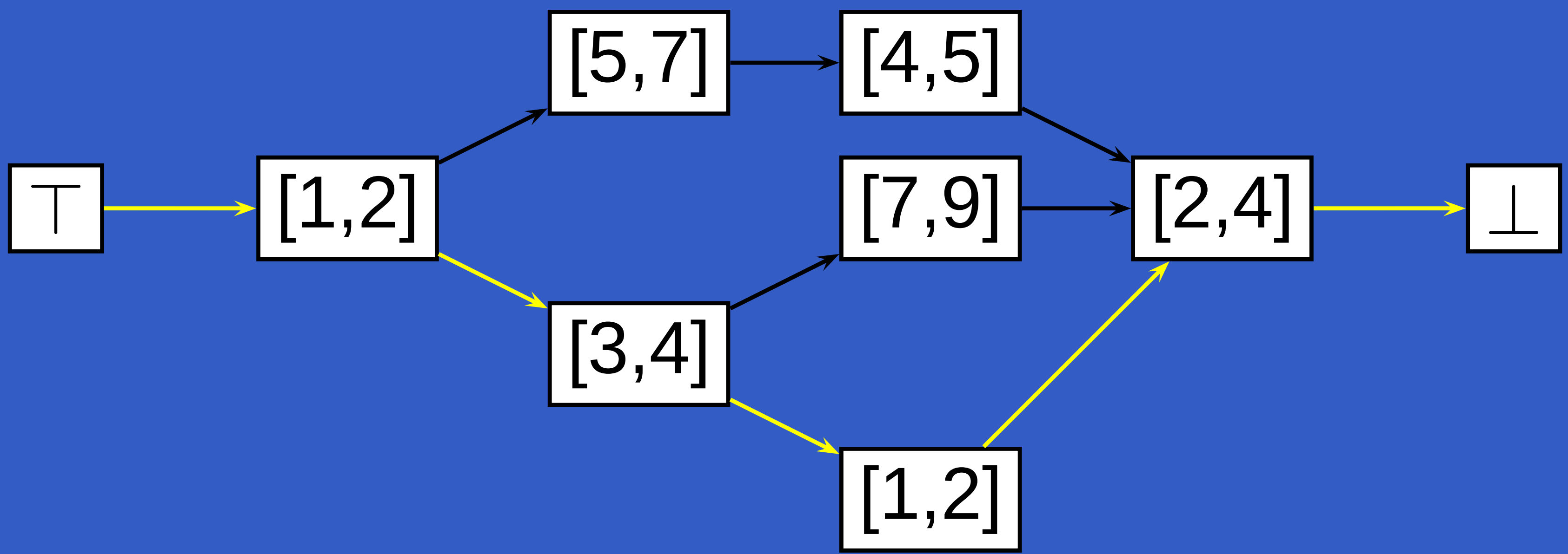

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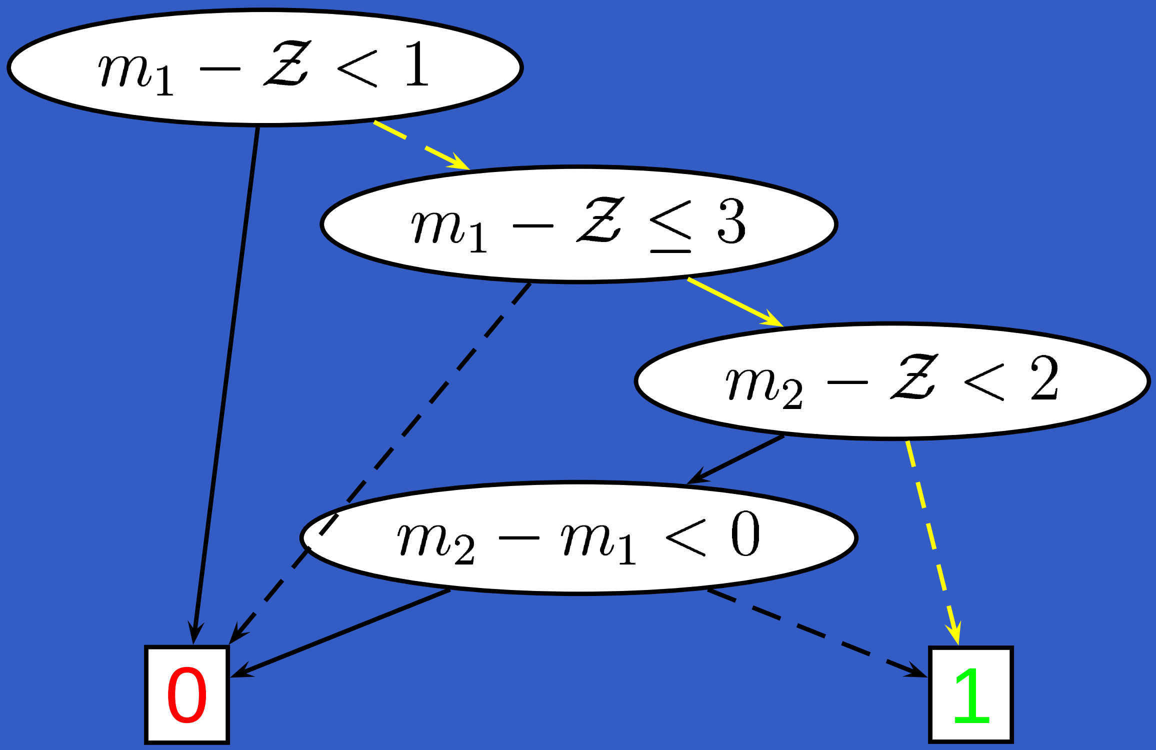

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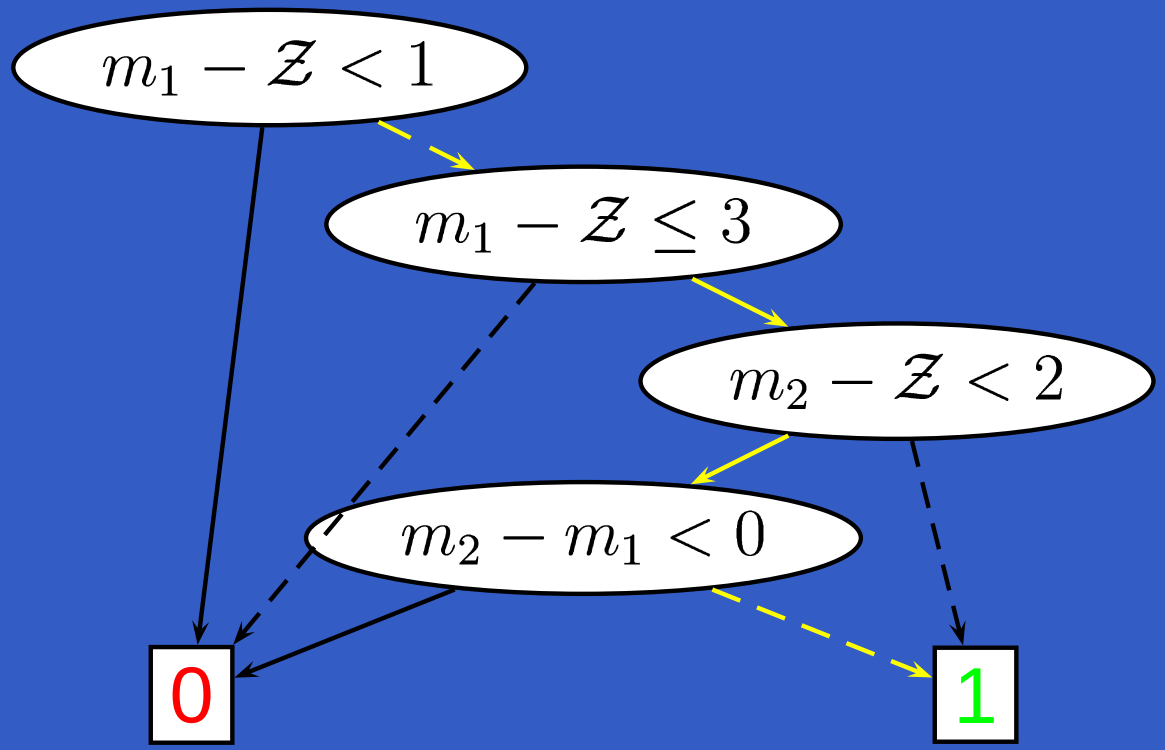

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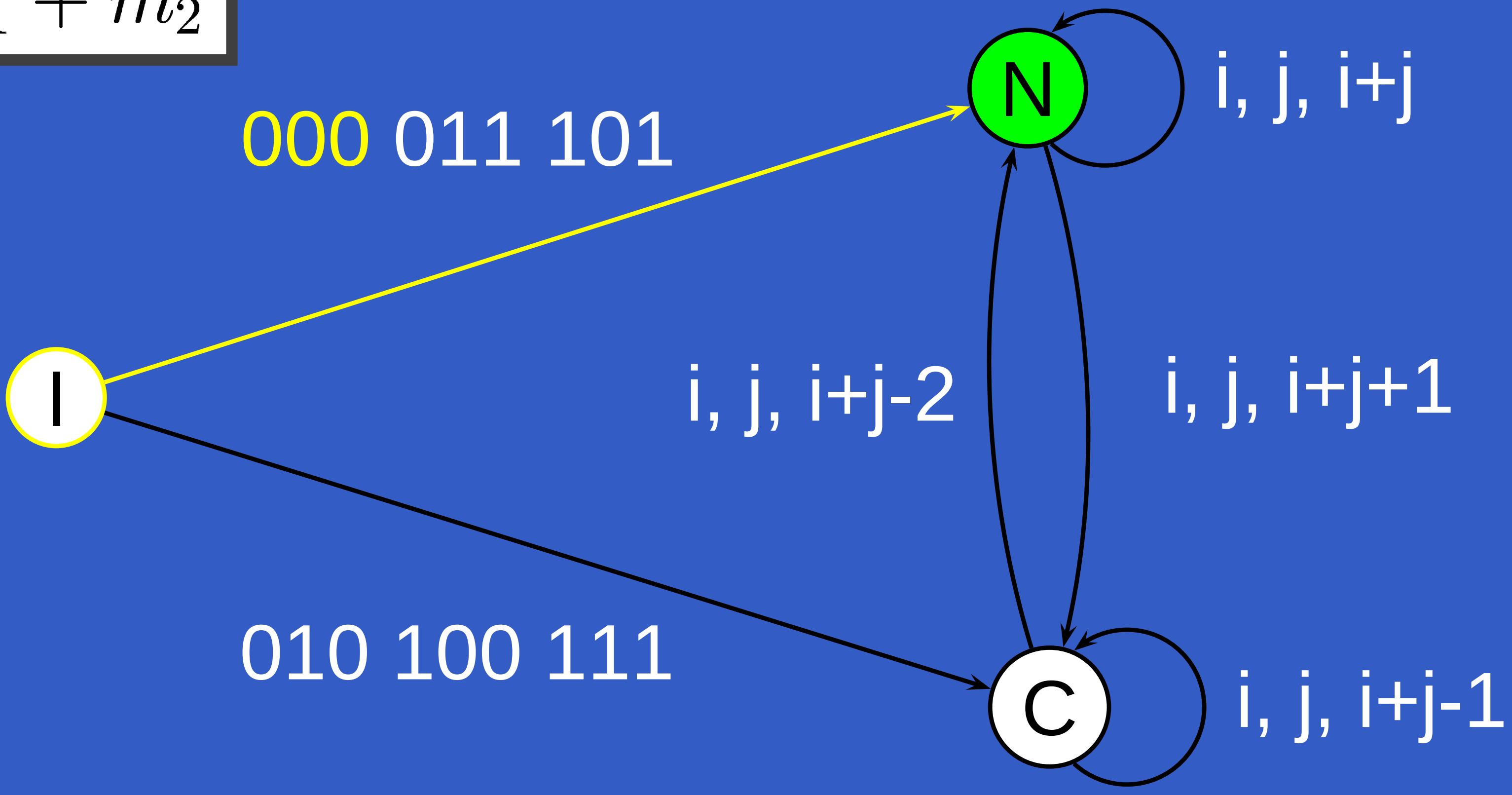

1+1=2: 001+001=010

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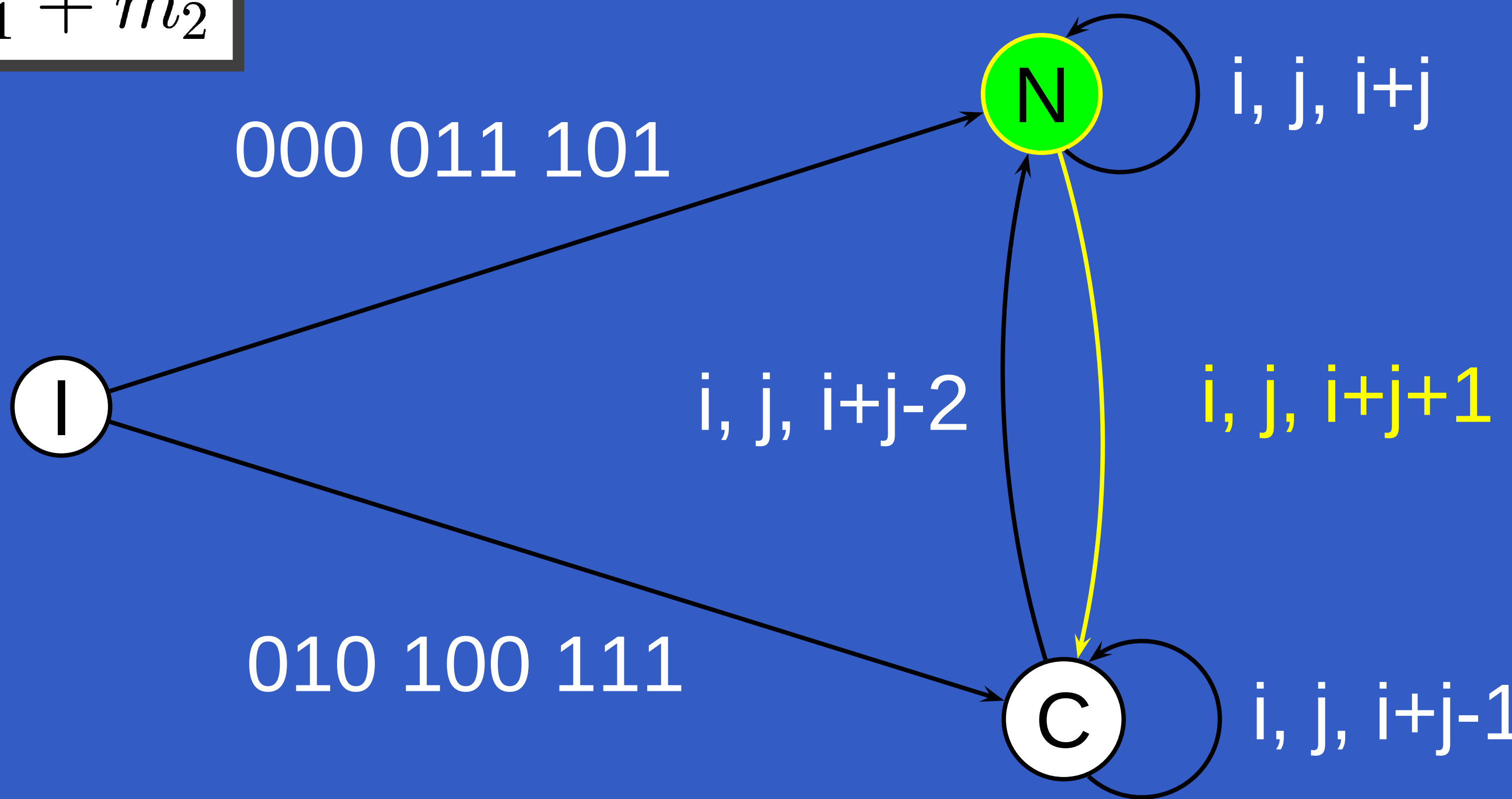

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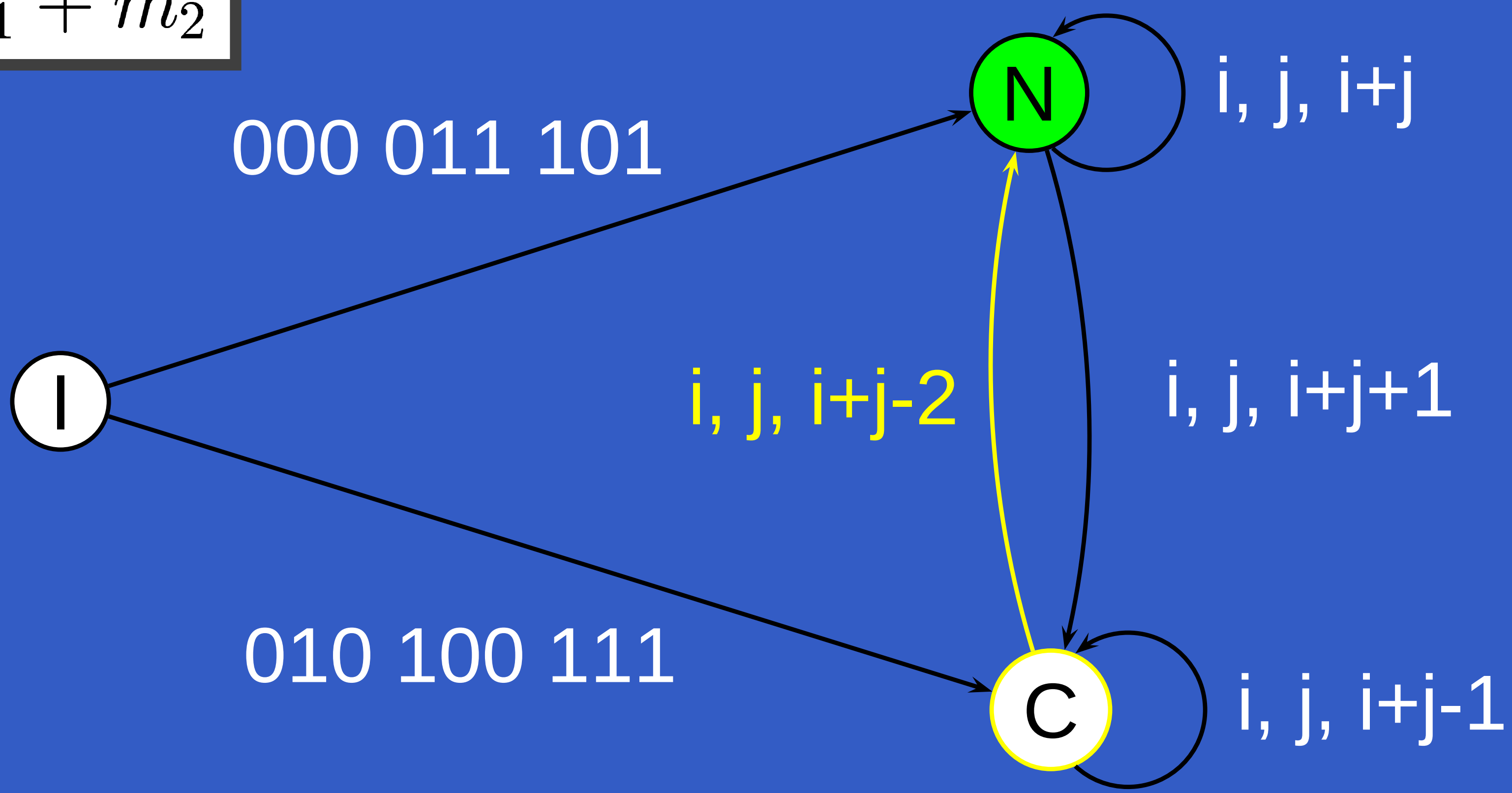

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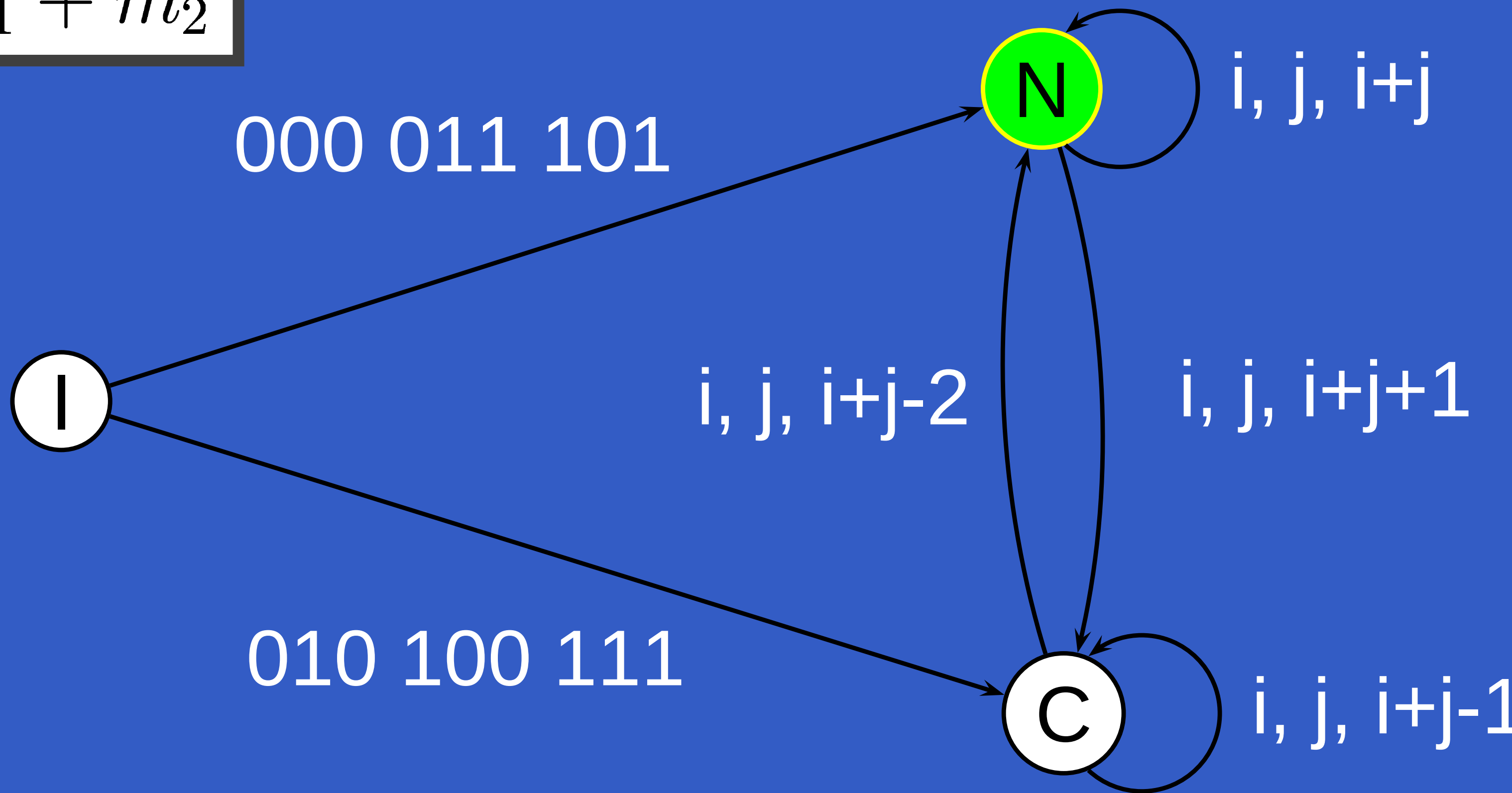

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```
class Set {
    virtual Set * Union (const Set * S) = 0;
    virtual Set * Intersection (const Set * S) = 0 ;
    virtual Set * Difference (const Set * S) = 0 ;
    virtual bool IsEmpty() = 0 ;
    virtual Set * Pre(void) = 0 ;  virtual Set * Pre(int i) = 0 ;
    virtual void EmptySet() = 0 ;  [. . .] }
```

Results – Second Phase

Execution times (sec.) – Algorithm 3

Example	CST	IST	DDD	NDD
Peterson	0.54	0.34	0.33	2'172.19
Lamport	0.14	0.1	0.13	139.19
Multipool	14.19	9.36	3.04	>3 hours
Mesh3x2	466.31	513.62	195.99	>3 hours

(. . .)

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- Many optimizations (invariants) have been used.
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A twofold comparison – Second phase

- YABA: a model-checker based on DDD and NDD.
  - NDD part $\rightarrow$ LASH library (ULg);
  - DDD part $\rightarrow$ DDD library (Møller) + new extensions.
- Other tools already exist for CST and IST.
- The algorithms are peculiar to the datastructures.
- Many optimizations (invariants) have been used.
- New optimizations techniques have been developped for DDD and NDD.
- Large set of examples.

Results – Second Phase

Execution times (sec.)

Example	CST	IST	DDD	NDD
Peterson	0.88	0.2	0.31	691.12
Multipool	3.39	5.44	0.49	1’309.12
Client/Server	0.27	0.09	0.44	3.34
Client/Server (Ex I)	–	–	0.04	0.9
Client/Server (He I)	0.04	0	6.28	–
Illinois	–	0	0.04	0.66

(. . .)

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- These experiments could be largely refined.
- Other datastructures ?

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- Benchmarks and collection of the results.