Unary One Counter Net Problems
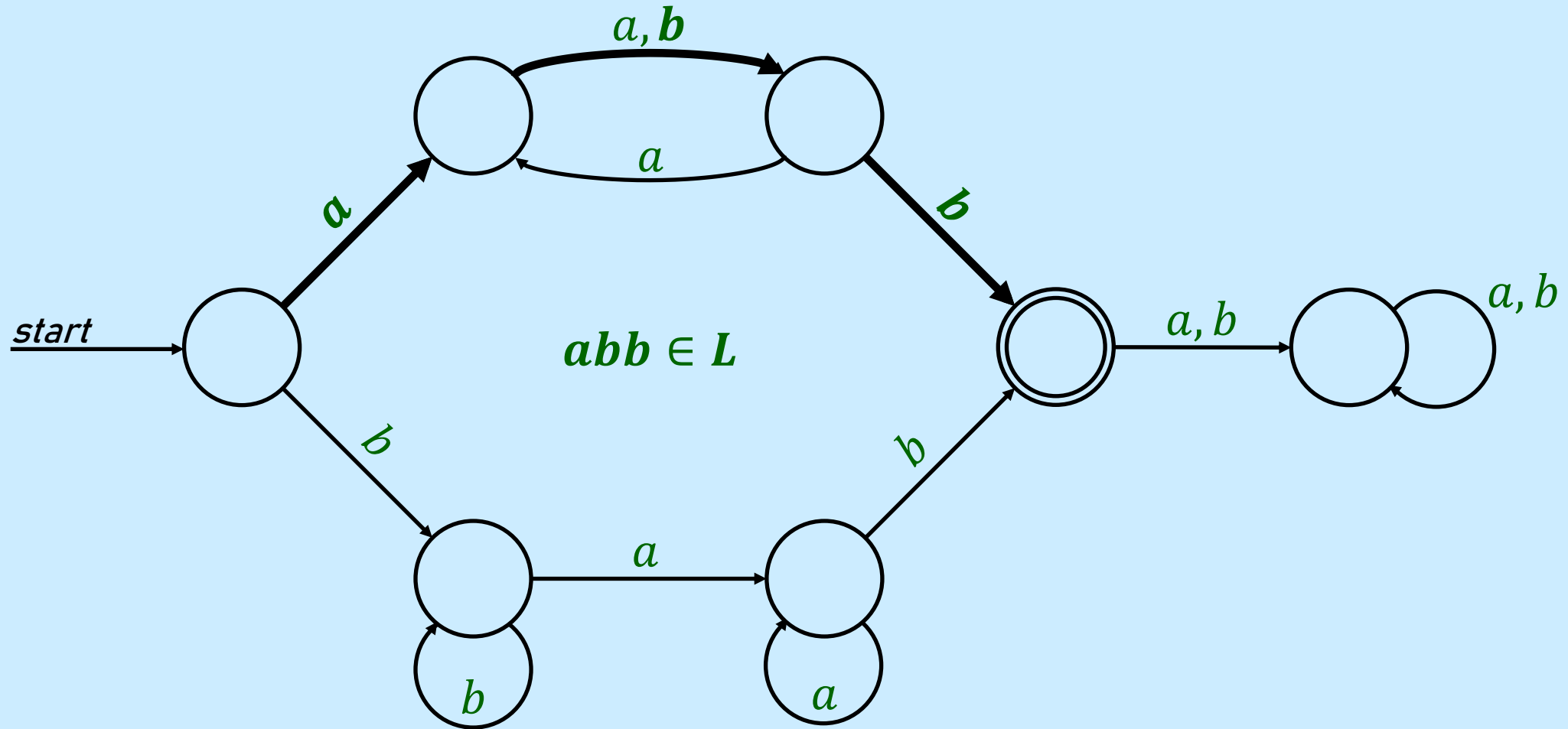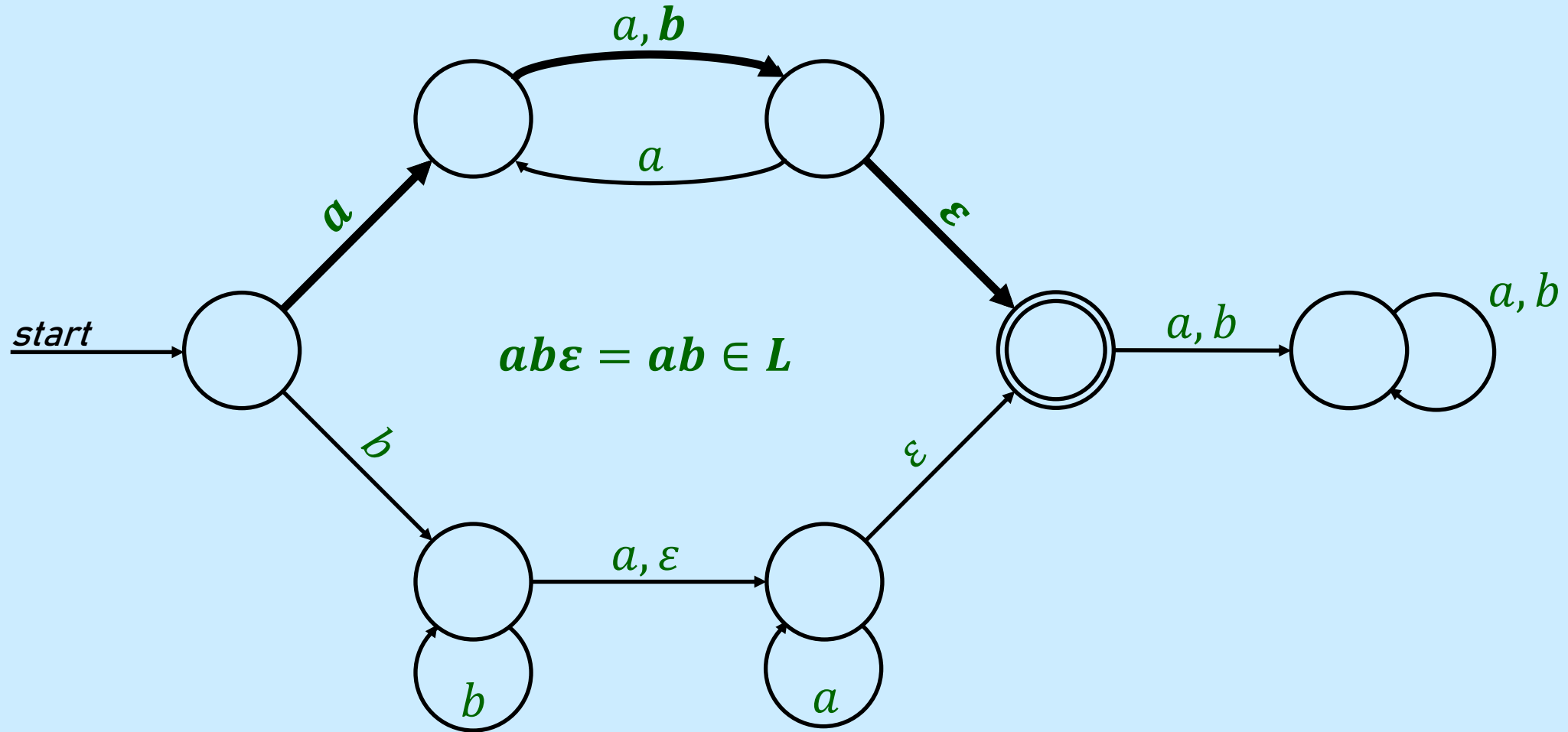## Henry Sinclair-Banks

Self-Introduction

- First year PhD student (undergraduate: BSc Discrete Mathematics)

- Supervisors: Dmitry Chistikov and Marcin Jurdzinski

- Research Interests: Automata, Complexity, Logic.

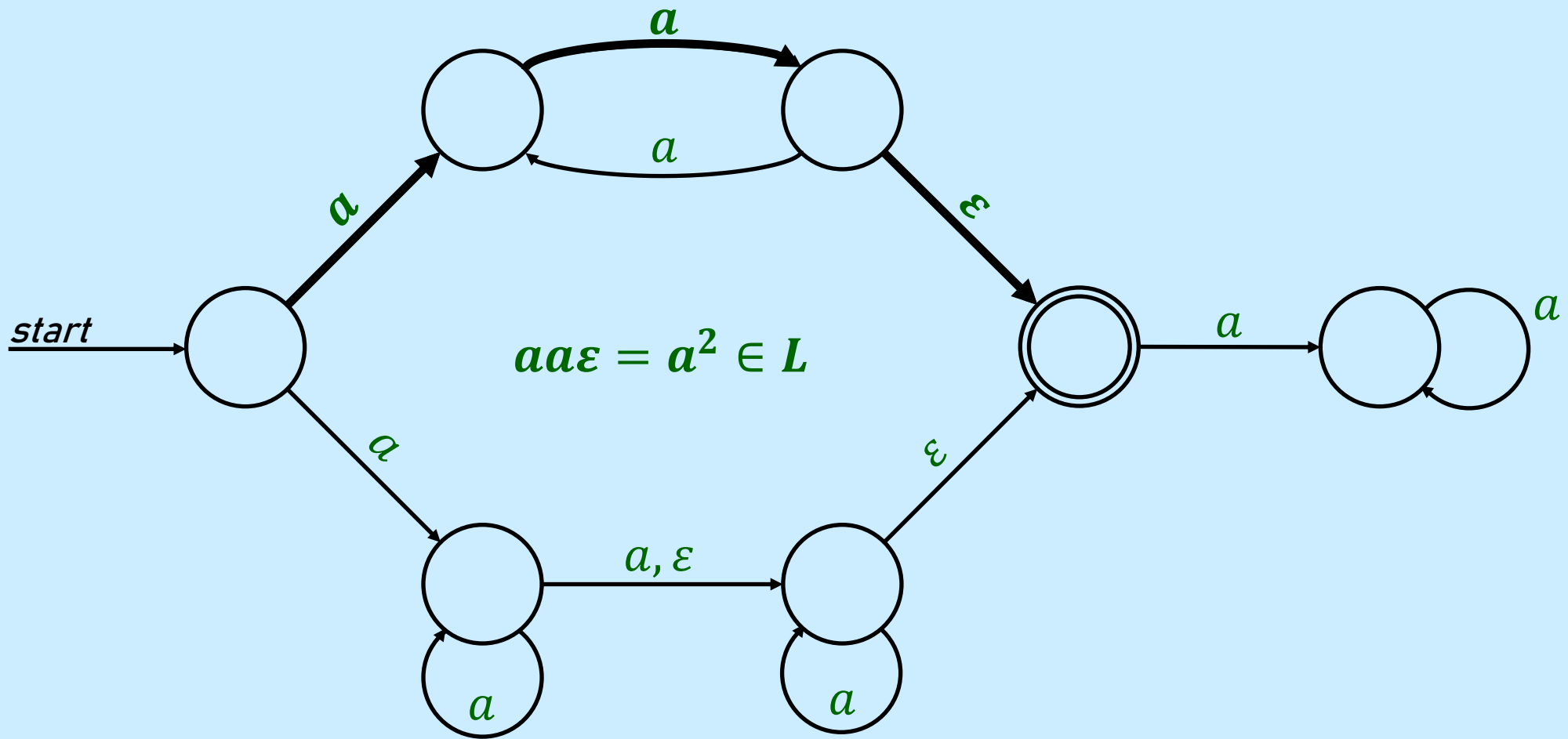- Interests: Cycling & Frisbee, Formula 1, Beer & Coffee.

Deterministic Finite Automata

$abb \in L$

$$ab\varepsilon = ab \in L$$

~~DFA~~ ~~NFA~~ Unary NFA

$$aa\varepsilon = a^2 \in L$$
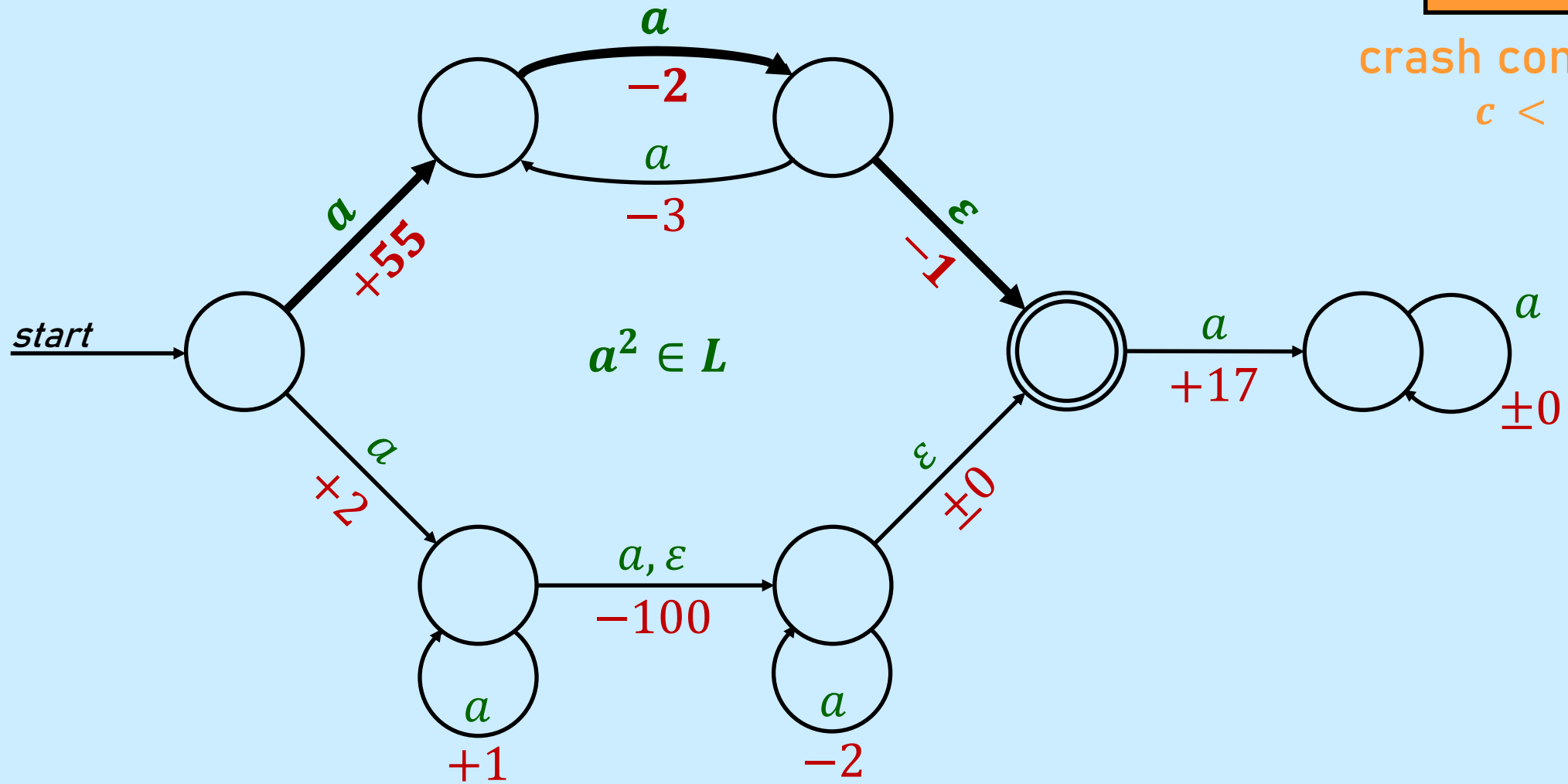
Decision Problems

› Emptiness

› (Compressed) Membership

› Universality

› Equality

› Inclusion

Goal: Classify Computational Complexity

Universality
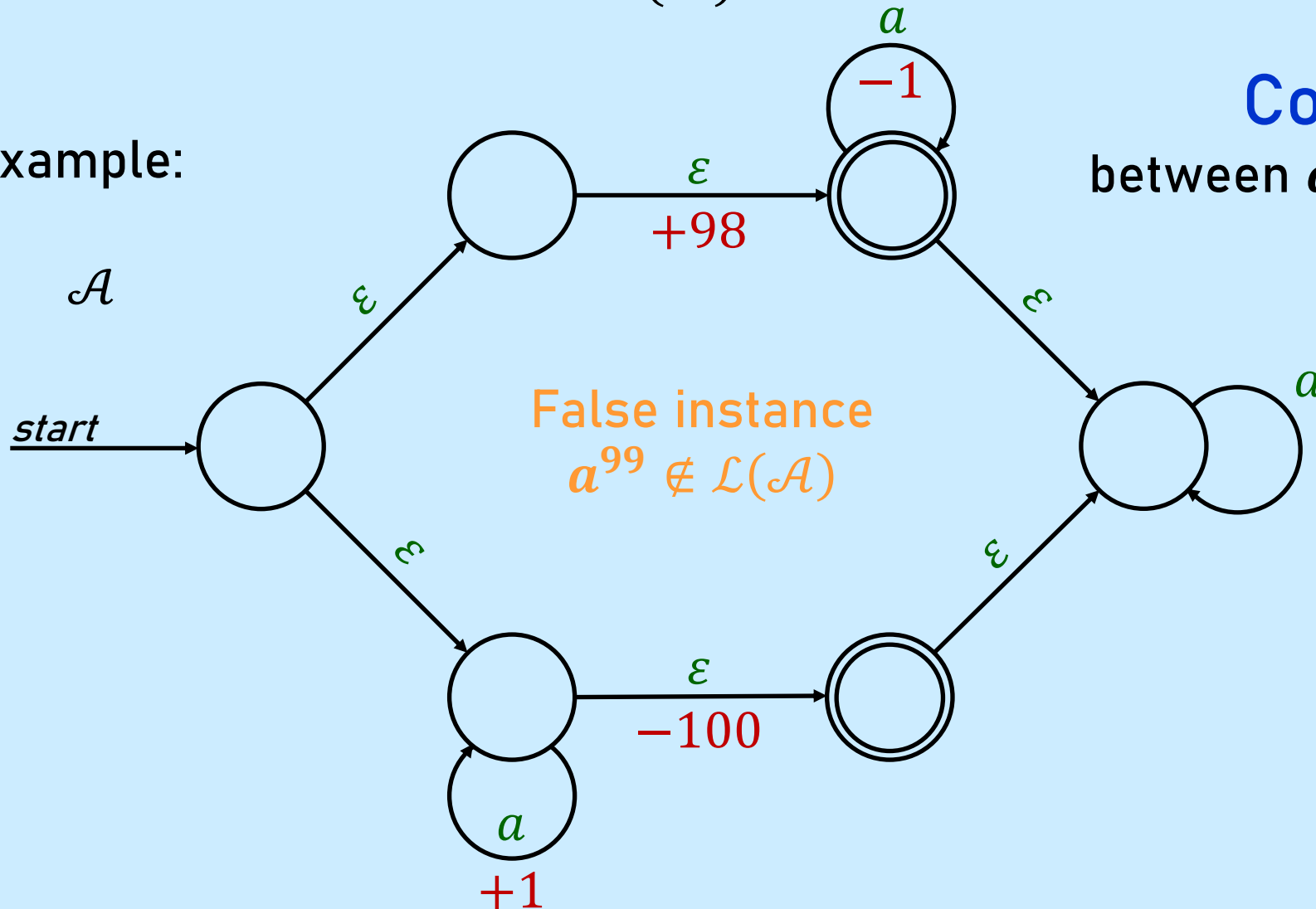
> INPUT   Unary OCN $\mathcal{A}$
> QUESTION $\forall n \in \mathbb{N}: a^n \in \mathcal{L}(\mathcal{A})$?

Example:

$\mathcal{A}$

Complexity
between $coNP$ and $coNP^{NP}$

False instance
$a^{99} \notin \mathcal{L}(\mathcal{A})$

Membership

> INPUT

> QUESTION

Unary OCN $\mathcal{A}$, word $w = aa \dots a.$

Does $w \in \mathcal{L}(\mathcal{A})$?

Example:

$\mathcal{A}$

$w = aaaaa$

$w =$
$aaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaaa$

start

ε

ε $+98$

a -1

ε

a

ε -100

a $+1$

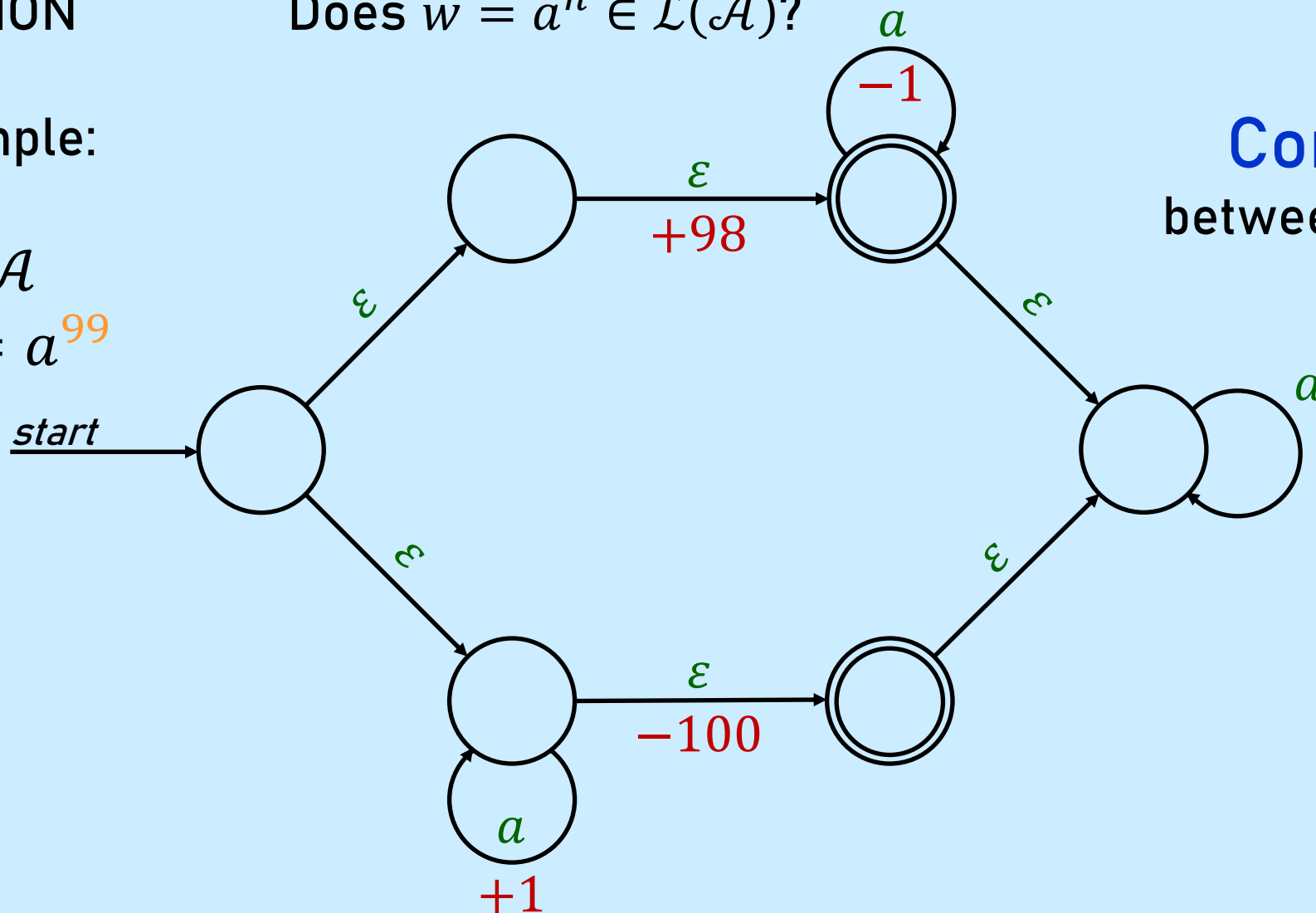ε

Compressed Membership

>INPUT   Unary OCN $\mathcal{A}$, number $n \in \mathbb{N}$ $\text{bitsize}(n) = \log(n)$

>QUESTION   Does $w = a^n \in \mathcal{L}(\mathcal{A})$?

Example:
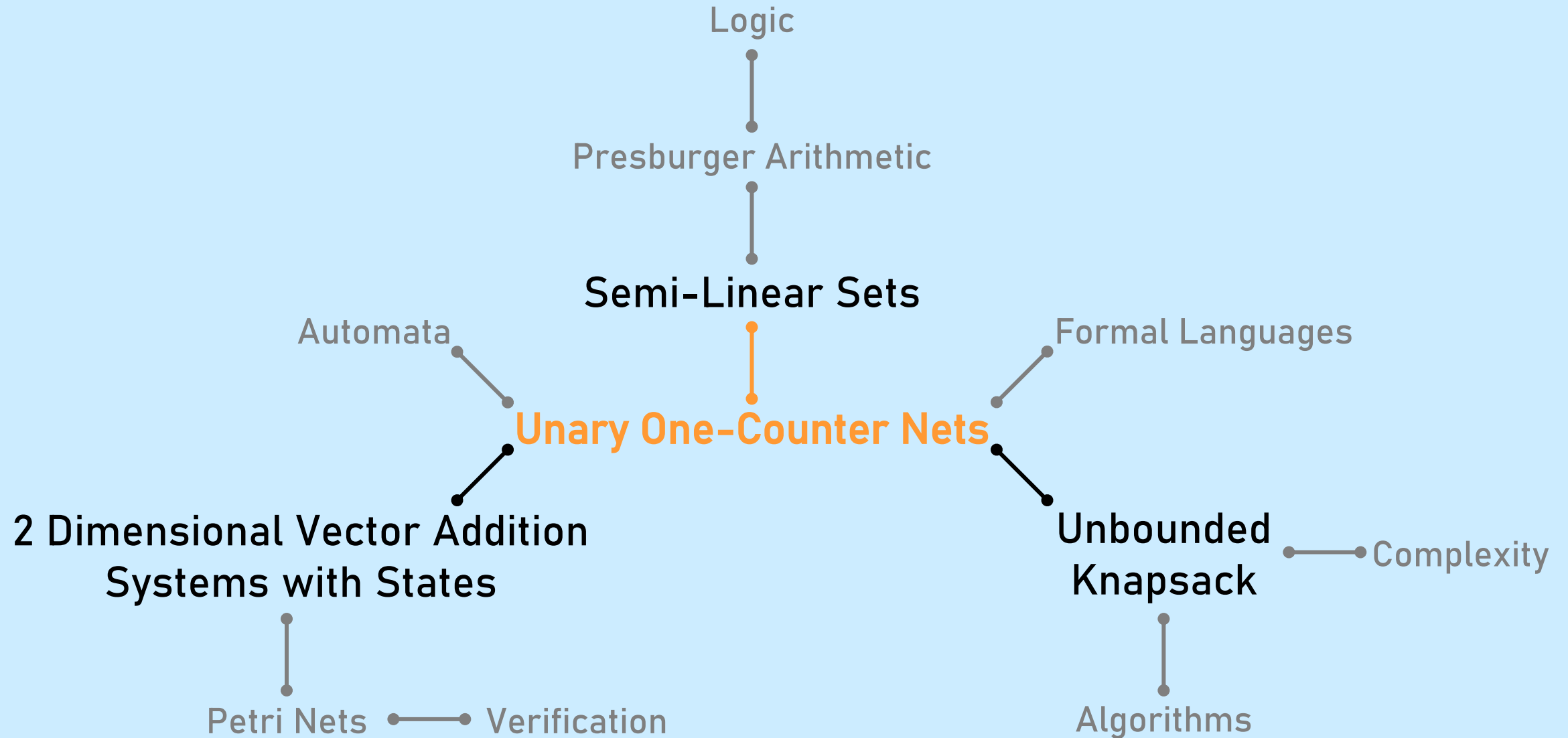
$\mathcal{A}$

$w = a^{99}$

Complexity

between $\boldsymbol{NL}$ and $\boldsymbol{NP}$

Improvements

	Lower Bound		Upper Bound	
Universality	**coNP-hard**	$coNP^{NP}$**-hard ?**	$\in coNP$ **?**	$\in coNP^{NP}$
				$\Uparrow$
Compressed Membership	NL**-hard**	NP**-hard ?**	$\in P$ **?**	$\in NP$

[CONCUR'20]

CONCUR'20:
Parameterized Universality Problem for One-Counter Nets
(S. Almagor, U. Boker, P. Hofman, P. Totzke)

Conclusion

Logic

Presburger Arithmetic

Semi-Linear Sets

Automata

Formal Languages

Unary One-Counter Nets

2 Dimensional Vector Addition
Systems with States

Unbounded
Knapsack

Complexity

Petri Nets — Verification

Algorithms

Questions?

FoCS Theory Workshop Short Presentation
"Unary One-Counter Net Problems" by Henry Sinclair-Banks
Monday 28th June