# Recognizing Expressibility of Process Graphs by Regular Expressions More Efficiently

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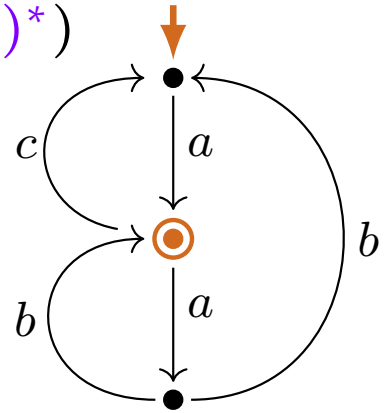
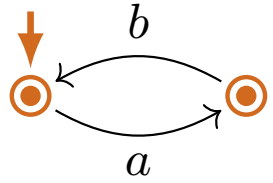
# Expressibility of process graphs by regular expressions

$P(a \cdot (c \cdot a + a \cdot (b + b \cdot a))^*)$

$P$-expressible




not $P$-expressible

$\neq P((a \cdot b)^* \cdot (a + 1))$

**Question (Milner, 1984)**

What structural property of process graphs can characterize expressibility?

**Refined Question**

What structural property of bisimulation-collapsed process graphs can characterize expressibility?

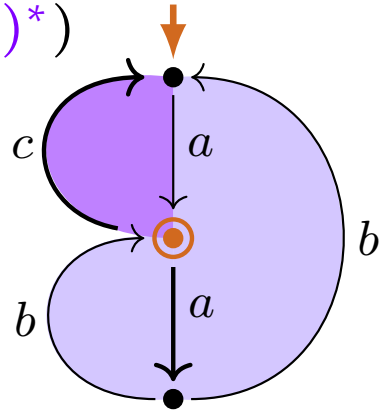
**Theorem (Baeten/Corradini/G, 2005)**

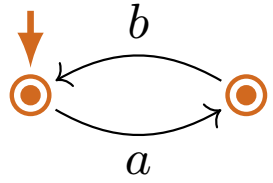
Expressibility is decidable. (With a super-exponential decision procedure.)

# Partial answer with efficient recognition

$P(a \cdot (c \cdot a + a \cdot (b + b \cdot a))^*)$

$P$-expressible




not $P$-expressible

$\neq P((a \cdot b)^* \cdot (a + 1))$

**Partial Answer to Refined Question (adapted from G/Fokkink [LICS 2020])**

The Loop Existence and Elimination Property (LEE)
characterizes those bisimulation-collapsed process graphs
that are expressible by 1-free-under-star regular expressions.

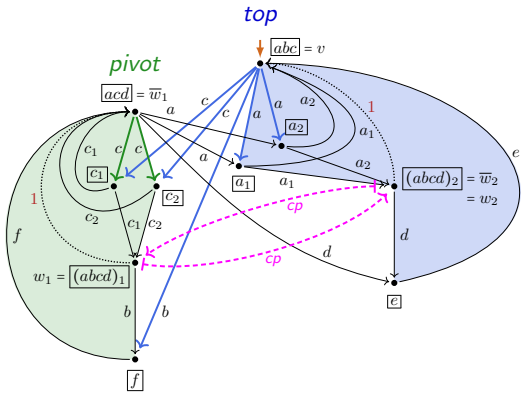
**Theorem (current work)**

Loop elimination is confluent. LEE can be recognized in polynomial time.

**Corollary**

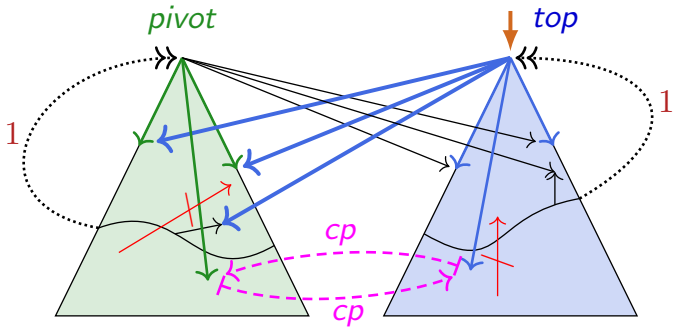
Expressibility of process graphs by 1-free under star regular expressions
is decidable in polynomial time.

# General answer (promising more efficient recognition)




twin-crystal

crystallized




## Answer to Refined Question (consequence of [LICS 2022])

Expansion into a crystallized process graph (with LEE)
characterizes bisimulation-collapsed process graphs that are expressible.

## Questions

Complexity of:

(i) Refinable by adding 1-transitions to obtain LEE? (likely polynomial)

(ii) Expansion into a crystallized process graph? (perhaps FPT result)

(iii) Expressibility? (same as (ii), due to answer above)

# Resources

resources:

- https://clegra.github.io/lf/
  - overview article: DCM-2023-proc.pdf
  - slides pitch: pitch-CS-retreat.pdf
  - poster crystallization: poster-lics-2022.pdf

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**Thank you for your attention!**