Soufflé in the Cloud

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THE UNIVERSITY OF SYDNEY

Soufflé in the Cloud provides the automatic synthesis of cloud services from logic programs.

Contribution

- **Programs become totally independent cloud systems.**
- Programs transformed to execute as concurrently as possible.
- Fully automated, no difference in how programs are written.
- No other system can do logic program to cloud service synthesis.

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Cloud Services

Logic Programs

separation of concerns

cost effective

✓ massive scalability

robust & reliability

expertly optimized

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Logic Programs

language simplicity
available concurrency
speed & efficiency
mathematical basis
correctness & verifiability

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limited optimization
network bottleneck
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lack of paradigms
self-hosted expenses
single-machine execution
system dependent behaviour
implementation specifics

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Cloud Services		Logic Programs
separation of concerns	$\longrightarrow$	lack of paradigms
cost effective	$\longrightarrow$	self-hosted expenses
massive scalability	$\longrightarrow$	single-machine execution
robust & reliability	$\longrightarrow$	system dependent behaviour
expertly optimized	$\longrightarrow$	implementation specifics
service complexity	$\longleftarrow$	language simplicity
limited optimization	$\longleftarrow$	available concurrency
network bottleneck	$\longleftarrow$	speed & efficiency
no standardisation	$\longleftarrow$	mathematical basis
difficult to analyse	$\longleftarrow$	correctness & verifiability

Soufflé
(Logic Programs)

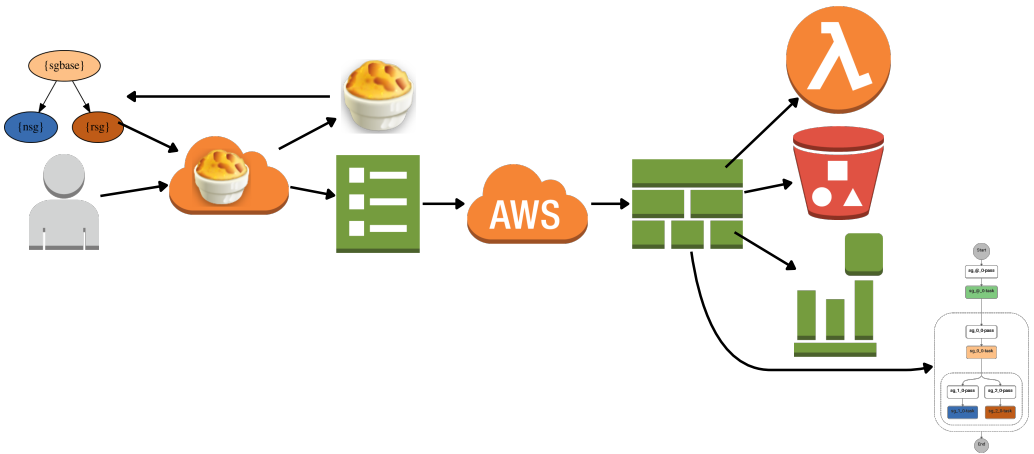
+

The Cloud
(Amazon Web Services)

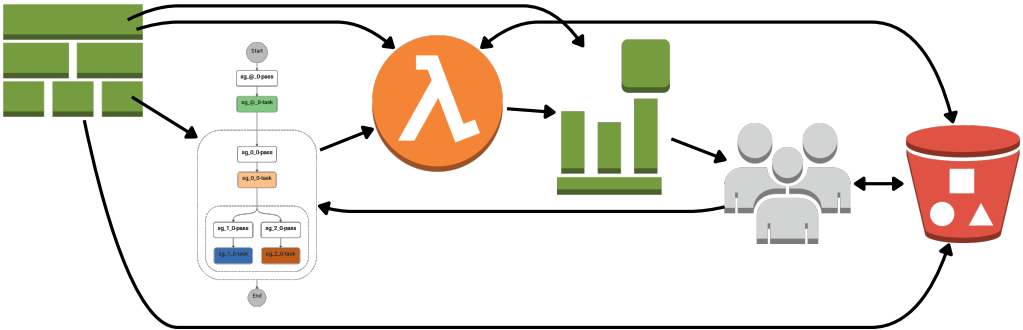
=

Soufflé in the Cloud

Creating a Service

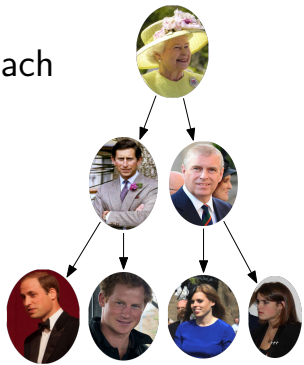


Using a Service



Same Generation Example

Concept Given a family tree, the people at each level are of the same generation.



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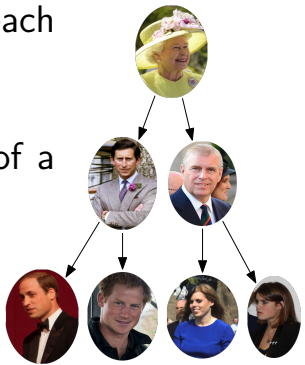
Problem Find all "same generation" vertices of a graph.



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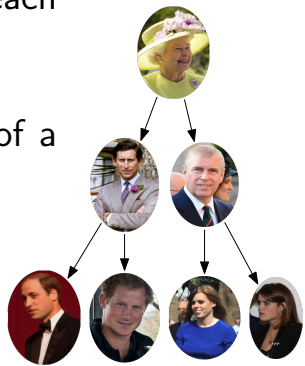

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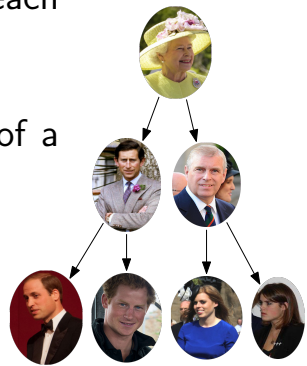
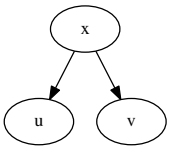


u and v are of the *same generation* if

- x is parent of u
- x is parent of v



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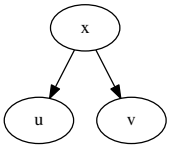
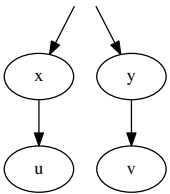


or

- x is parent of u
- y is parent of v
- x and y are of same generation



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.input sgbase
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// Base Relation
.input sgbase
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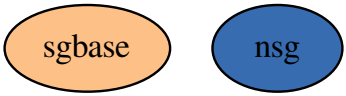

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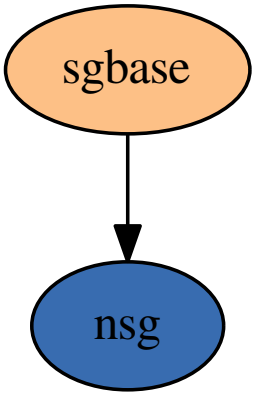

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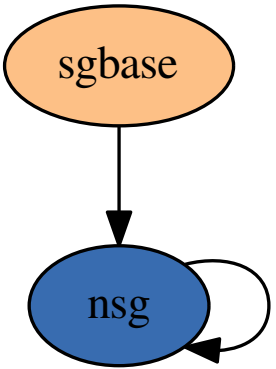

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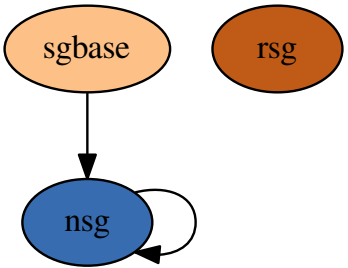

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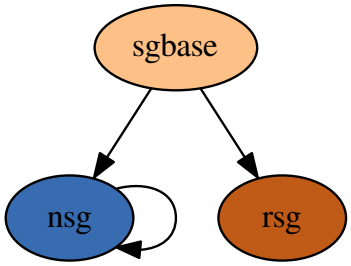

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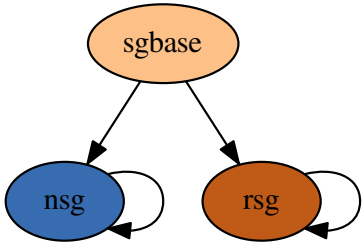
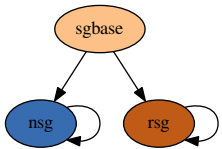
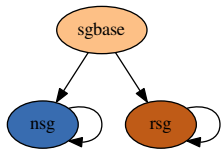


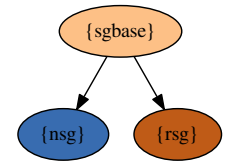
Precedence Graph



1. Obtain dependencies of program.

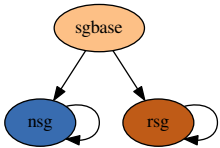
Precedence Graph $\longrightarrow$ Strongly-Connected Component Graph

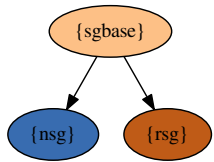


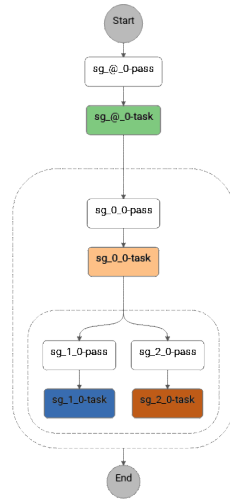


1. Obtain dependencies of program.
2. Contract cycles to sets.

Precedence Graph ⟶ Strongly-Connected Component Graph ⟶ AWS StateMachine







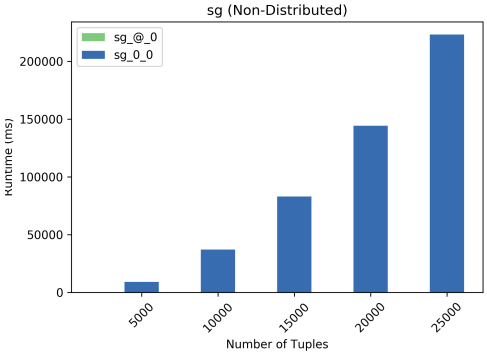
1. Obtain dependencies of program.
2. Contract cycles to sets.
3. Convert to execution template.

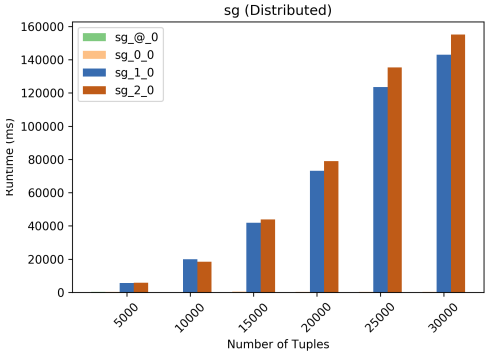
Subprograms as Actors

- ⋆ Subprogram become actors.
- ⋆ Actors communicate by message passing.
- ⋆ Models only actors, acts, and messages.

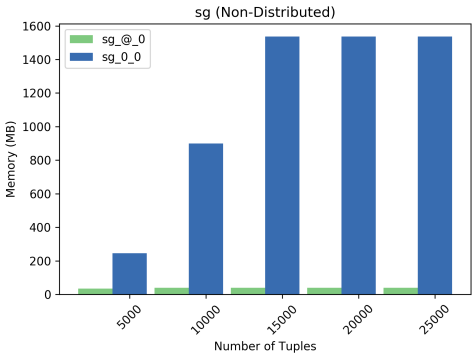
- No global locks.
- Localised coordination.
- Earliest possible execution.
- Minimal communication.
- Reduced overhead.
- Power by model simplicity.

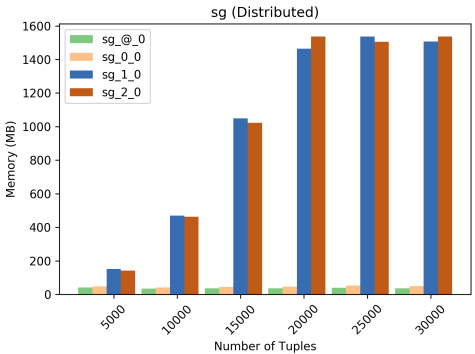
Runtime of Same Generation



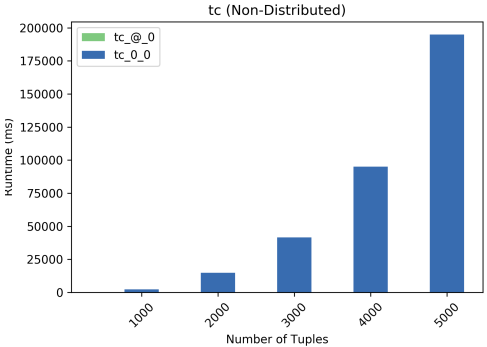


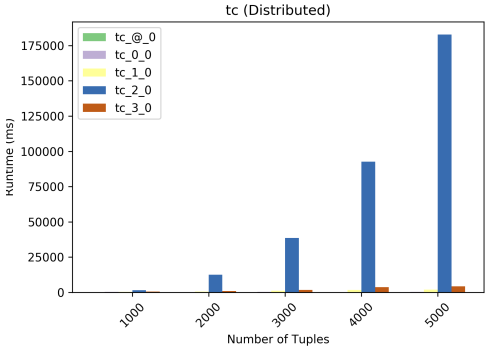
Memory of Same Generation





Runtime of Transitive Closure





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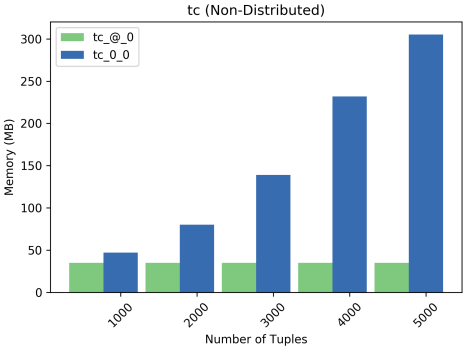
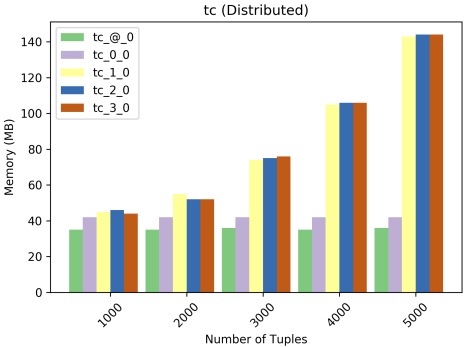


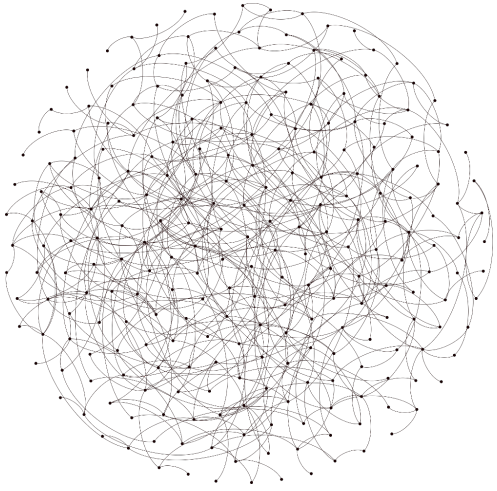


Experiments & Results

Same Generation	Exponential 2^{14}	Distributed	62.85s	1287MB	−32.22s	66%
		Non-Distributed	95.06s	1571MB	−284MB	82%
	Linear 25×10^3	Distributed	135.95s	1628MB	−87.13s	61%
		Non-Distributed	223.08s	1576MB	+52MB	103%
Transitive Closure	Exponential 2^{12}	Distributed	103.10s	192MB	−14.68s	88%
		Non-Distributed	117.78s	284MB	−92MB	68%
	Linear 5×10^3	Distributed	183.24s	222MB	−11.73s	94%
		Non-Distributed	194.97s	340MB	−118MB	65%

Summary of Findings

- Generally more performant in runtime & memory than Soufflé.
- Limited by resources available to AWS Lambda, Soufflé is not.
- Longest duration subprograms are greatest bottleneck.



https://github.com/souffle-lang/souffle

https://github.com/lyndonhenry/souffle-in-the-cloud