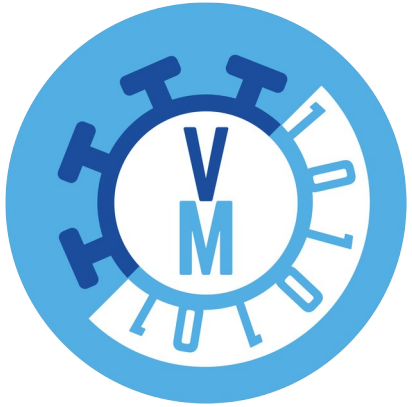
The power of Virus Machines

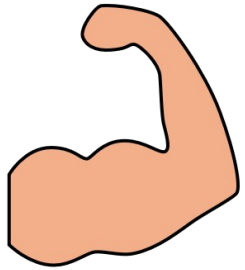
Antonio Ramírez de Arellano Marrero



Research Group on Natural Computing

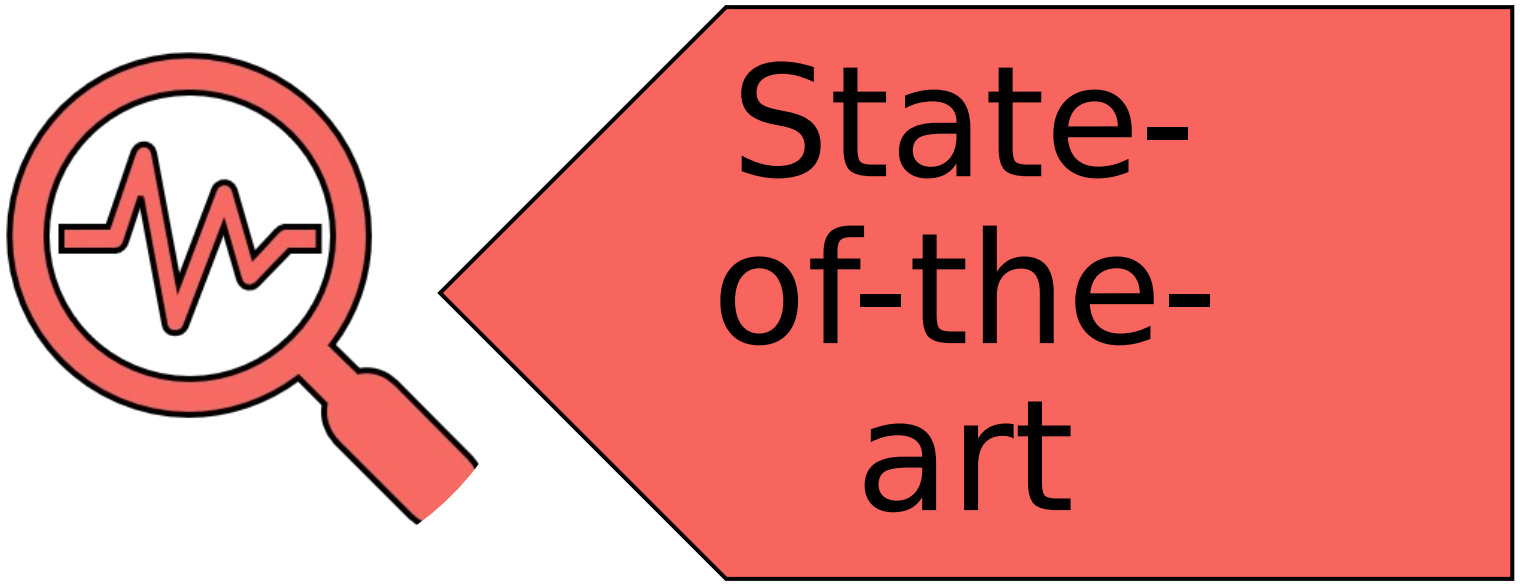
21st BWMC

State-of-the-art



New power! Generating strings

Pathways for collaborations


State-
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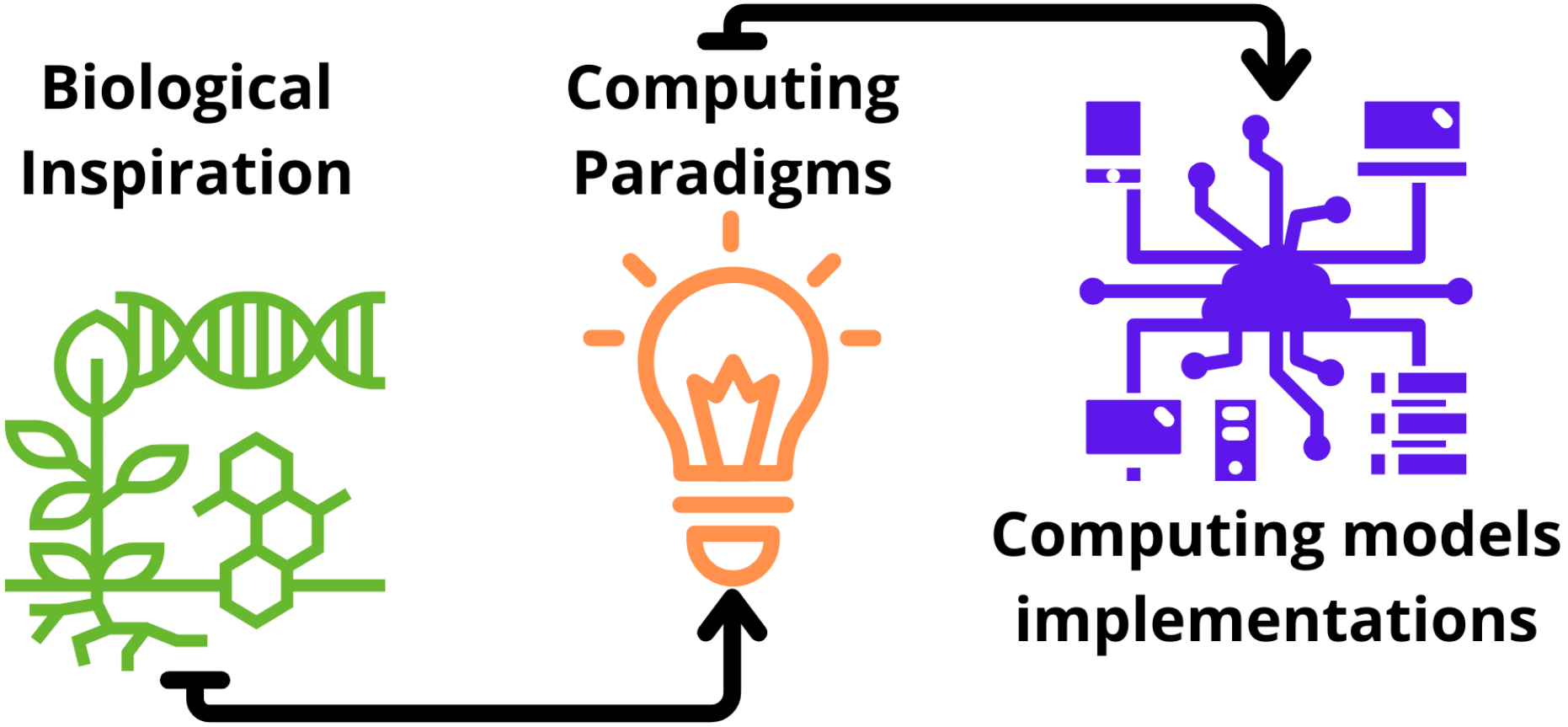
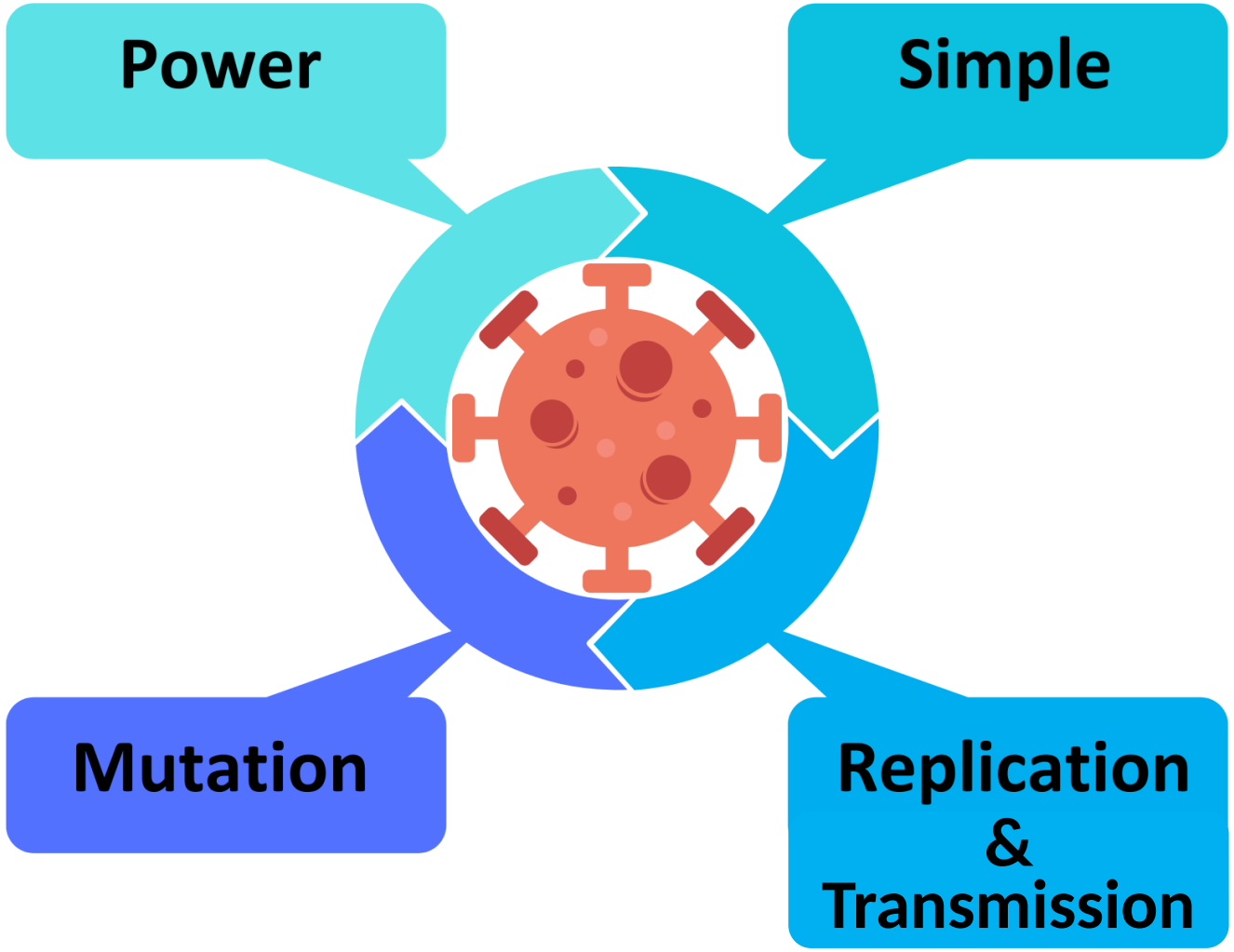
Natural Computing



Inspiration: Biological Viruses

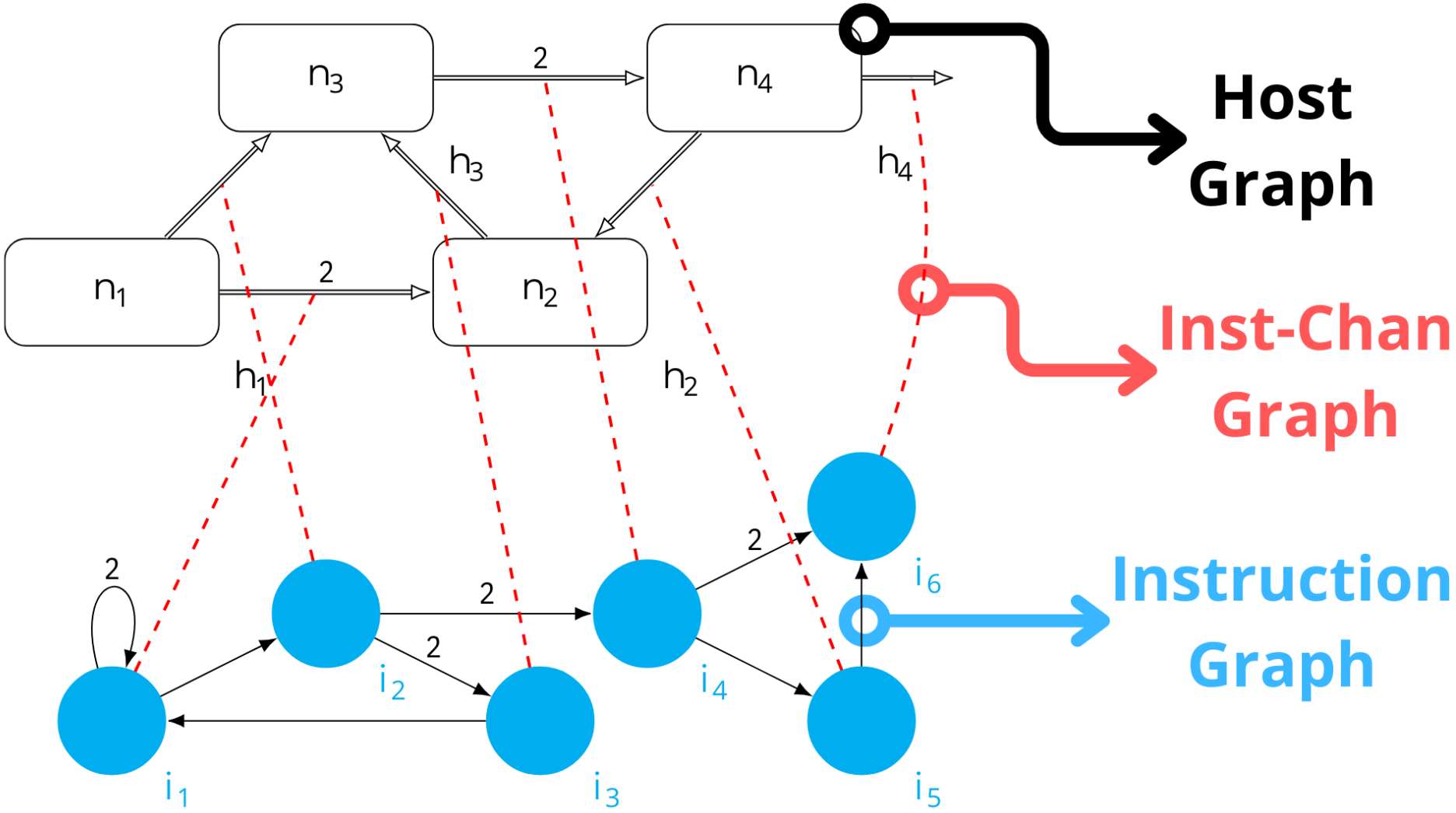


Virus Machine (VM) of degree (p,q)

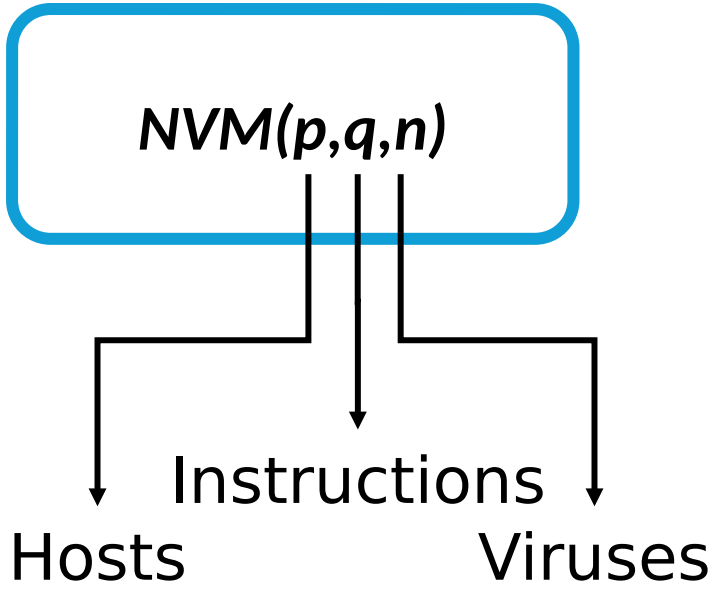
$$\Pi = (\Gamma, H, I, D_H, D_I, G_C, n_1, \ldots, n_p, i_1, h_{out})$$

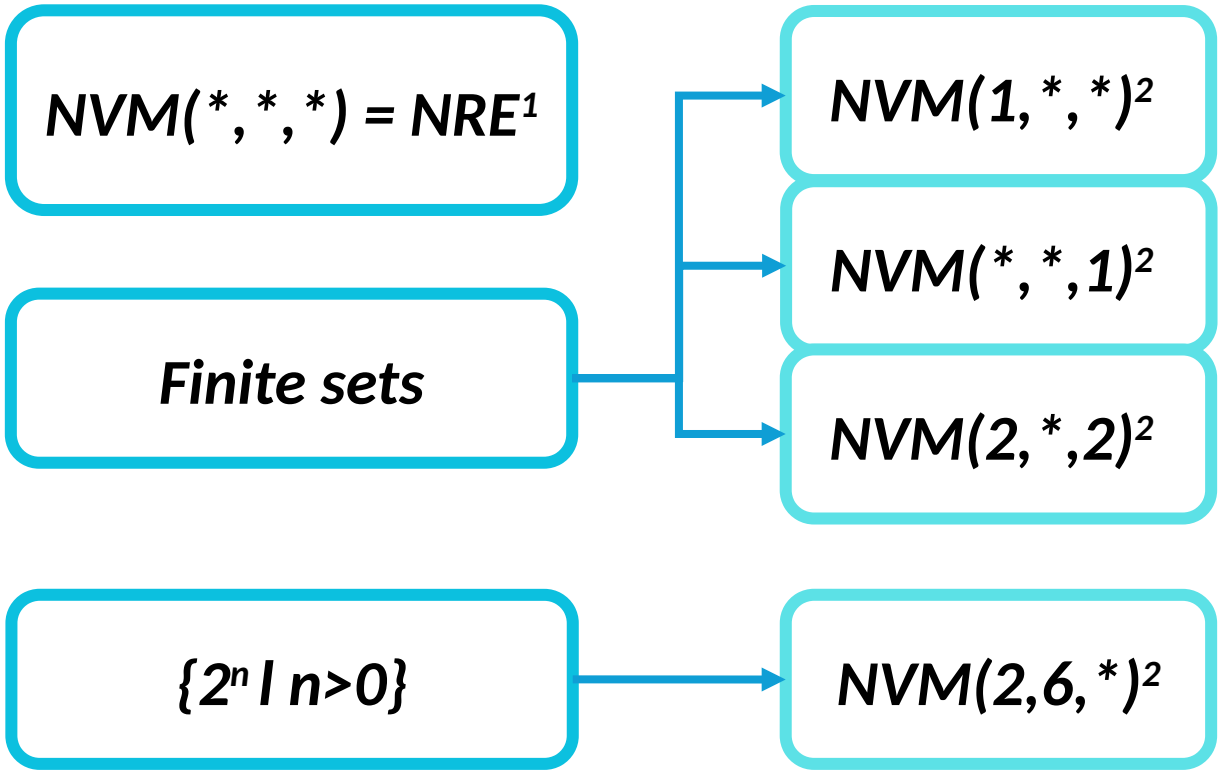
1. L. Valencia-Cabrera, M.J. Pérez-Jiménez, X. Chen, B. Wang, X. Zheng. et al. **Basic virus machines**. *CMC16*, 2015, Valencia, Spain.

Virus Machine of degree (4,6)



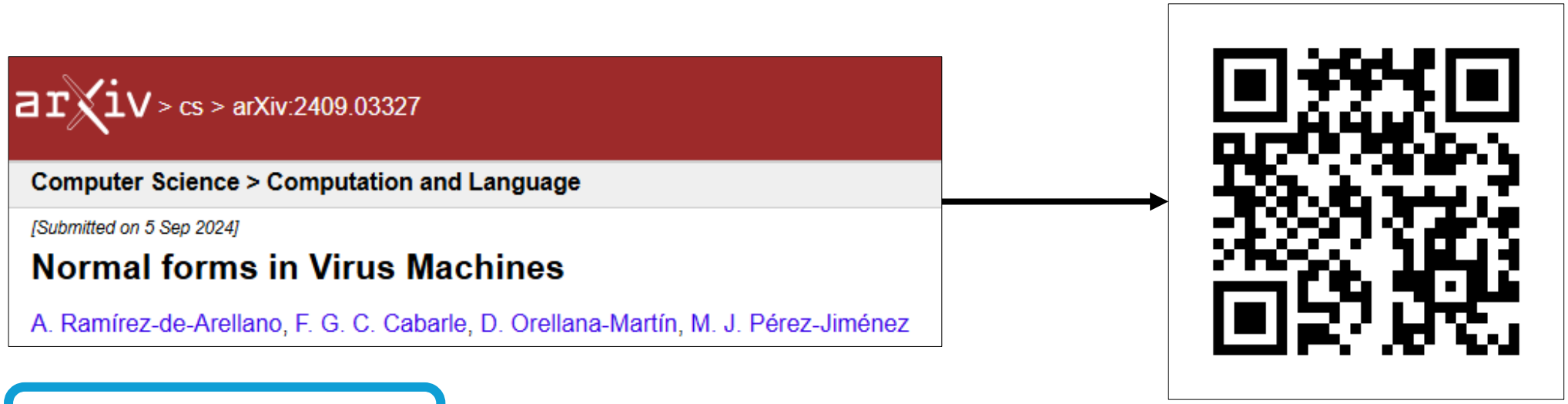
The power of VM
Generating sets of natural numbers





1. X. Chen, et al. **Computing with viruses**. *Theoretical Computer Science*, 623 (2016).
2. A. Ramírez-de-Arellano, et al. **Generating, Computing and Recognizing with VM**. *Theoretical Computer Science*, 972(114077), (2023).

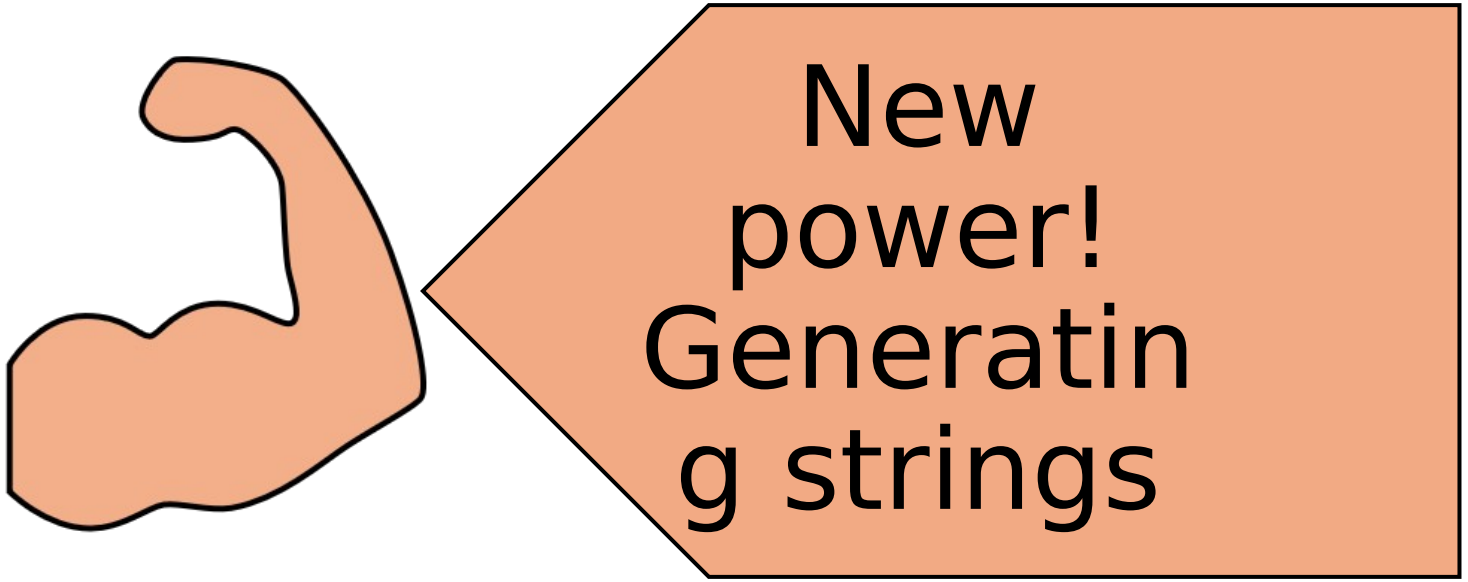
What if the topology matters?



Limitations

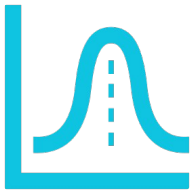
1. The biggest loops in the instruction or/and host graphs
2. Bijection between channels and hosts
3. Weight of the channels
4. Out-degree of each host in the host graph

Normal forms


New
power!
Generatin
g strings

New power: Generating Strings

Semantics



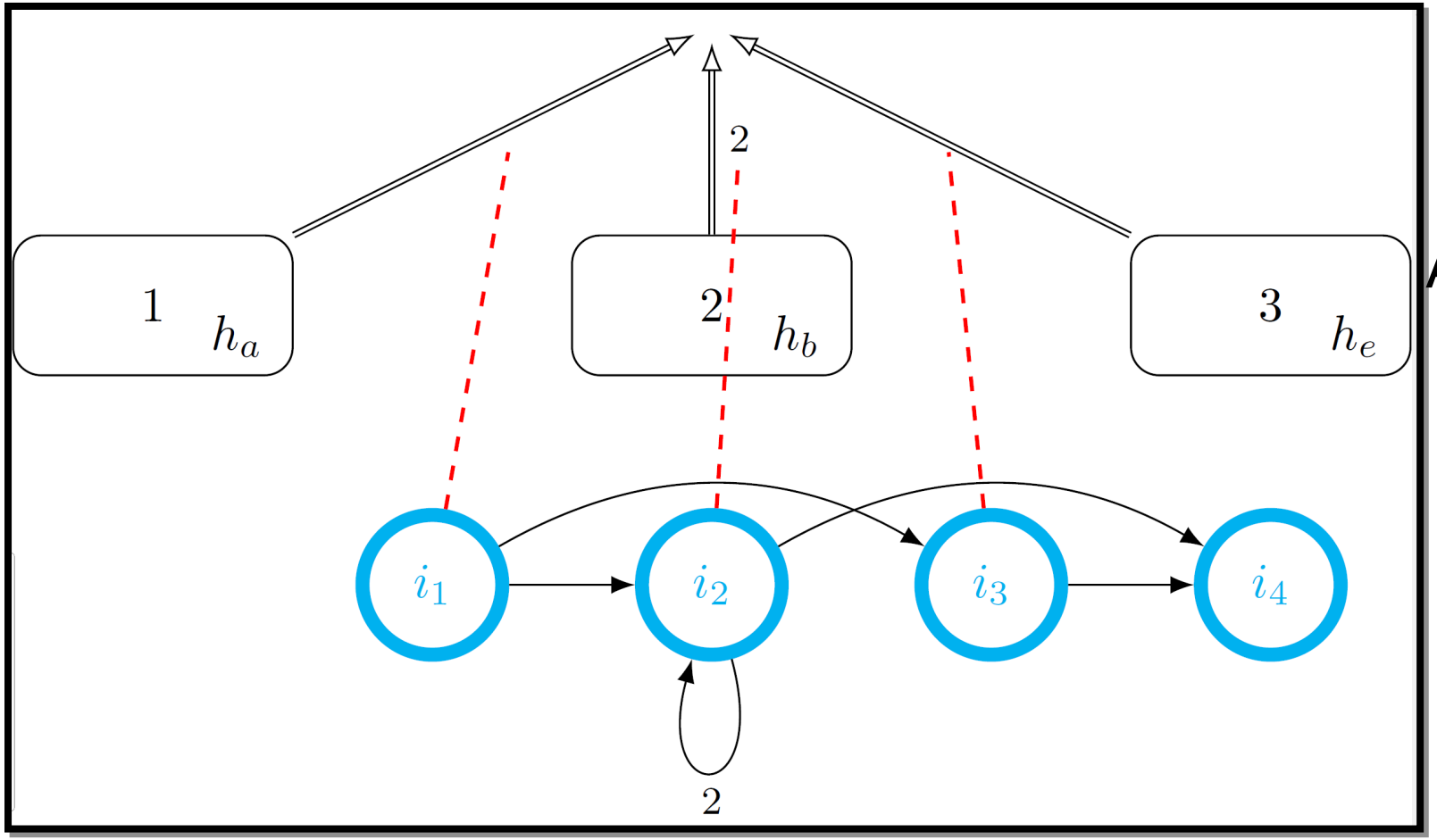
“standard form”

Scope: regular expressions

Semantics

- Let the finite alphabet **Σ**, a VM in generating strings mode of this alphabet will have labeled each host to a one element of **Σ**, including the empty string.
- Let L(**Π**) the set of strings generated by VM **Π**.
- Let LVM(p,q,n) the class of languages generated by VMs with the usual limitations.

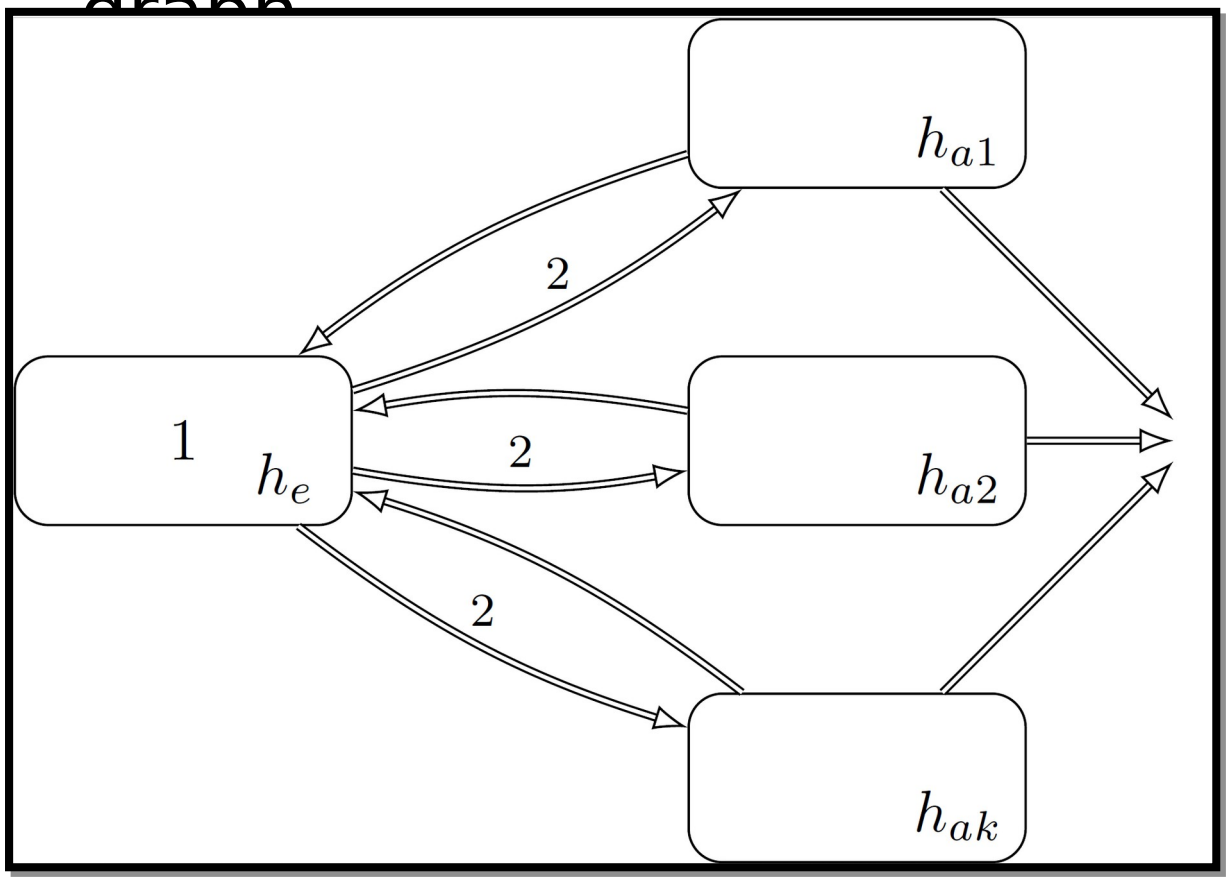
An example



A VM of degree (3,4) that generates {a,abbbb,a}

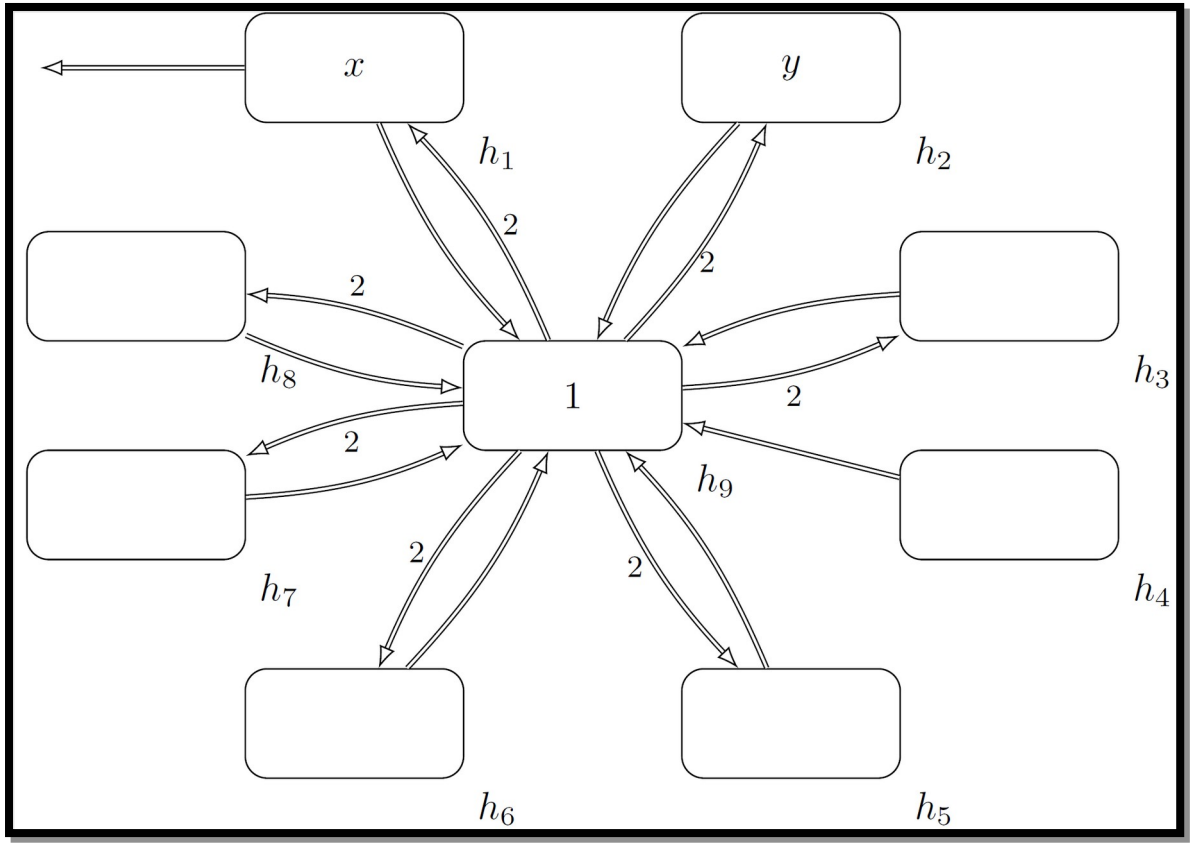
Standard form

- Fix the topology of the host graph



- Initial instruction is i_1 and there is only one halting instruction i_{halt} .
- In the halting configuration h_e only has one host and al the other host must be empty.

“Standard” seems to be a good name



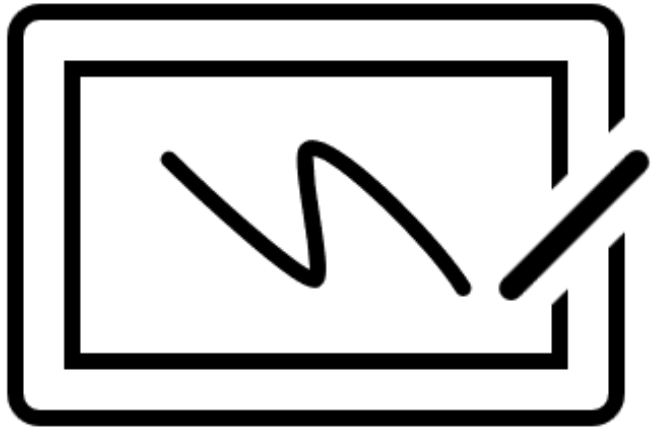
Host graph of a small universal VM[1]

It is a standard form!

1. A. Ramírez-de-Arellano, et al. **Using VM to compute Pairing functions**. *Int. Journal of Neural Systems*, 33(05), (2023)

over a finite alphabet if

1. $\emptyset$
2. ε
3. $\{a\}$
4. $r_1 r_2$ (Concatenation)
5. $r_1 \cup r_2$ (Alternation)
6. r^* (Kleene star)



Let’s go to the blackboard!

Pathways for collaborations

A new field of exploration

Characterization of REG by VM

Normal forms

Can we skip the “standard form”

Variants of VM

Thank you

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