A Hands-on Introduction to the CnC Programming Model

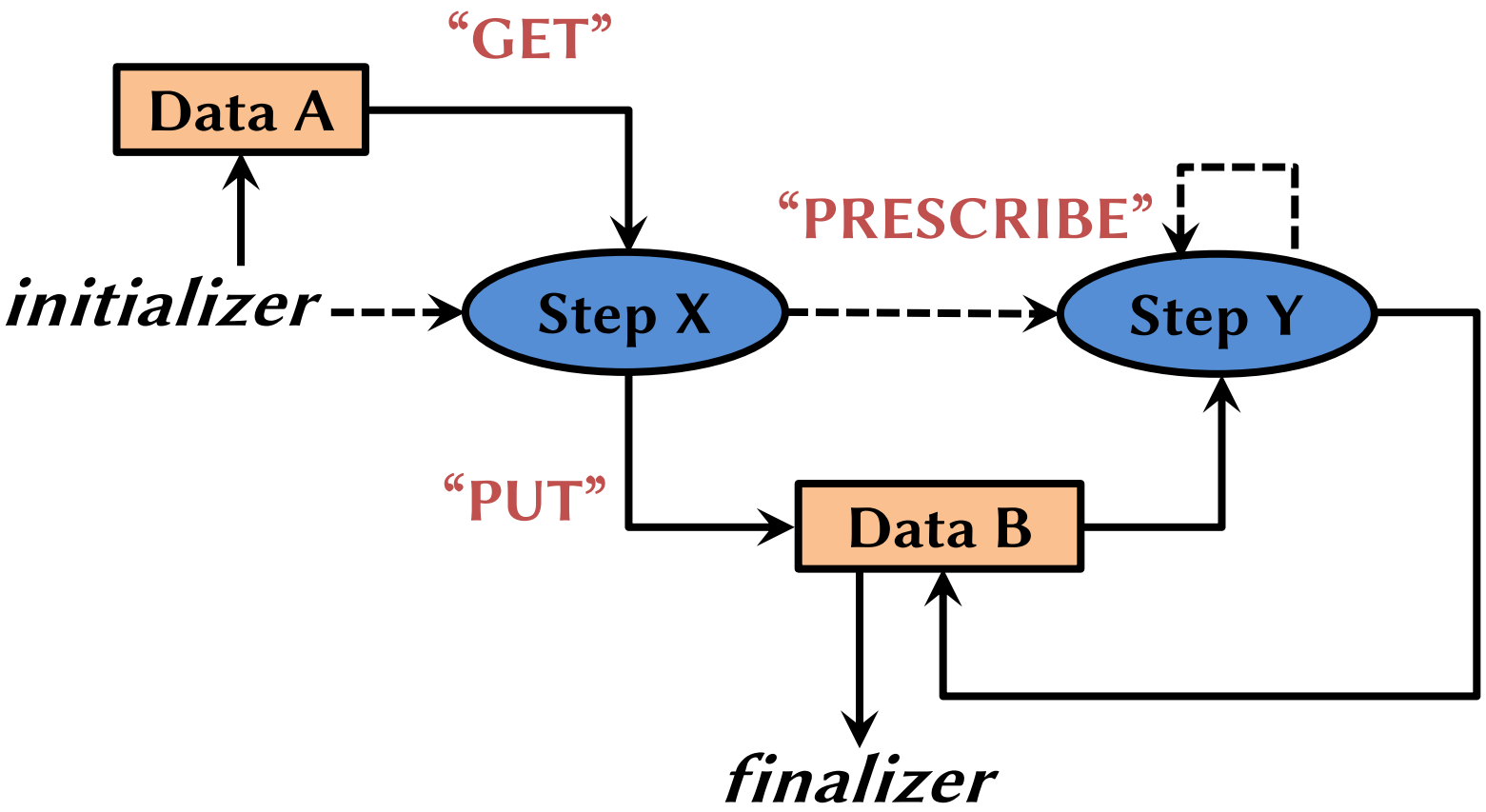
Nick Vrvilo, Two Sigma Investments
nick.vrvilo@twosigma.com

9th Annual Concurrent Collections Workshop
Texas A&M University – College Station, TX
October 13, 2017

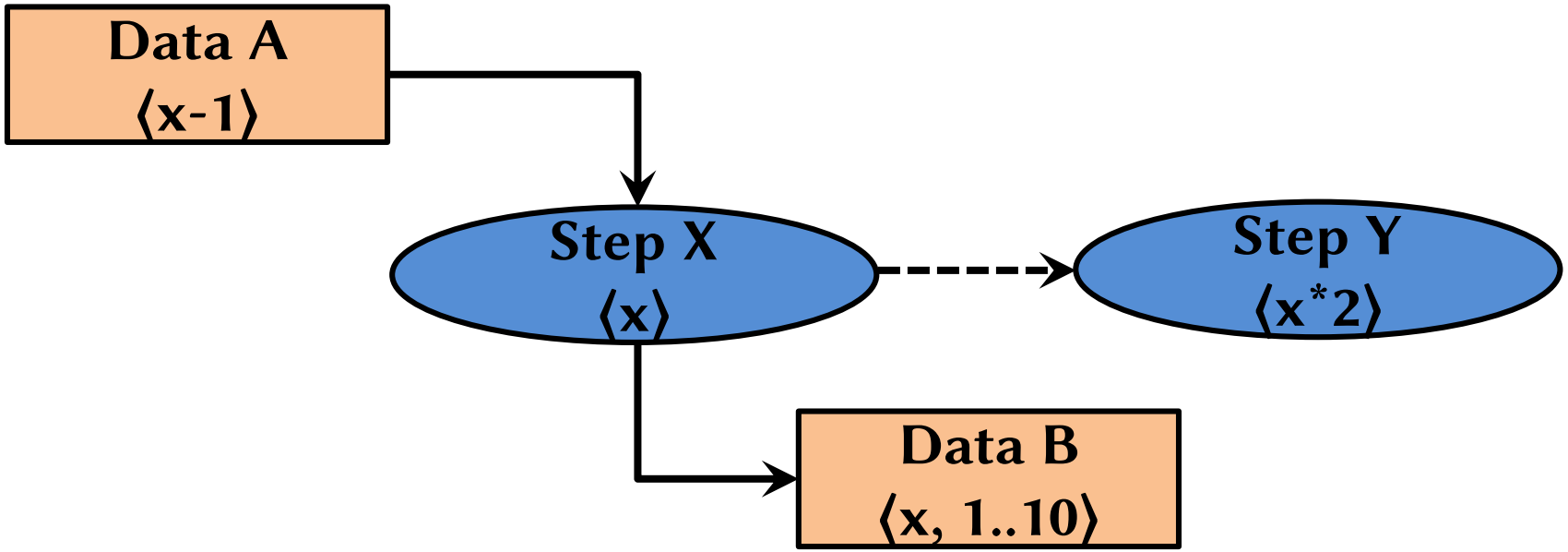
The CnC programming model

- Programming model (not a language)
- Graph coordination
  - Declare data ***items*** and computation ***steps***
  - Similar computation/data instances grouped into *collections*
- Data items use *single assignment*
  - A given item's value cannot be updated
- Step functions written in host language

Simple CnC graph sketch

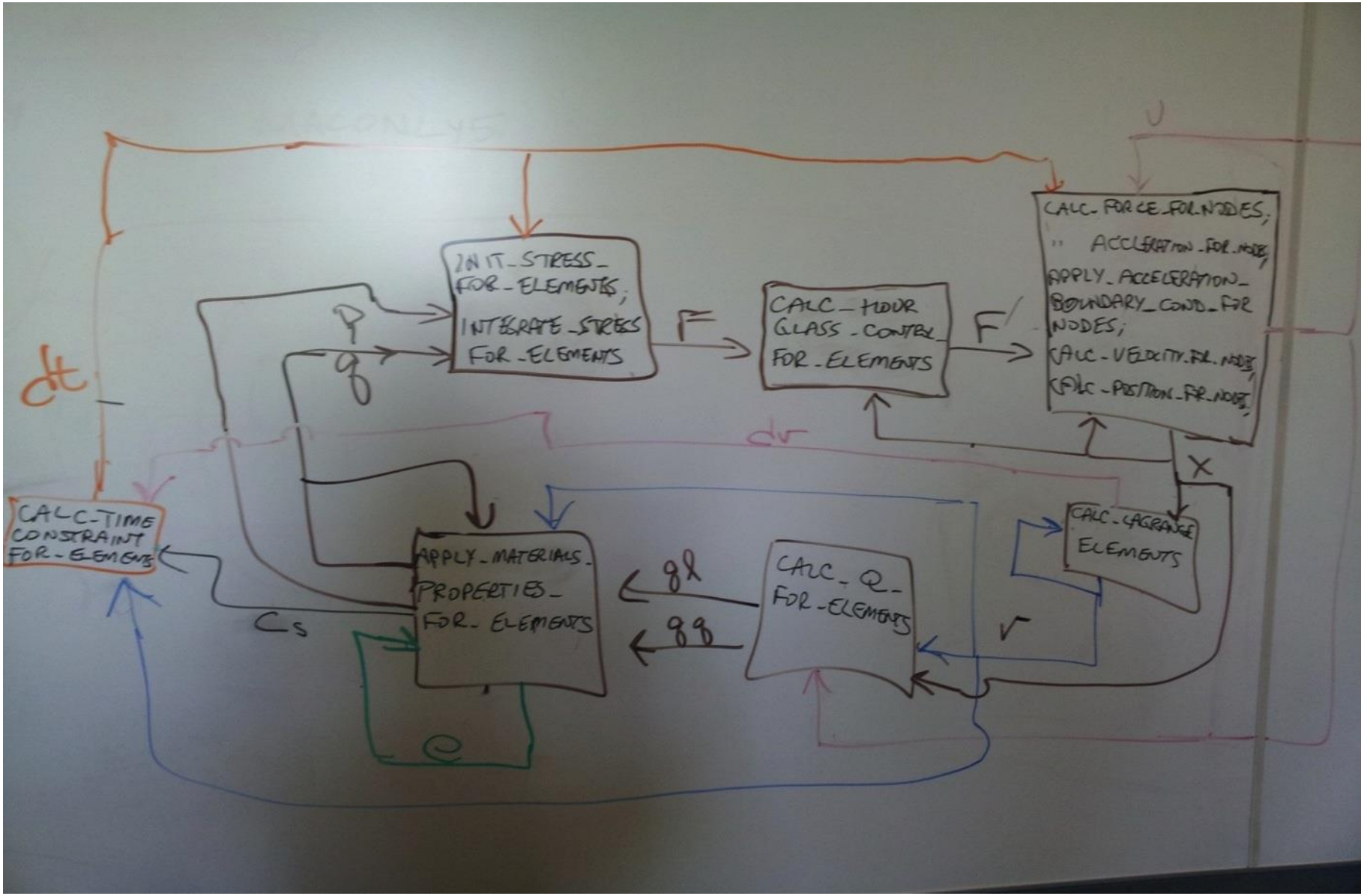


CnC input/output relations
(“tag functions”)

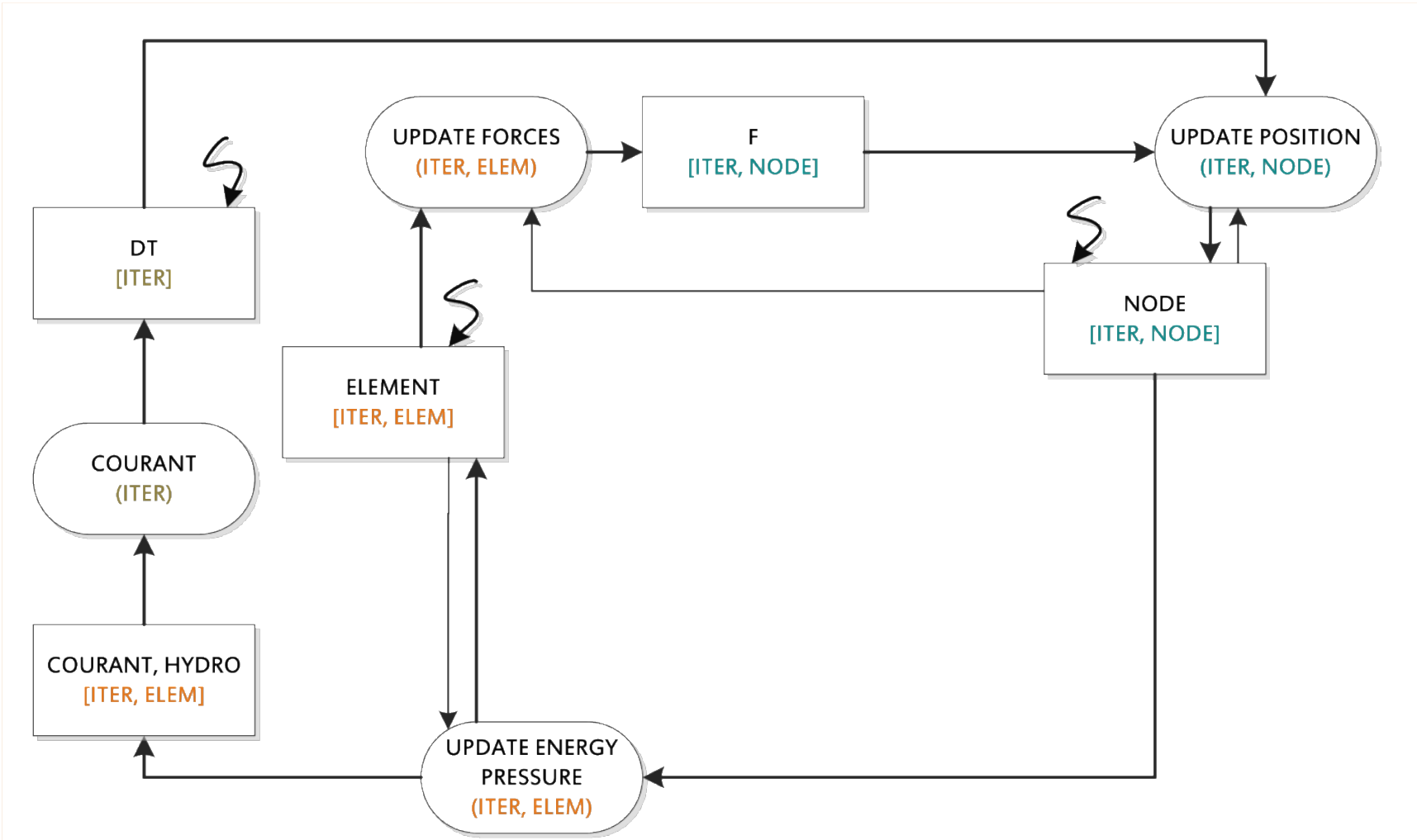


Benefits of the CnC model

- Collection relationships are *declarative*
- Exposes implicit parallelism
- Program structure follows naturally from the "whiteboard" design process



Thanks to Kath Knobe for this LULESH sketch



Thanks to Ellen Porter for this LULESH graph

CnC-OCR workflow

1. Specify CnC graph
   - Currently in text form
   - Ideally provide a graphical tool
2. Run graph translator tool
   - Parses the textual graph specification
   - Provides step function skeleton (suggested code)
   - Generates makefile, scaffolding code
3. Implement step function bodies
4. Compile and run the application

Hands-on example

3-point 1D stencil

Stencil description

- 3-point stencil over a vector of size N
- $a_{i,t}$ → vector element at index i on timestep t

$$a_{0,t} = a_{N-1,t} = 1$$

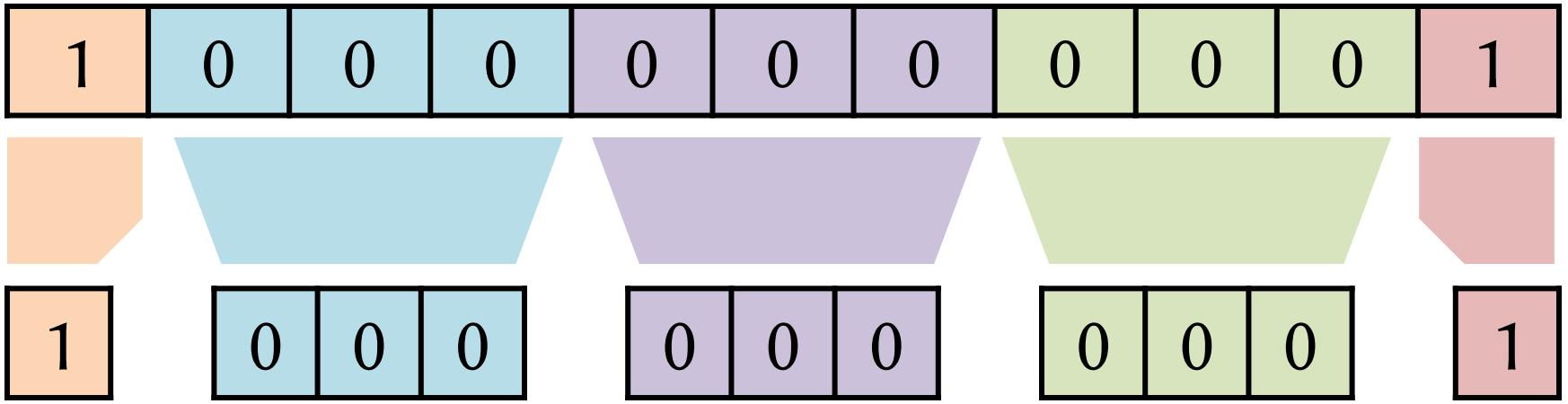
$$a_{i,0} = 0$$

$$a_{i,t} = \frac{1}{2} a_{i,t-1} + \frac{1}{4}\left(a_{i-1,t-1} + a_{i-1,t+1}\right)$$

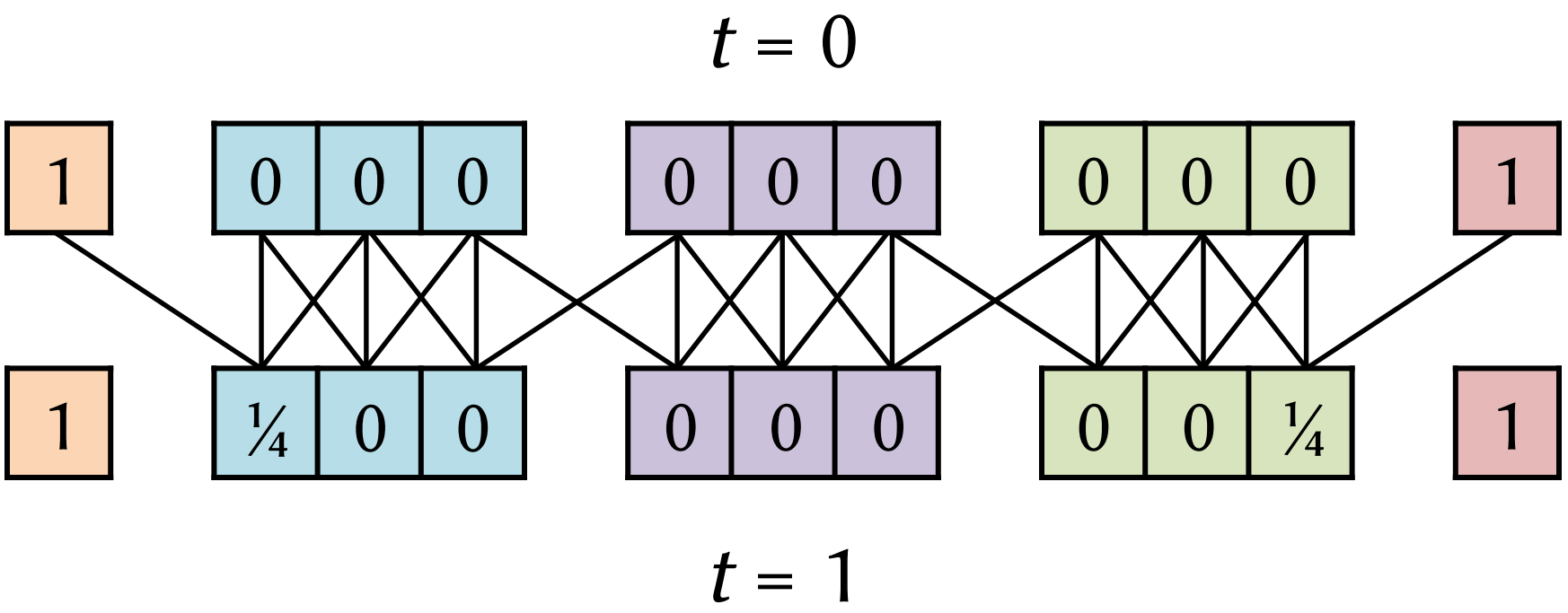
Vector at t=0

1	0	0	0	0	0	0	0	0	0	1

Tiling the vector



Calculating values for t=1

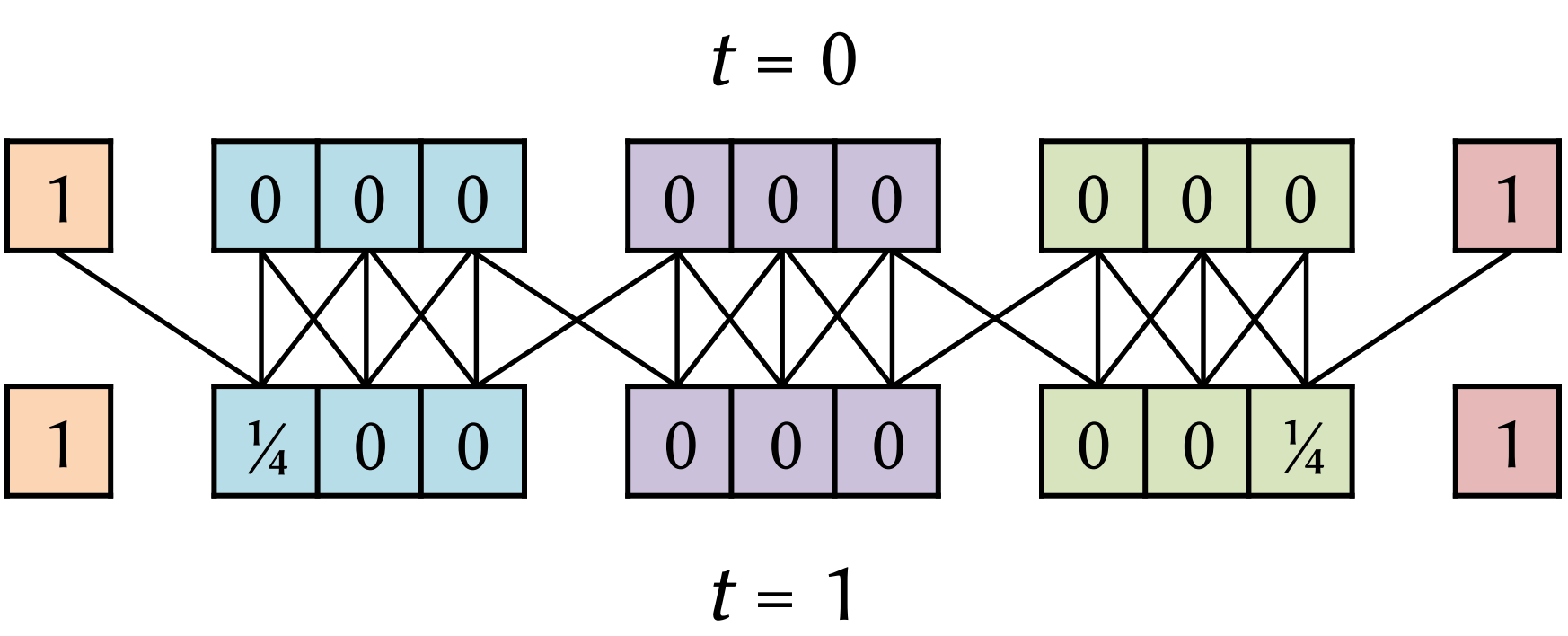


Time to code!

1. Install Intel CnC:
   https://icnc.github.io/

2. Install the Habanero CnC Framework:
   https://github.com/habanero-rice/cnc-framework

3. Get CnC Framework dependencies
   (just run the translator tool: *ucnc_t*)



$$a_{0,t} = a_{N-1,t} = 1$$

$$a_{i,0} = 0$$

$$a_{i,t} = \frac{1}{2} a_{i,t-1} + \frac{1}{4}\left(a_{i-1,t-1} + a_{i-1,t+1}\right)$$