

# **Creative Mathematical Sciences Communication**

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**ALTA ACDICT 2014**

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The image shows a browser window displaying the website csunplugged.org. The browser's address bar shows the URL and navigation icons. The website's main banner features the text 'COMPUTER SCIENCE Unplugged' in a stylized font. Below the banner, there are three main sections: a navigation menu on the left, a central content area, and a 'Get Started' section on the right. The navigation menu includes 'Home', 'Activities', and 'Books', with 'Books' selected. The central content area has a heading 'Computer Science... without a Computer!' and a sub-heading 'Free activities for classroom or home'. The 'Get Started' section has a heading 'Get Started' and a sub-heading 'Download the book'. At the bottom right, there is a small image of the book cover for 'COMPUTER SCIENCE Unplugged'.

Computer Science L x

→ ↻ 🏠 📄 csunplugged.org ☆

Log In

# COMPUTER SCIENCE Unplugged



- Home
- Activities
- Books

## Computer Science... without a Computer!

### Free activities for classroom or home

CS Unplugged is a collection of [free learning activities](#) that teach Computer Science through engaging games and puzzles that use cards, string, crayons and lots of running around.

The activities introduce students to underlying concepts such as [binary numbers](#), [algorithms](#) and [data compression](#), separated from the distractions and technical details usually associated with computers.

### Get Started

#### Download the book

Twelve of the most-used Unplugged activities, with easy instructions for use in the classroom.



Computer Sc... .htm

Show all downloads...

# ABZ ETH INTERNATIONAL MEDAL OF HONOR IN COMPUTER SCIENCE EDUCATION



**TIM BELL**



**MIKE FELLOWS**

- European Association of Theoretical Computer Science (EATCS) inaugural Fellow 2014
- THIS IS MEGA-Mathematics!

# ATTRACT MATHEMATICIANS AND COMPUTER SCIENTISTS TO DO OUTREACH

## GOALS:

Establish a new international conference series in mathematical sciences communication, Journal, YouTube and other records, new activities, possibly a certificate program.

Produce holistic, whole-body, storyfull math activities that show the ‘both-ways’ and 21st Century Competencies philosophy, and incorporate computational ways of thinking in all subjects. These will be incorporated into the PD plans.



# Computational thinking across cultures: indigenous learners

## Australian Aboriginal, Canadian Native American, Tamil Nadu

The screenshot shows a web browser window with the address bar displaying `cdu.edu.au/conference/csmaths`. The website header features the Charles Darwin University logo and the text "Parameterized Complexity Research Unit School of Engineering and IT". A search bar is present with the text "CDU Web" and "enter search term".

The main navigation menu includes links for "FPT Workshop", "Home", "Registration", "Participants", "Volunteers", "Contacts", and "News".

The main content area features a large banner with the text: "The first international conference on: **Creative Mathematical Sciences Communication** Computer Maths: Curiosity Art, Story! August 2-5 and August 6-10 Charles Darwin University, NT". The year "2013" is displayed vertically on the right side of the banner. A small caption at the bottom right of the banner reads "Image courtesy of Tourism NT".

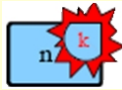
Below the banner is a secondary navigation menu with links for "Program »", "Abstracts »", "Professional Credit »", and "Sponsorship information »".

The browser's taskbar at the bottom shows the "start" button and several open applications: "ALTA\_pics", "jonathan - Mic...", "Microsoft Pow...", and "Charles Dar...". The system clock in the bottom right corner shows "12:34 A".

Our Wonderful Sponsors



# An event of the Creative Mathematical Sciences Communication Computer Maths with Art, Story, Thinking!



Conference Dates: 2—10 August  
[www.cdu.edu.au/conference/csmaths](http://www.cdu.edu.au/conference/csmaths)

MULTISENSORY LEARNING  
MAKE THE ABSTRACT  
CONCRETE

## FAMILY MATH NIGHT

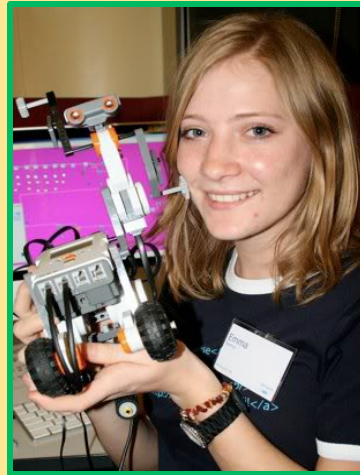
### MATH ON THE GREEN

**FREE** to the community Welcome

Bring the family for a Walkabout on the SORTING NETWORK. Play with ROBOTS, symmetry with GIANT KNOTS, the ROUTING GAME, CASINO PROBABILITY, MORE Explore outdoor Math.

PLACE: Charles Darwin University, Casuarina  
On the grassy lawn in front of Purple 12

DAY: Friday, 2 August TIME: 5:30—7:30 pm



*Robogals CEO, Nicole Brown  
would like to establish  
Chapters in Darwin and NT. Come  
meet Nicole.*

From Kinder to graduates,  
interesting and vital maths for all ages

*The Sorting Network in action  
Computer Science Unplugged!  
[www.unplugged.org](http://www.unplugged.org)*

### Math With Motion and Dance ERIK STERN WORKSHOP

Teaching cross-discipline?  
Music, sports, writing, dance,  
science, VET and math?

**This Is For You.**







Establish relationships

Prototype Activities







Professional Development

Summer Camps in  
Darwin and Alice



# OUTCOMES ARE INTERNATIONAL

Street Theatre in Frankfurt, Germany Banking District,  
Verena Specht-Ronique

Do not be  
So sure  
You know  
What is  
Behind the clothes.



# OUTCOMES ARE INTERNATIONAL

Learning Connexion Art Academy, Wellington NZ.  
*One of the big things is connectedness. STEAM is about re-connecting the parts (and the conference was a manifestation of STEAM).* Jonathan Milne, Director

New accredited program in creative thinking/maths



[Second International Conference on Creative Mathematical Sciences](#) in Chennai, India from 9–12 December 2014. Professor Ramaswamy Ramanujam (Jam) , Professor of Computer Science at the prestigious Institute for Mathematical Science Chennai (IMSC) is our local host.



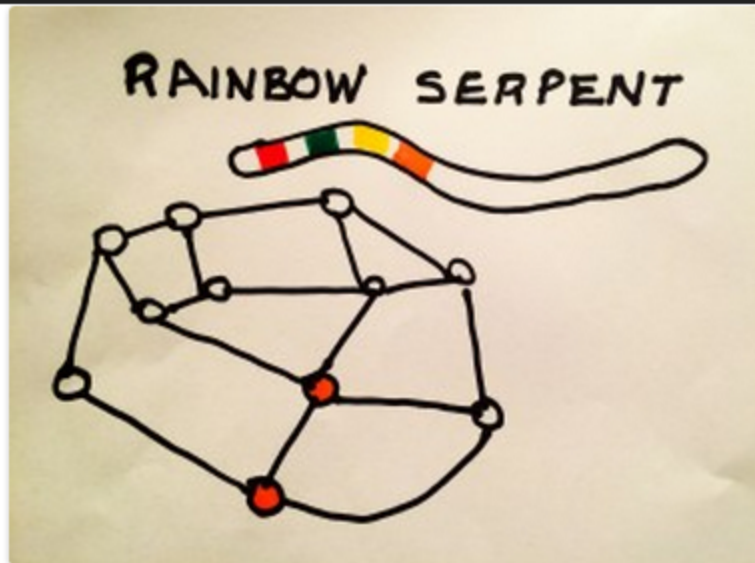
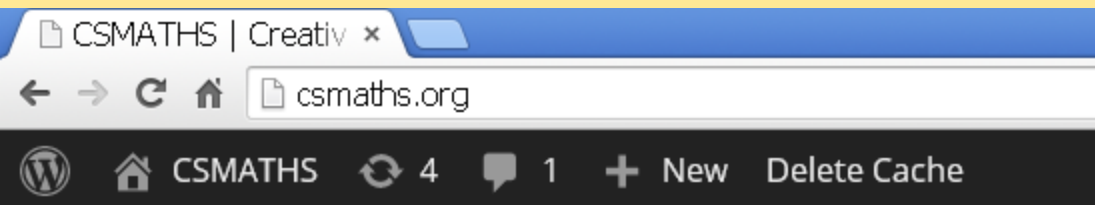
Join the conference in December in India.

# NEW RESOURCE: WWW.CSMATHS.ORG

## NEW ACTIVITIES

START WITH MATH –  
CONNECT TO  
CULTURE AND STORY

START WITH STORY---  
CONNECT TO MATH



by Mike Fellows and

Frances Rosamond

Colouring a graph properly (no adjacent vertices can receive the same colour) is important in scheduling (classrooms, jobs, exams, resources).



A close-up photograph of a green tarp. The tarp is covered with a network of brown and red striped straps. At the intersections of these straps, there are yellow reflective patches. The tarp has a wrinkled texture. In the center, there is a yellow rectangular box containing the text "NOW LETS GO TO TARPS IN ACTION".

**NOW LETS GO TO  
TARPS IN ACTION**

# Represent algorithms by concrete constructions

Start with a physical, concrete  
experience and progress it  
to the textual format of  
modern programming  
languages



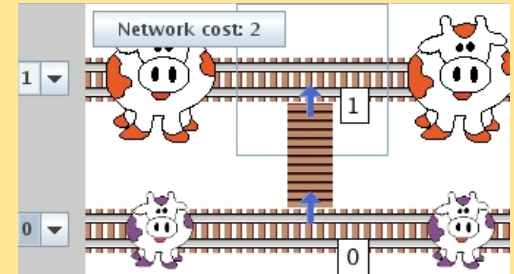
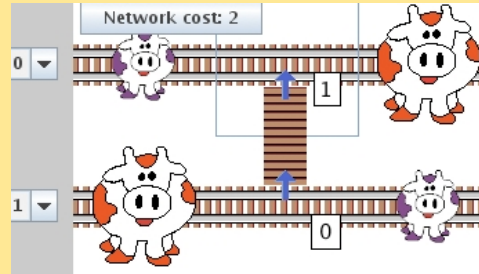
# Problem Solving in IT by

- *Constructivism*
- *Situated learning*
- *Collaborative learning*
- *A program of staged activities*
- *Concrete operations moving quite Piagetingly through to an informed and abstracted familiarity.*
- *Strengthen students' building schemata by associating their action with appropriate language for its labelling and discussion.*

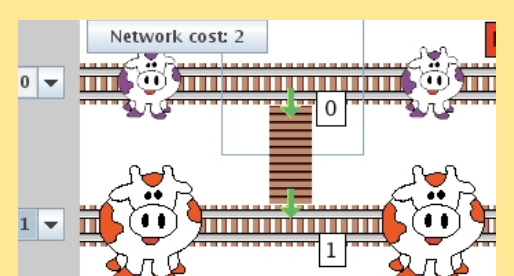
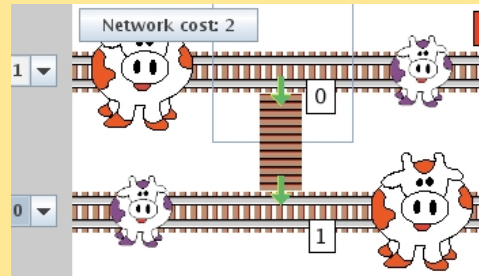


# The sorting bridges / gates --- building blocks

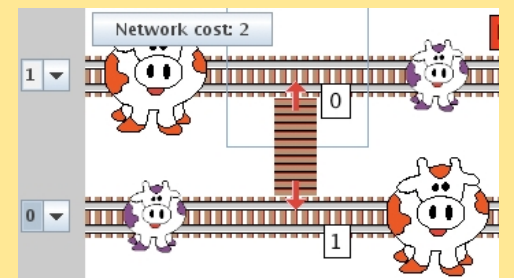
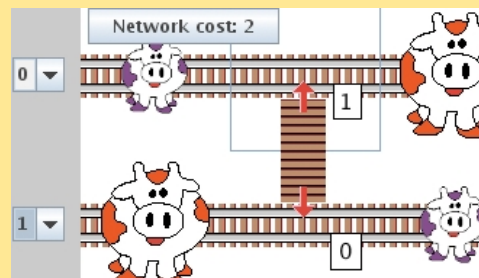
BLUE places larger up



GREEN places larger down



RED always swaps

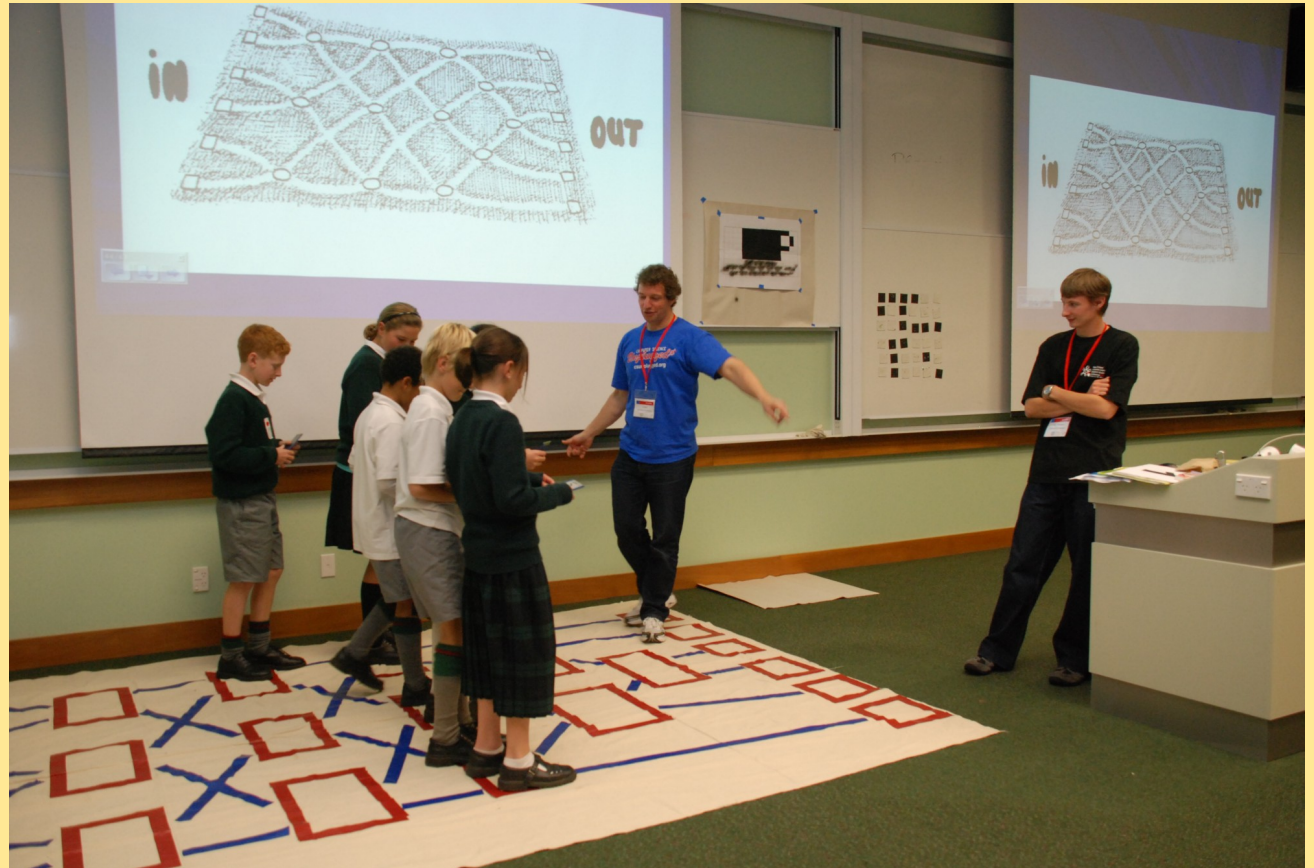


# The problem (s)

- Build rail/gate/ bridge structures that sort
  - Find the largest cow
  - Find the smallest cow
  - Find the largest and the smallest
  - Sort the cows in ascending order
- Parameters
  - Size of network
  - Type of bridges
  - Cost of bridges

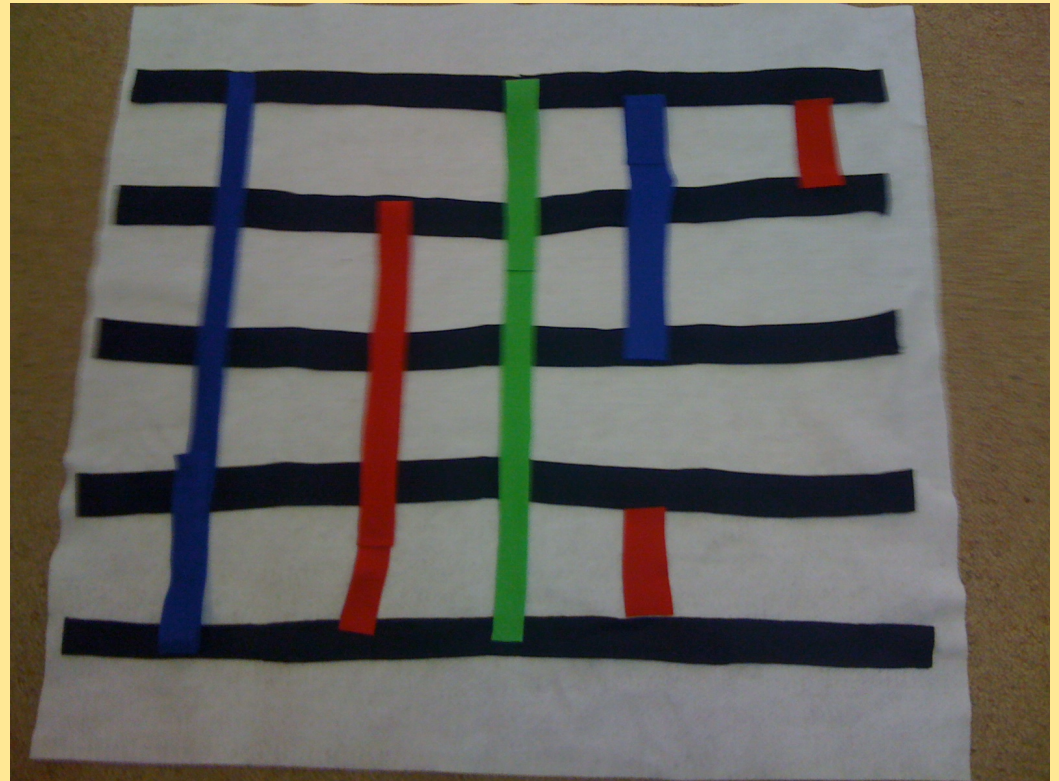
# Stage 1:

- The physical experience

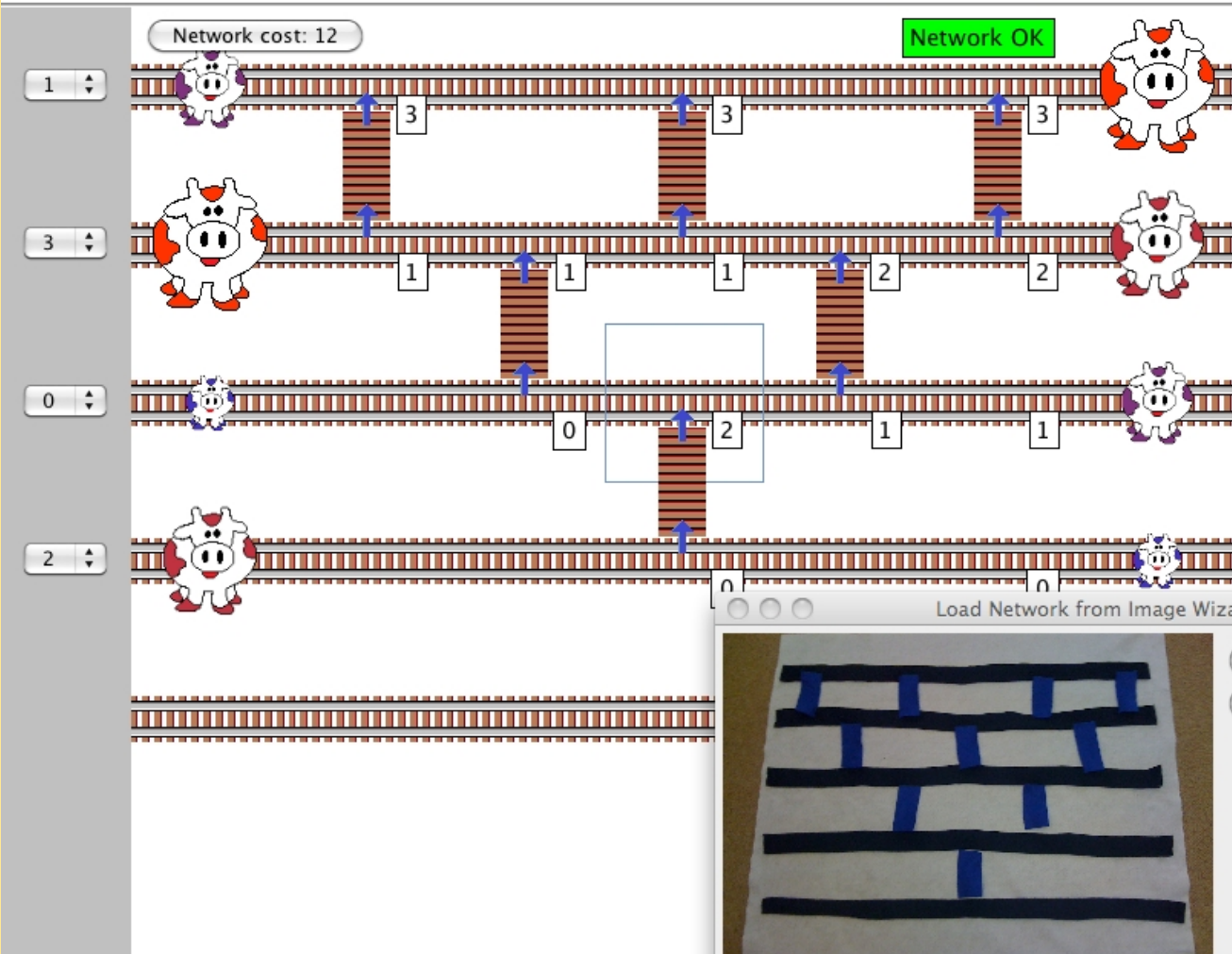


# Stage 2:

- Construct the networks for several problems and experiment, evaluate, interact







- Run Simulator
- Next Fail
- Next Permutation
- Random Permutation

Simulator not yet run.

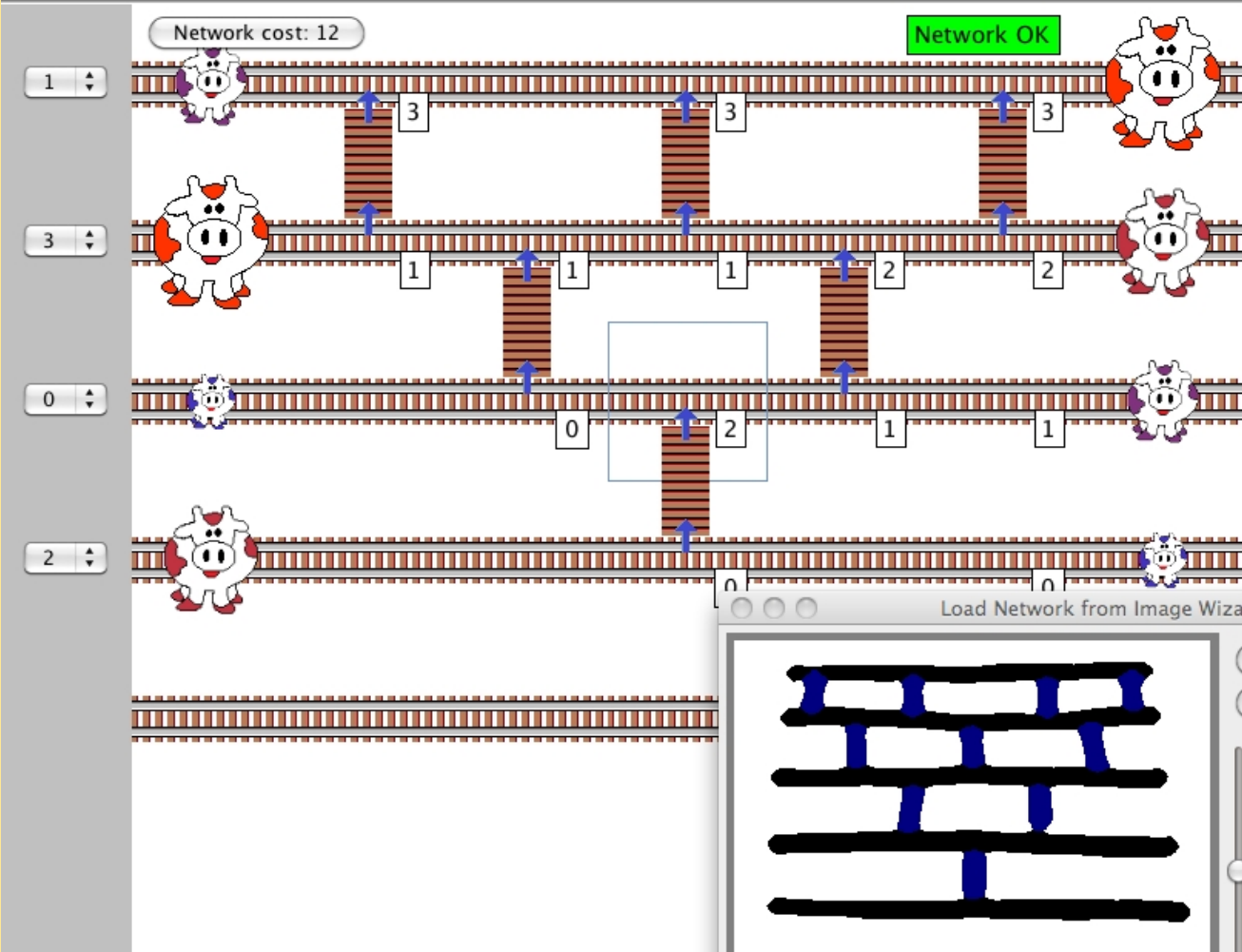
Load Network from Image Wizard



Image...  
Crop

Step 1 - Select and crop the source image.

Cancel < Prev Next >



- Run Simulator
- Next Fail
- Next Permutation
- Random Permutation

Simulator not yet run.

Load Network from Image Wizard

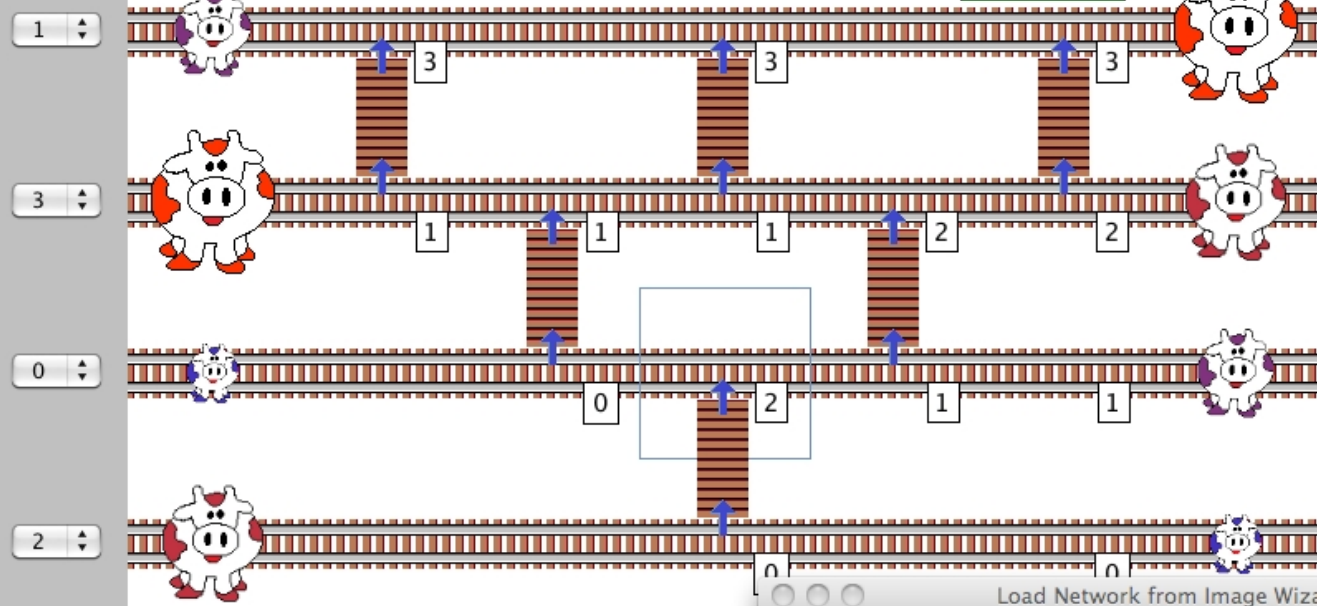
Classifier...  
Calibrate

Step 2 - Check classification, calibrate and

Cancel < Prev Next >

Network cost: 12

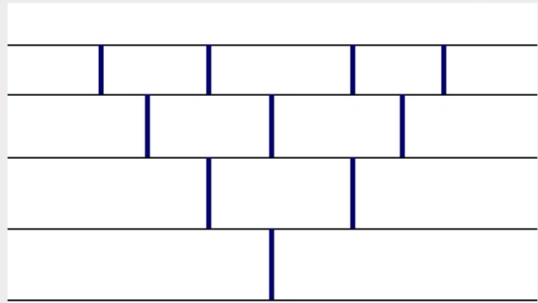
Network OK



- Run Simulator
- Next Fail
- Next Permutation
- Random Permutation

Simulator not yet run.

Load Network from Image Wizard



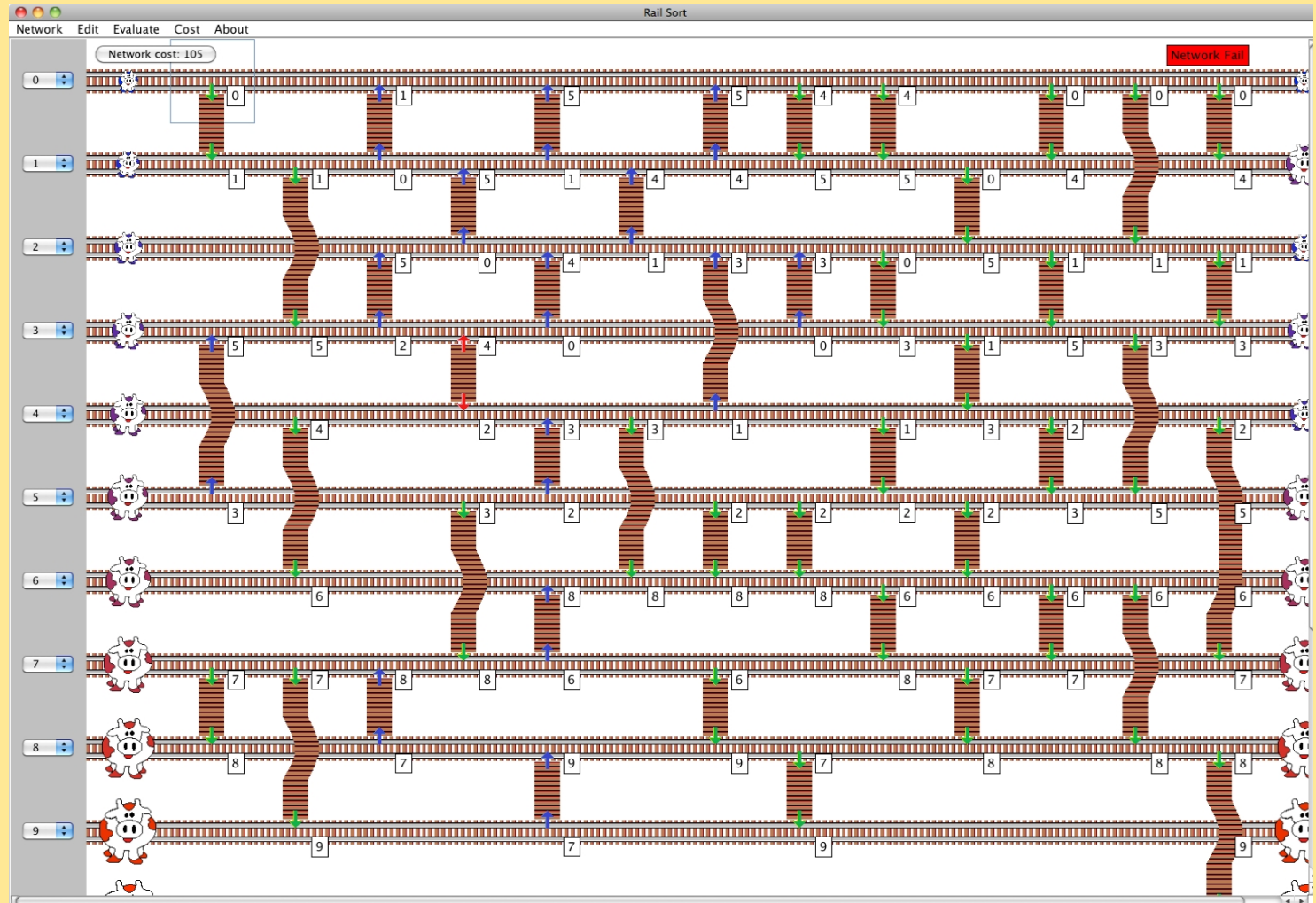
Step 4 - Check the imported network. Go back to recalibrate if necessary.

- Cancel
- < Prev
- Finish

# Feedback

- **Overall Network Score:** <A measure of the success of this network.>  
---- SUCCESS ----  
# **Runs:** <The total number of inputs tested.>  
# **Success:** <The number of inputs that the network succeeded on, based on its current evaluation measure.>  
# **Fails:** <The number of inputs that the network failed on, based on its current evaluation measure.>  
  
---- COST ----  
**Cost of this network: 10**
  - time: 5
  - operations: 5
  - parallel: 0
  - bridges: 0

# Stage 3: Experiment in virtual environment



# Introduce and illustrate concepts

- Discover patterns
- Use previous solutions as tools for new problems
  - Finding largest  $\Rightarrow$  Sorting
- Consider algorithmic strategies
  - Recursion
  - Divide and Conquer
- Illustrate correctness
  - Induction

# Stage 4: Work on abstract / textual programming environment

- Use the **MaSH** programming tool
  - Making Stuff Happen [Andrew Rock, 2008]
- Stage 4
  - Level: statements
- Concepts:
  - identifier
  - method invocation
  - sequential control
  - comments
  - abstract execution
  - displaying output



# Stage 4: Textual programming environment

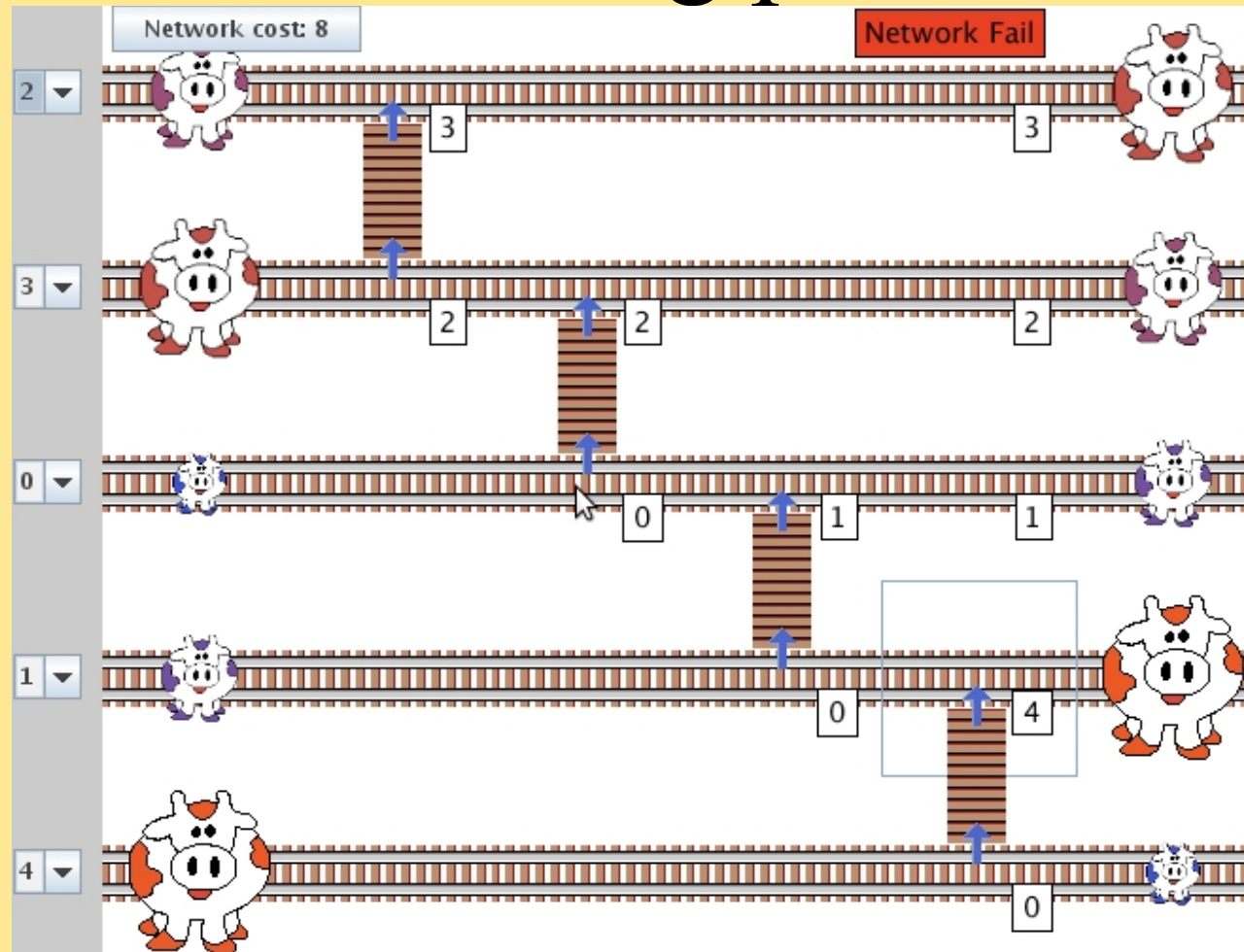
- **MaSH**
  - Level: statements

```
import sortingNetwork;  
  
createRails(2); // create two rails with data in random order  
  
printOrder(); // print the data  
  
redSwap(0,1); // Swap values in position 0 and 1  
  
printOrder(); // print the data
```

output:

```
0, 1,  
1, 0,
```

# An interesting pattern:



- With **blue bridges**, it places smallest at the bottom

# Stage 4: Textual programming environment

- **MaSH**

- Level: control

```
import sortingNetwork;

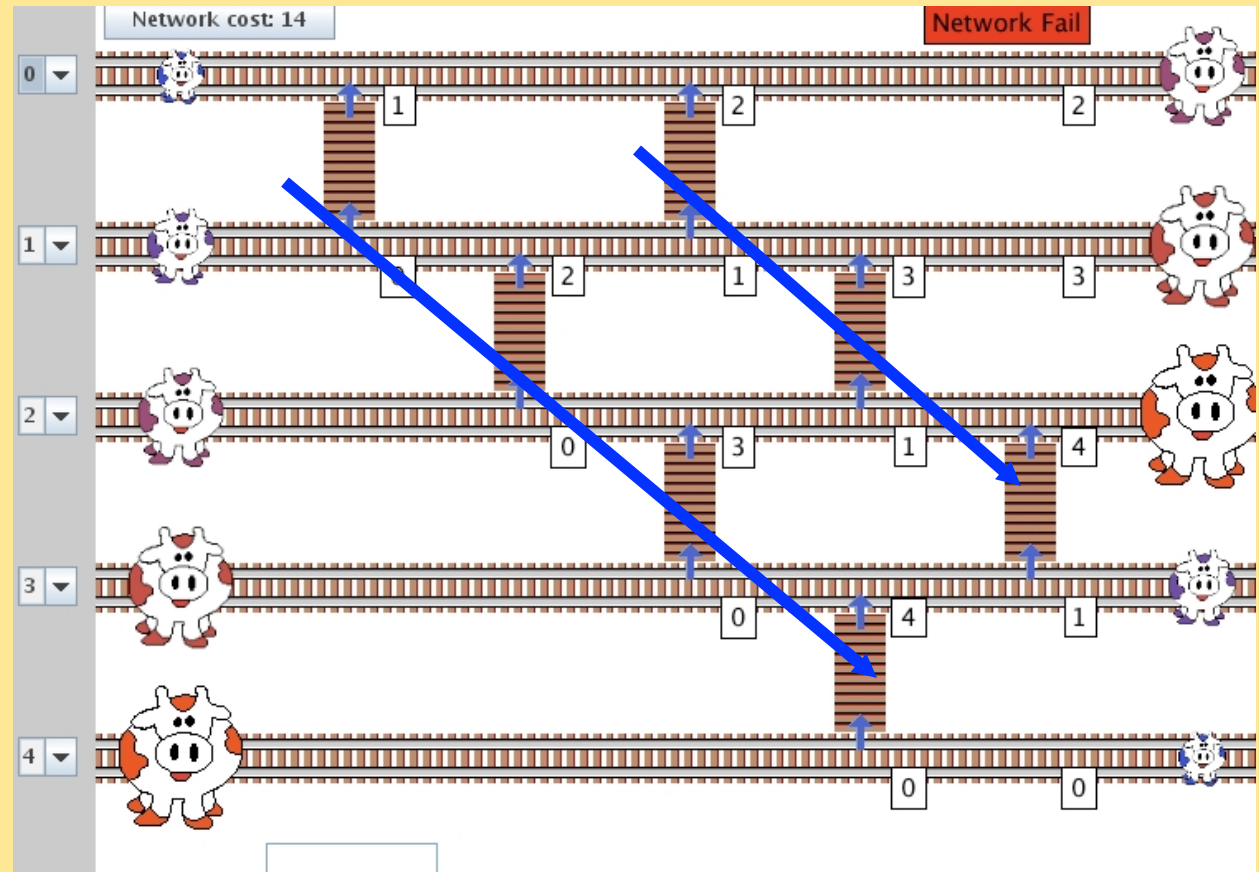
createRails(5); // create 5 rails with data in random order

printOrder(); // print the data

        // cyclically shift one position to the left
for (int i=0; i<4; i=i+1)
    redSwap(i,i+1);

printOrder(); // print the data
```

# Repeat the pattern



- This places the smallest at the bottom and second smallest just one above

# Stage 4: Textual programming environment

- **MaSH Level: methods**

```
import sortingNetwork;



void select (int place) {
    for (int i=0; i<place; i=i+1)
        blueLargerUp(i,i+1);
}

void main() {
    createRails(5); // create five rails with data in random order

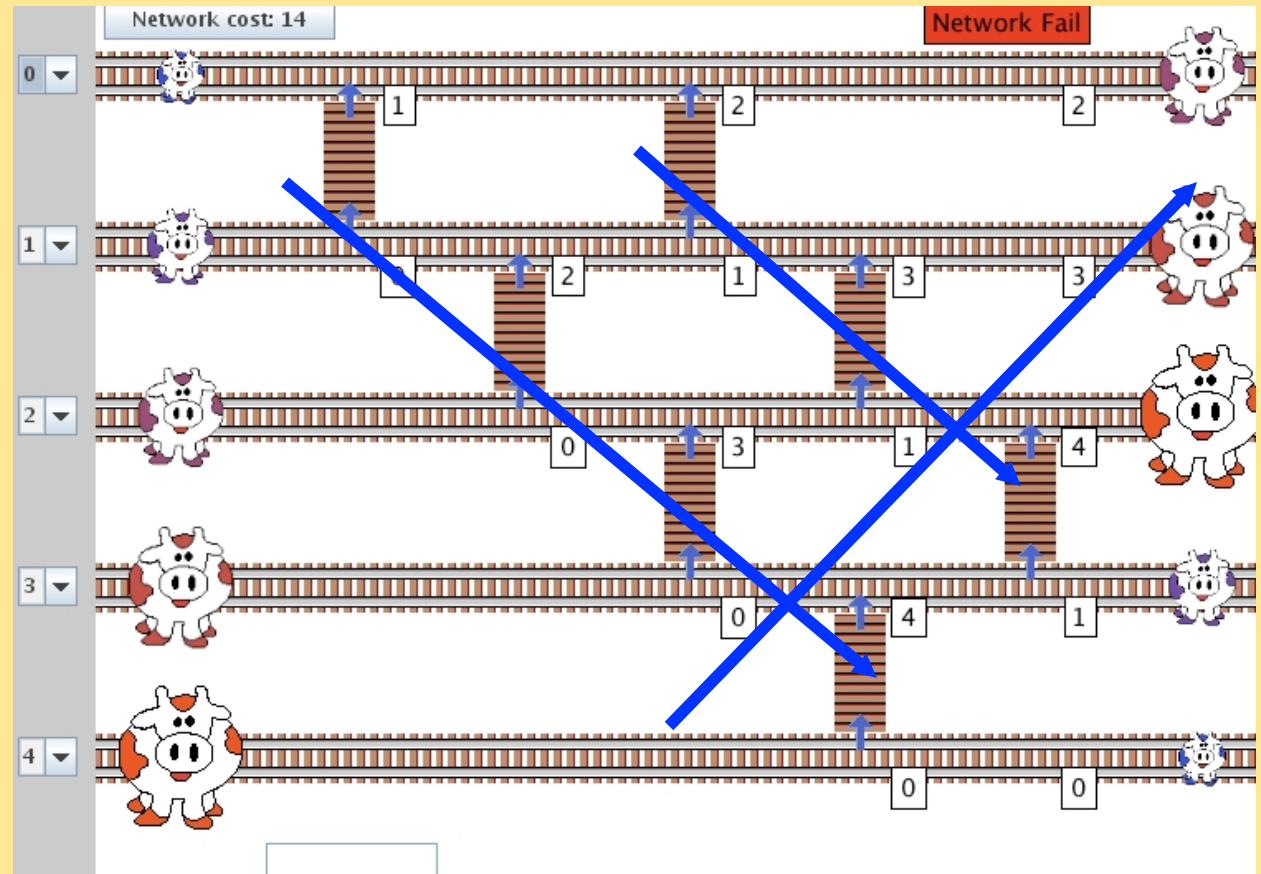
    printOrder(); // print the data

    // Select and place smallest at the bottom
    select(4);
    select(3);
    select(2);
    select(1);

    printOrder(); // print the data
}
```



# A pattern in the pattern



- This places the smallest at the bottom and second smallest just one above

# Stage 4: Textual programming environment

- **MaSH Level: methods**

```
import sortingNetwork;

void select (int place) {
    for (int i=0; i<place; i=i+1)
        blueLargerUp(i,i+1);
}
void sort (int place) {
    for (int i=place; i>0; i=i-1)
        select(place);
}

void main() {
    createRails(5); // create five rails with data in random order

    printOrder(); // print the data

    sort(4); //Sort

    printOrder(); // print the data
}
```



# Other concepts of textual programming

- With **MaSH** and the virtual tool
  - constants
  - arrays
  - sorting algorithms
  - complexity
- Proceed to object-orientation
  - class / object
  - encapsulation

# Stage 5: What if?

- Links to research and open questions
  - What if the cost of building blocks varies?
  - What if sometimes the bridge does not succeed
  - What is the fastest with only blues?
  - Is the fastest with blues and red as costly as only with reds?
  - What is the cost gap between finding the median and sorting?
  - Can artificial intelligence techniques optimize the cost?

**THANK YOU**

