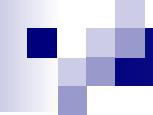




Ours: Exploring Machine Learning and Automation through Smart Textiles

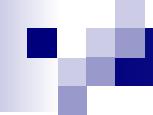
Carolyn Penstein Rosé and Jim McCann

*Language Technologies Institute
Human-Computer Interaction Institute
Robotics Institute*



Workshop Schedule (Day 2)

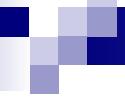
- Sat 10:30-12:30 Introduction to Matrix Factorization and Pattern Weave, Weaving Software Exploration
- Sat 4pm-6pm, More complex pattern weave, Machine Learning and Textiles



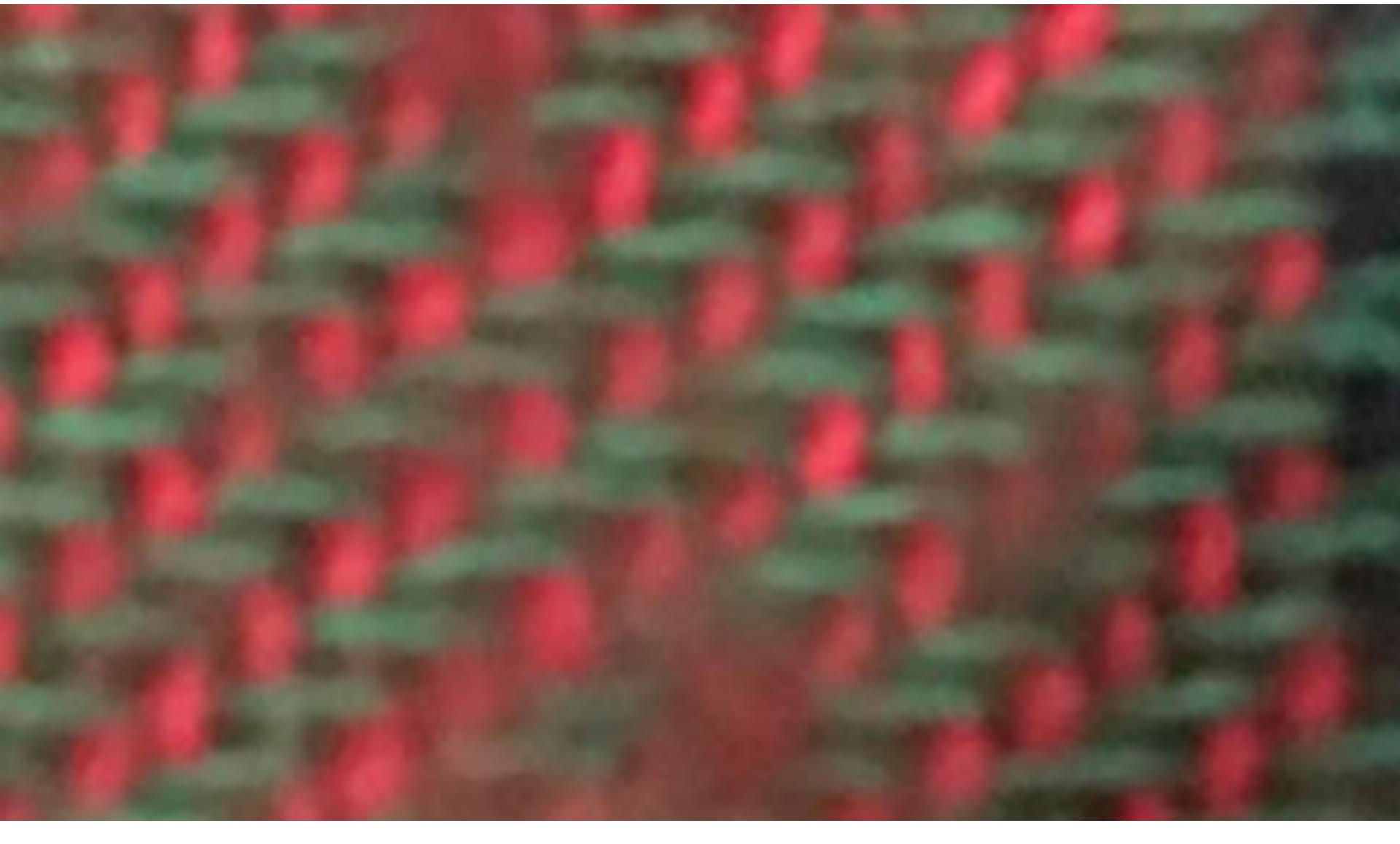
Sat 10:30-12:30

Introduction to Matrix Factorization and Pattern Weave

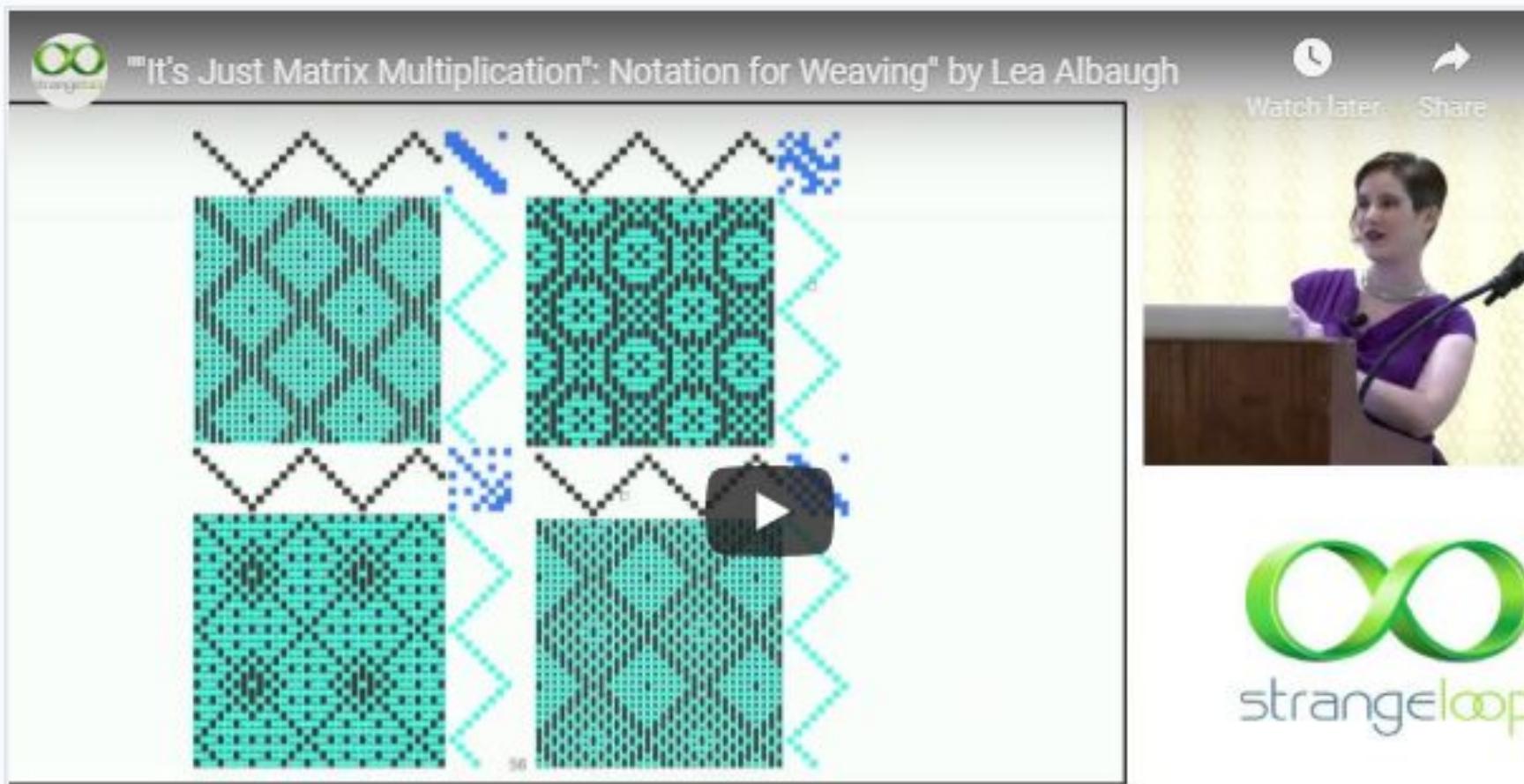




2X2 Twill



<http://lea.zone/blog/weaving-notation-at-strange-loop/>

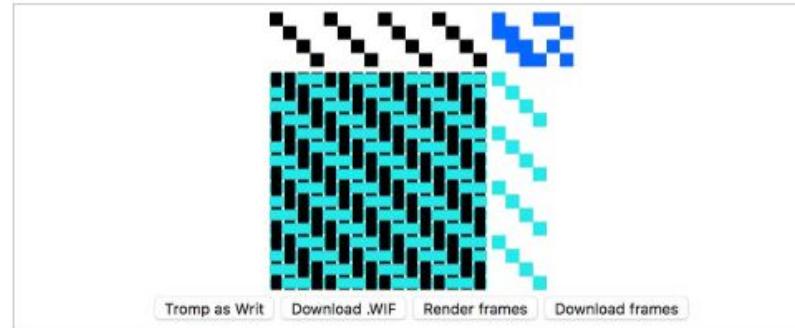


Sept 27-28, 20
thestrangeloop.com

<http://lea.zone/little-looms.html>

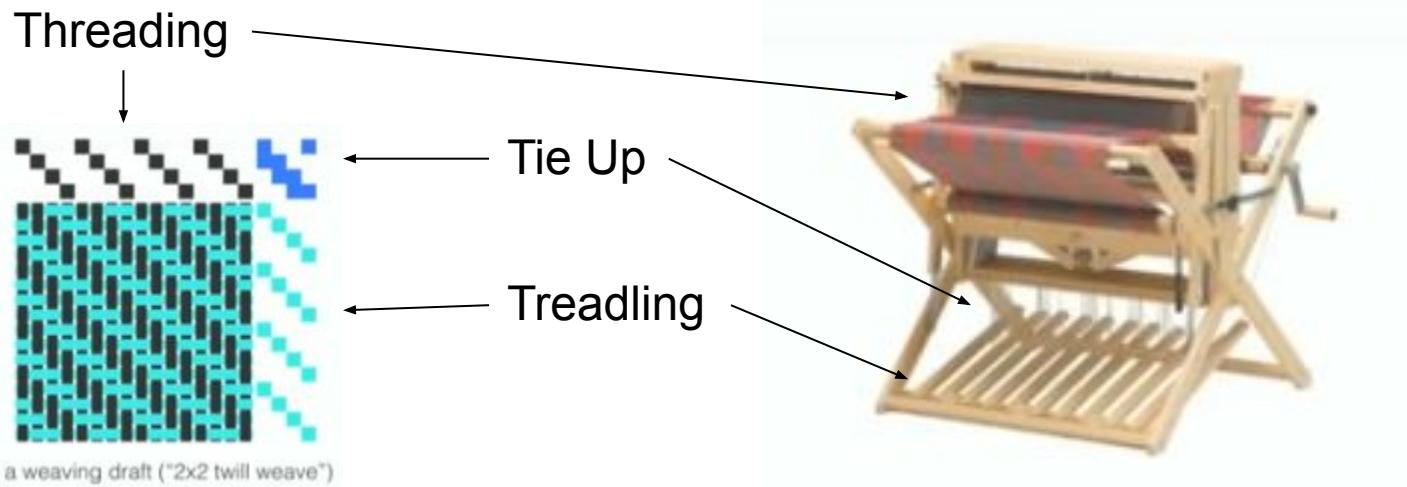
Lea Albaugh

About
RSS

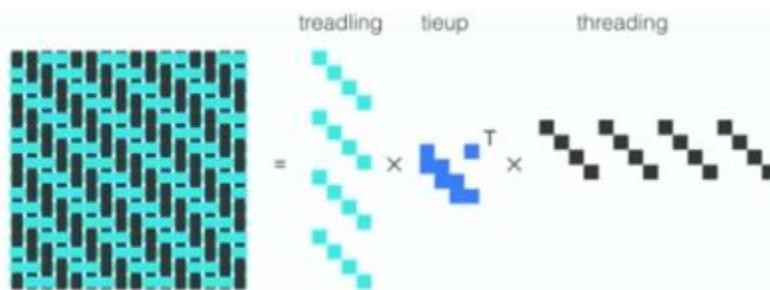


A little client-side loom simulator and generator to accompany my 2018 Strange Loop talk, '[It's Just Matrix Multiplication: Notation For Weaving](#)'. The heddle frames generated can be cut out of cardboard or acrylic and used in any kind of shoebox or backstrap loom, as shown in the included video on building a shoebox loom. [View the repo on Github](#), or visit [a live demo](#).

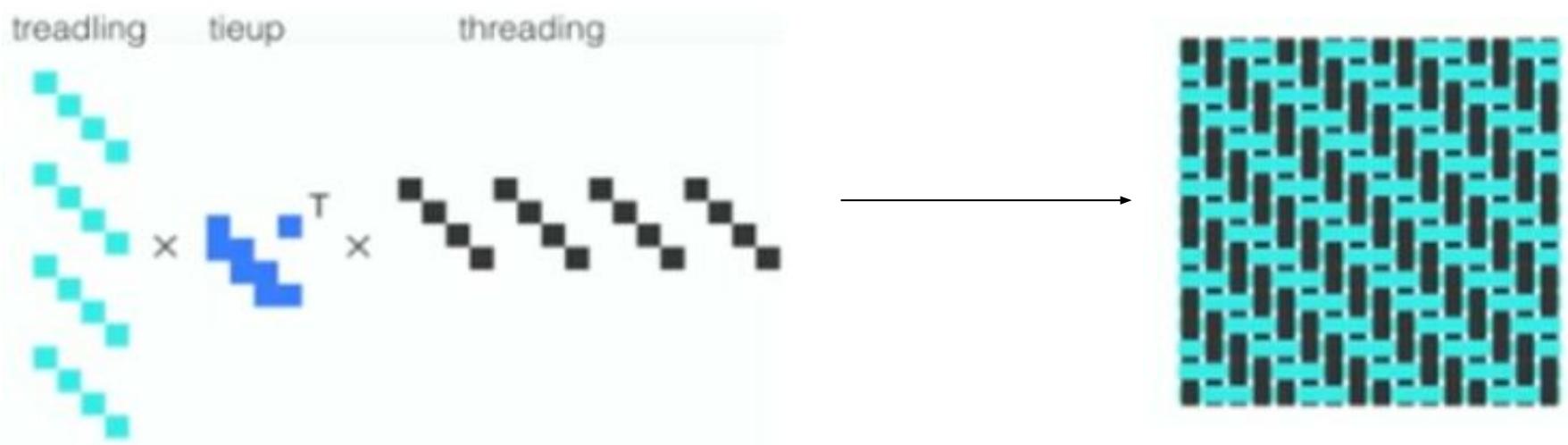
Interpreting a Weaving Draft



Simple Cloth Structure from Matrix Multiplication



If this is a model, how do we apply it?

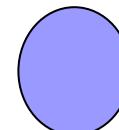


Applying a Learned Model

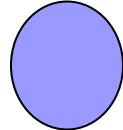
Treadle 1
pressed



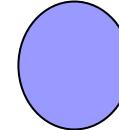
Shaft 1
Lifted



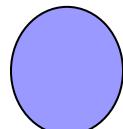
Treadle 2
pressed



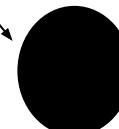
Shaft 2
Lifted



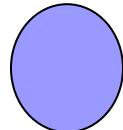
Treadle 3
pressed



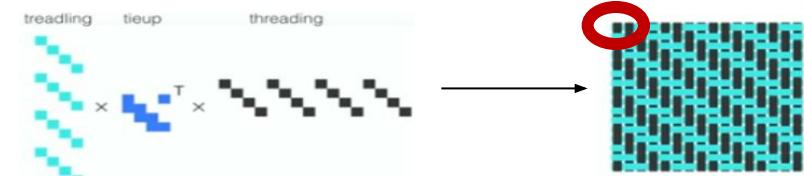
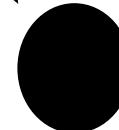
Shaft 3
Lifted



Treadle 4
pressed



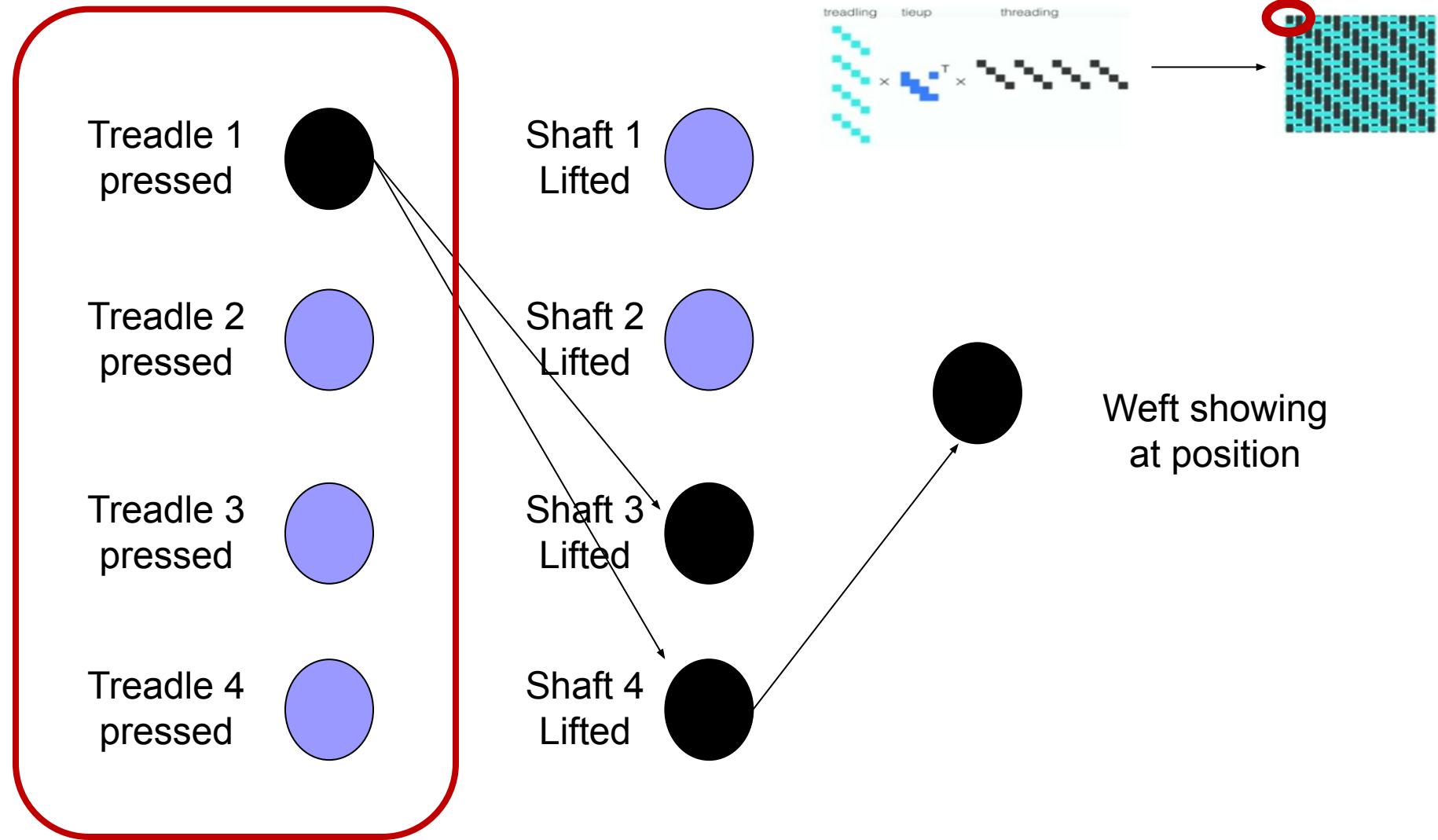
Shaft 4
Lifted



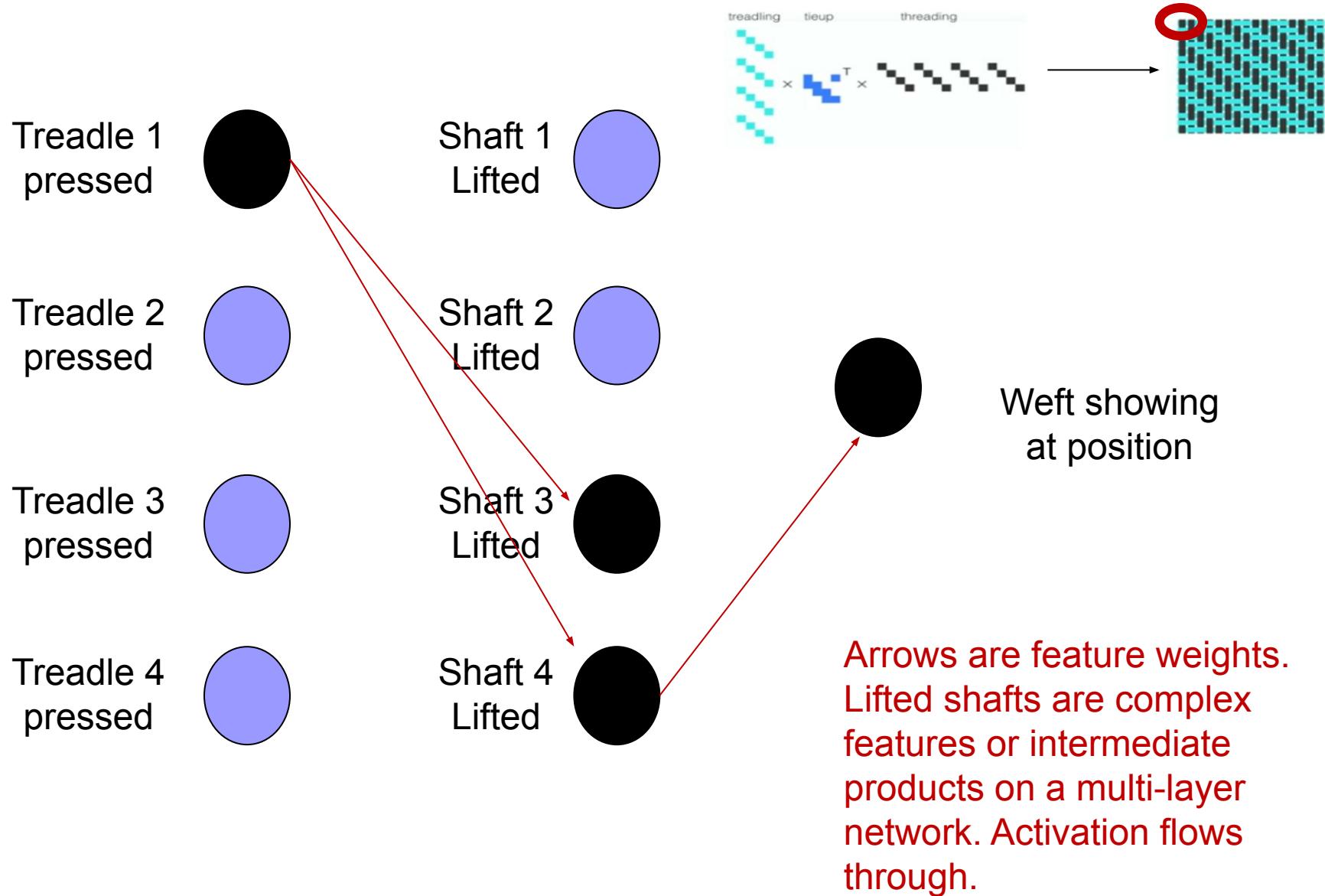
Weft showing
at position

Imagine a fully connected
multi-layer network.
Arrows showing are
non-zero weights.

Applying a Learned Model

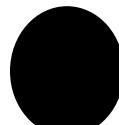


Applying a Learned Model

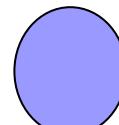


Applying a Learned Model

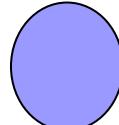
Treadle 1
pressed



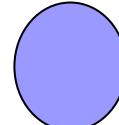
Shaft 1
Lifted



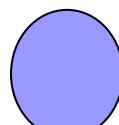
Treadle 2
pressed



Shaft 2
Lifted



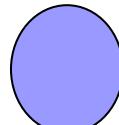
Treadle 3
pressed



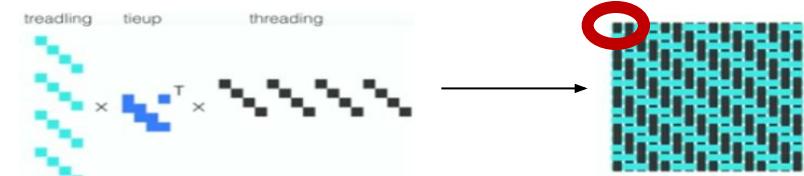
Shaft 3
Lifted



Treadle 4
pressed



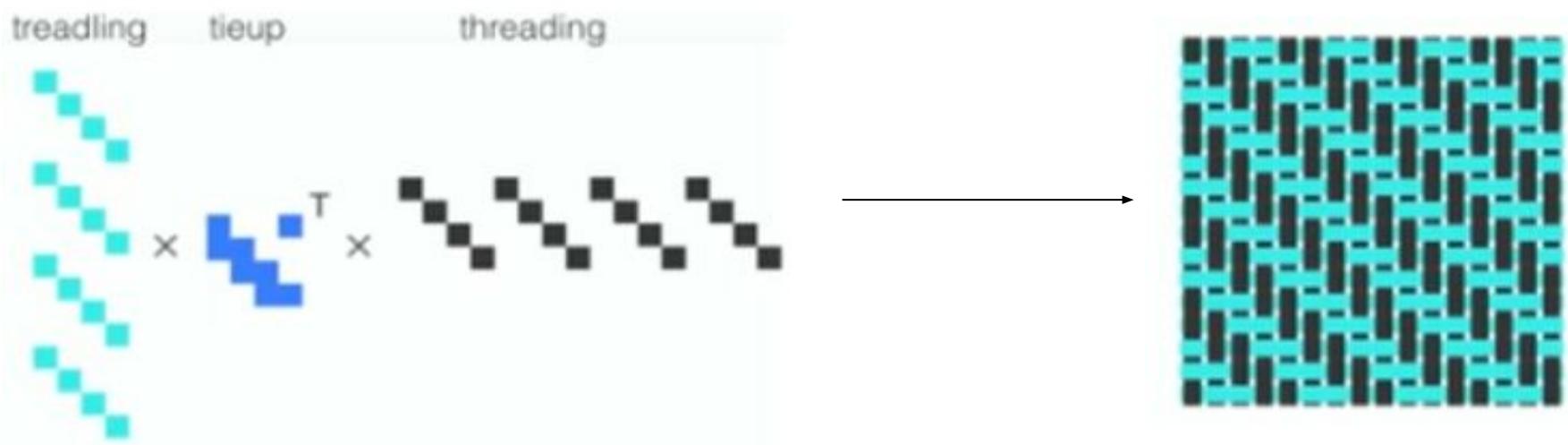
Shaft 4
Lifted



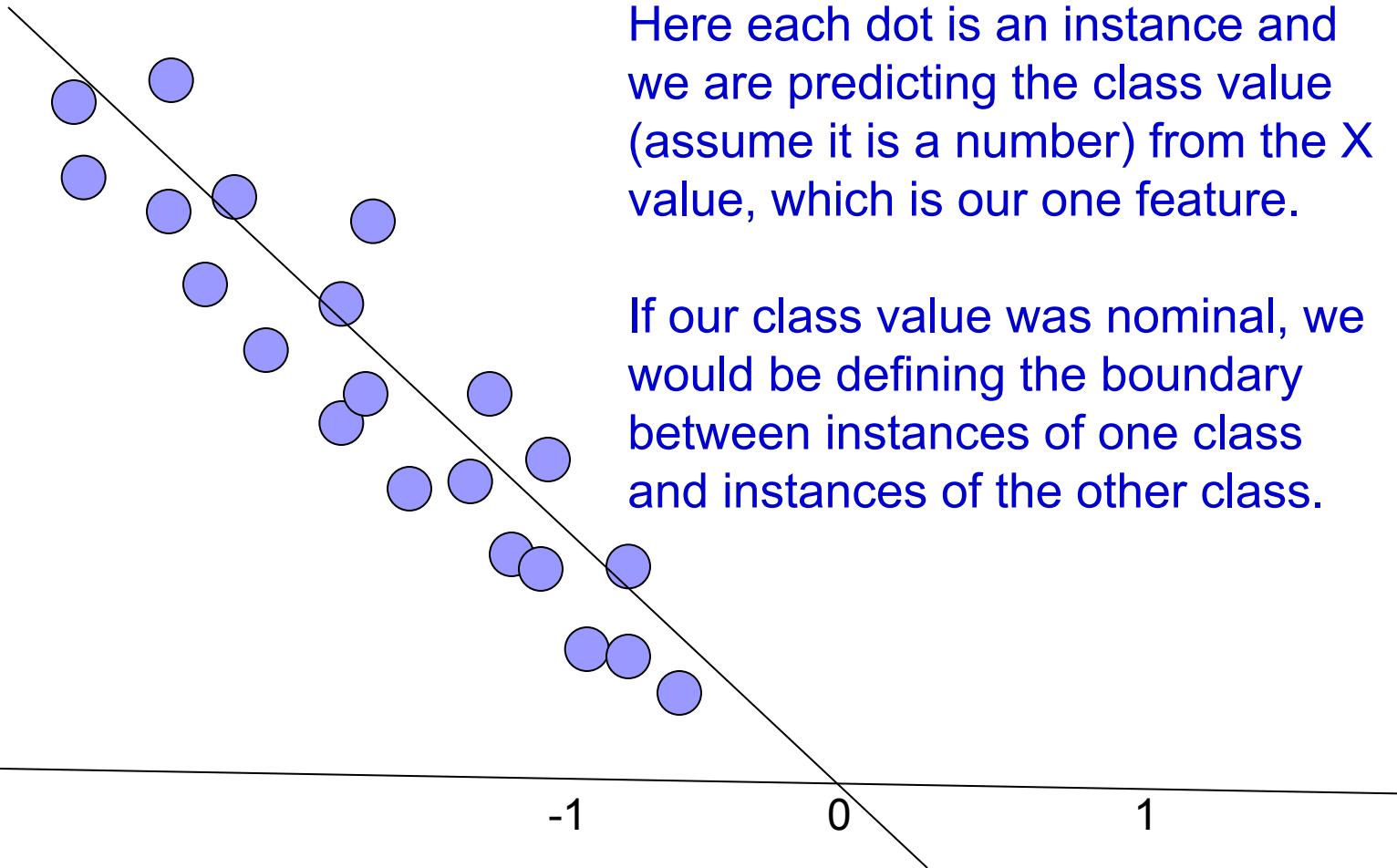
Weft showing
at position

Class value is whether the weft is showing or not.
A prediction is made at each time step for each thread across the loom. So multiple predictions are made at each time step (like multi-task models).

If this is a model, how do we learn it?



Remember discussion on fitting functions to data

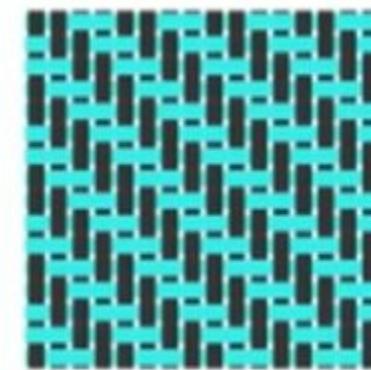


What is machine learning?

Matrix Multiplication

treadling tieup

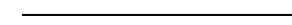
threading



Matrix Factorization

treadling tieup

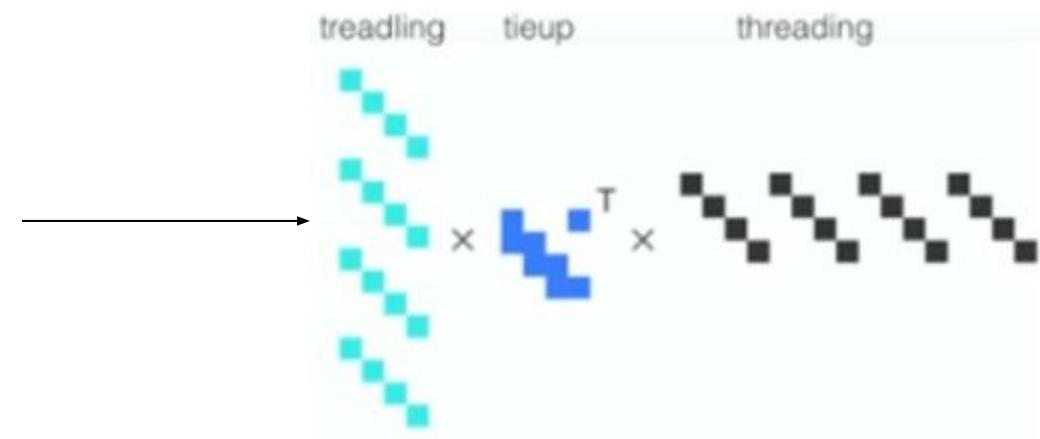
threading

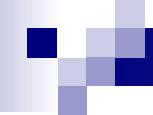


What is machine learning?

If we know parts of the pattern, the other parts are easier to search for because the search space is smaller.

Matrix Factorization





2 Different 4 Shaft Overshot Drafts

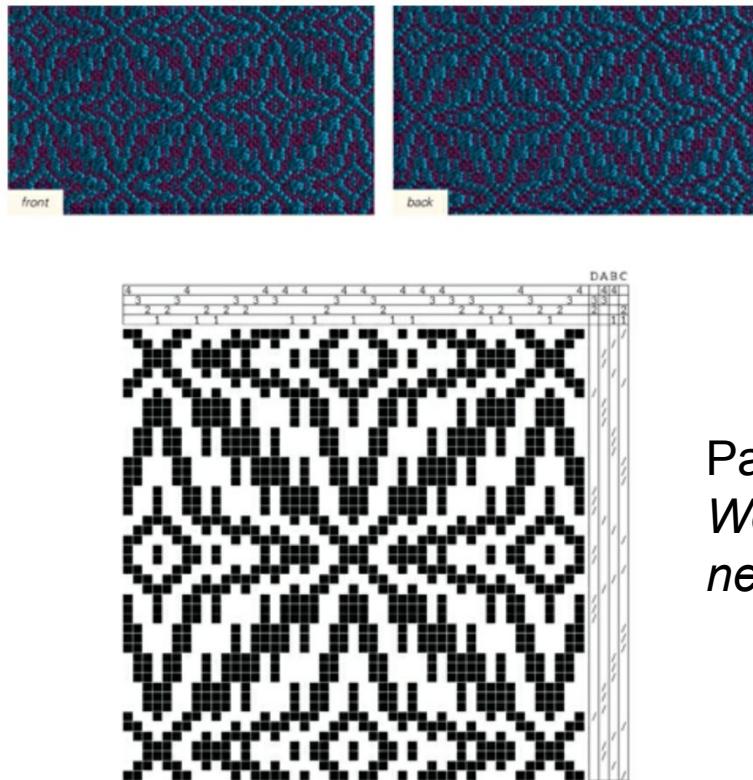


Figure 11: Sample 2: Draft for Star of Bethlehem woven star fashion.

Notice also that some of the pattern blocks are treadled with only a single pattern weft pick. These blocks contain only 2 warp ends. For example, the first 2 warp ends are on shafts 4 and 3 for Block C. Remember that the treadling for star fashion is determined by counting the number of warp ends in the block and subtracting 1. Therefore, only one pattern pick is treadled for Block C at the very beginning of the draft.

Although Figure 11 provides the treadling to weave this draft as

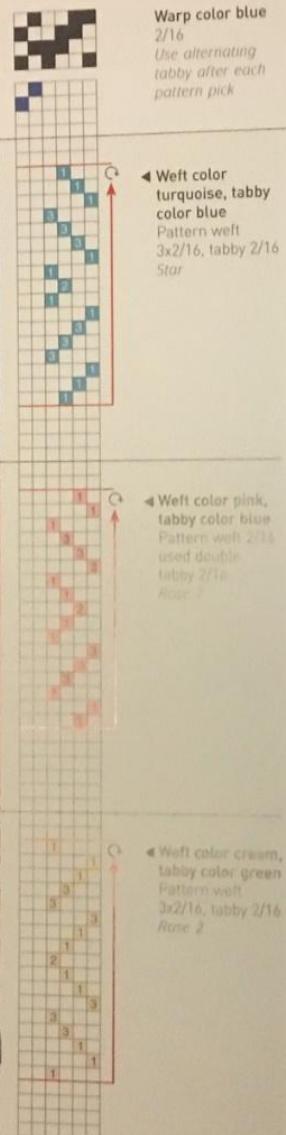
Patty Graver (2015). *Next Steps in Weaving: What you never knew you needed to know*, Interweave

Same warp, different weft, different treadeling



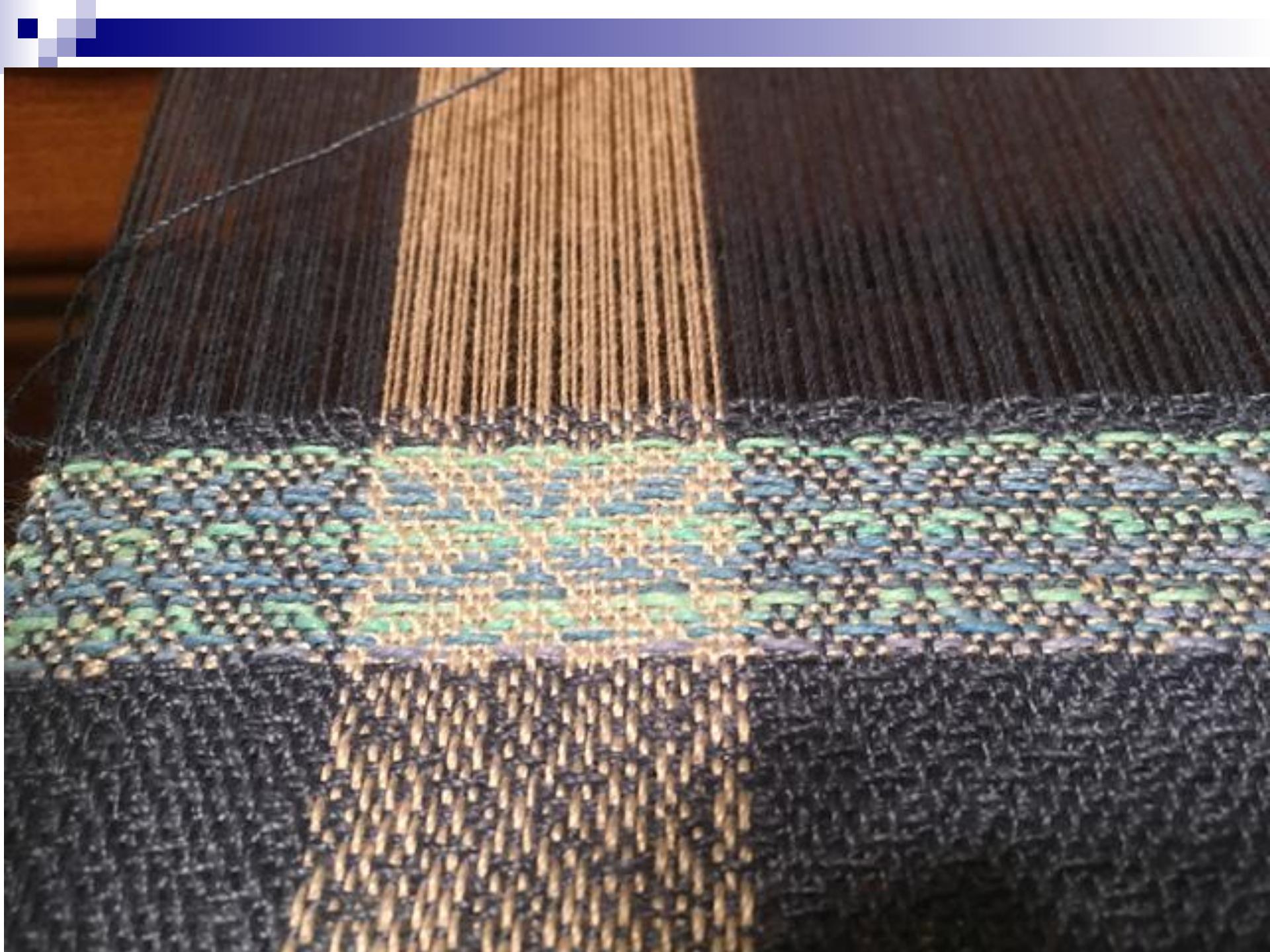
Overshot: Small Honeysuckle

Warp color blue
2/16
Use alternating tabby after each pattern pick

**Overshot: Small Honeysuckle Borders**

Warp color blue
2/16
Use alternating tabby after each pattern pick, unless indicated

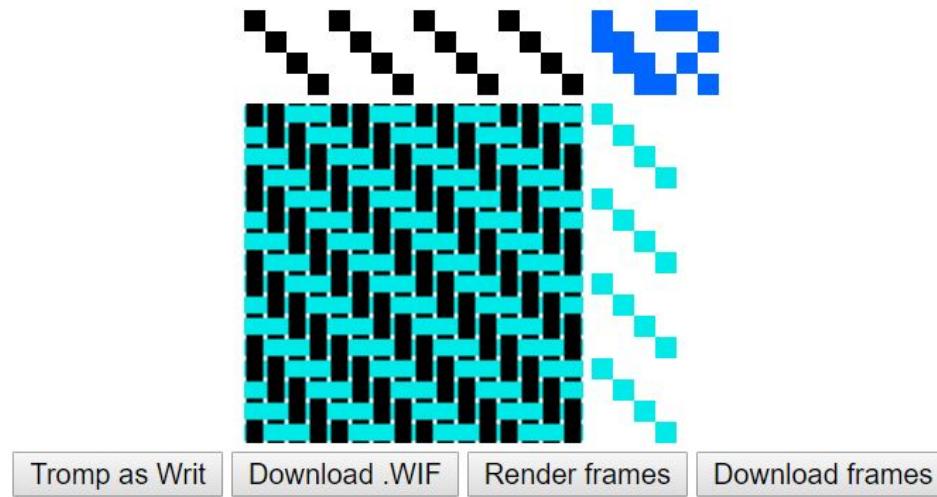








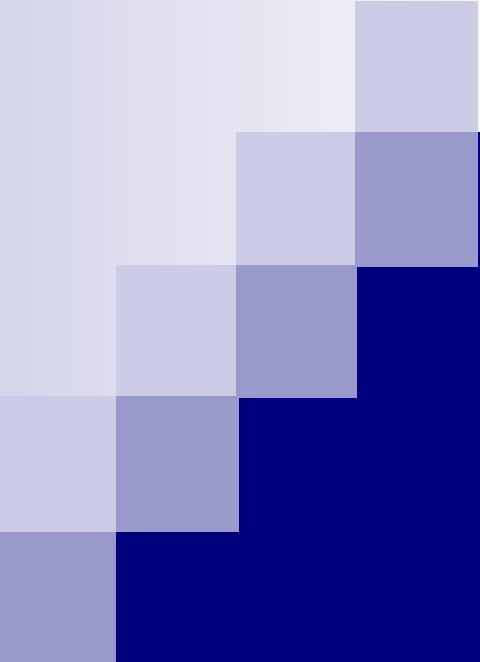
Try it! <https://lealbaugh.github.io/little-loom/>



Load a [WIF](#) file by dragging and dropping onto this page. You can find some starter WIFs at [the repo for this project](#).

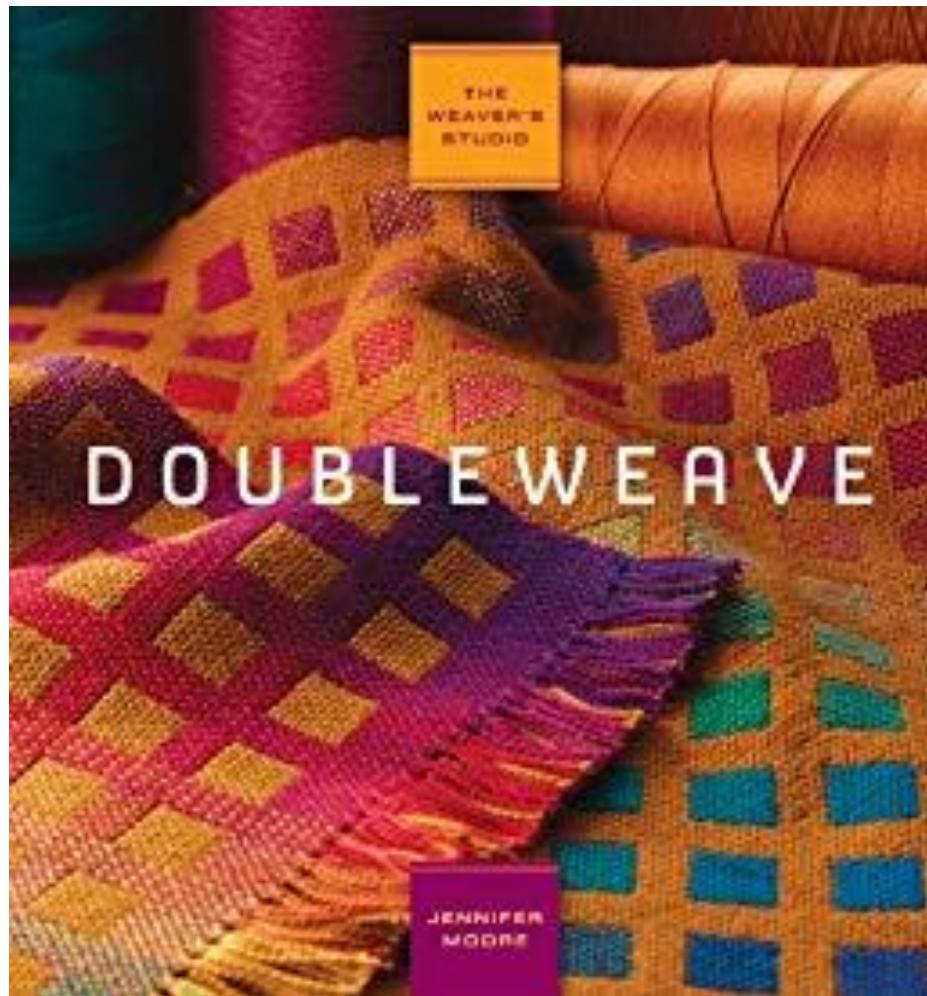
This is a little client-side loom simulator and generator to accompany my 2018 Strange Loop talk, ['It's Just Matrix Multiplication': Notation For Weaving](#). The heddle frames generated can be cut out of cardboard and used in any kind of shoebox or backstrap loom. You can watch my [brief video on building a shoebox loom](#) for some inspiration.

Sat 4pm-6pm,
More complex pattern weave,
Machine Learning and Textiles



More Complex Pattern Weave

8 Shaft Double Weave



4 layers of 2 shafts each

THE WEAVER'S STUDIO: DOUBLEWEAVE

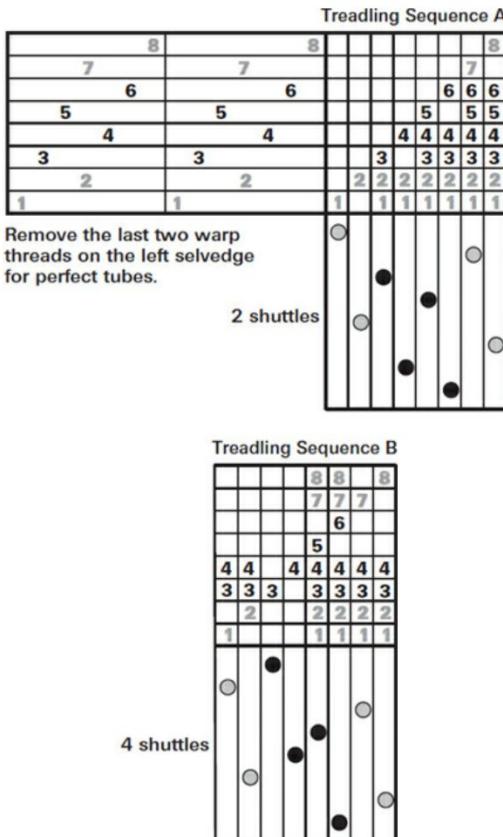
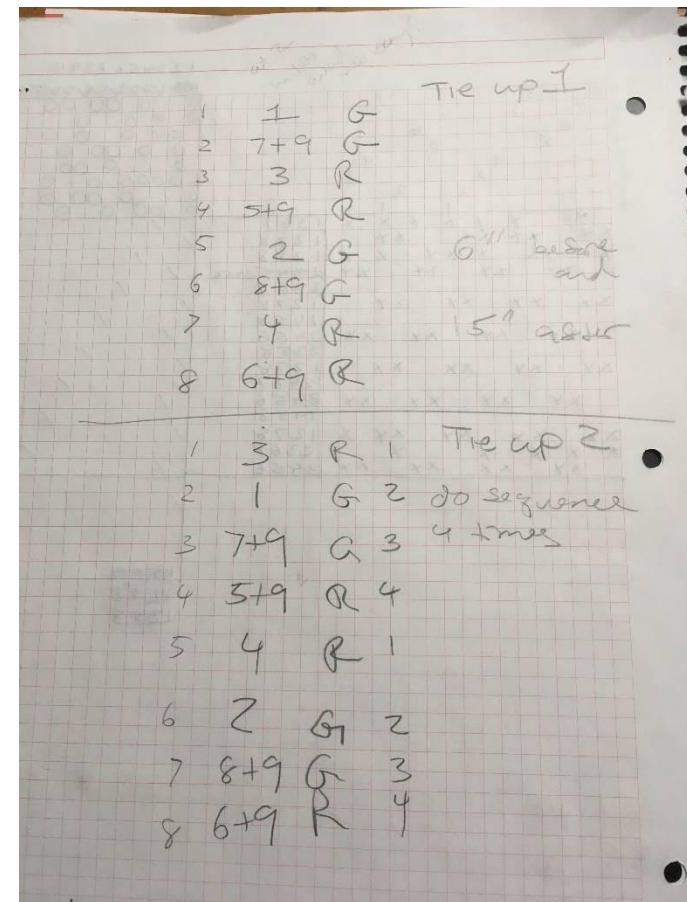
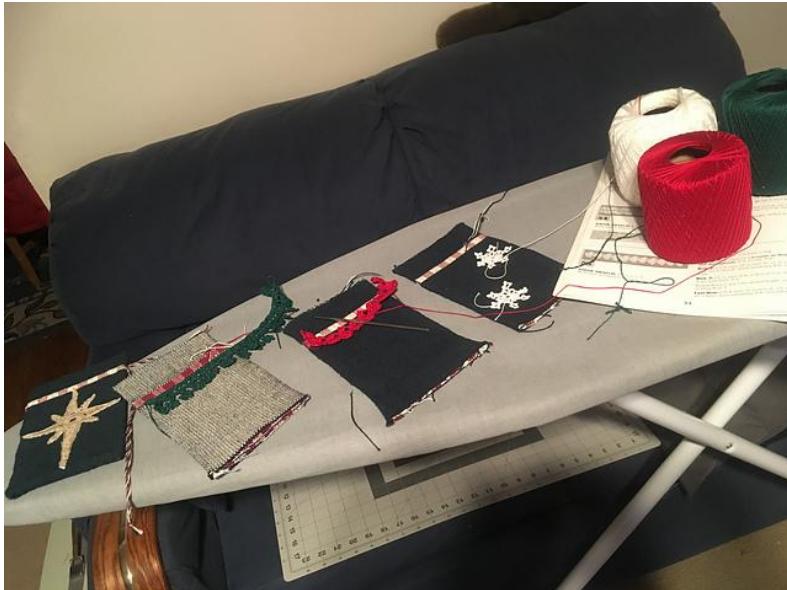


Figure 9: Reversible lined drawstring pouch.

- Make pedal 9 have 1-4 and remove these from 5-8



First experiments



4 layers of 2 shafts each

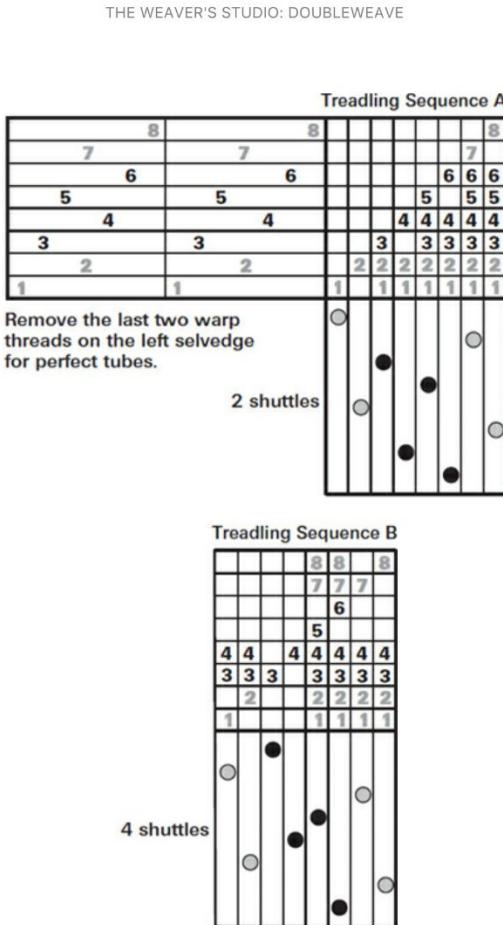


Figure 9: Reversible lined drawstring pouch.

- Make pedal 9 have 1-4 and remove these from 5-8

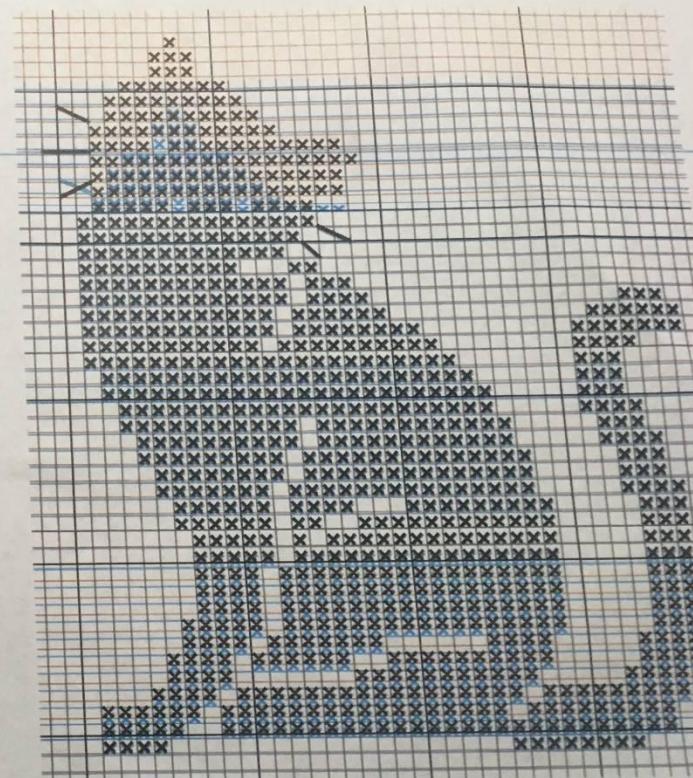
For pattern bags also do:

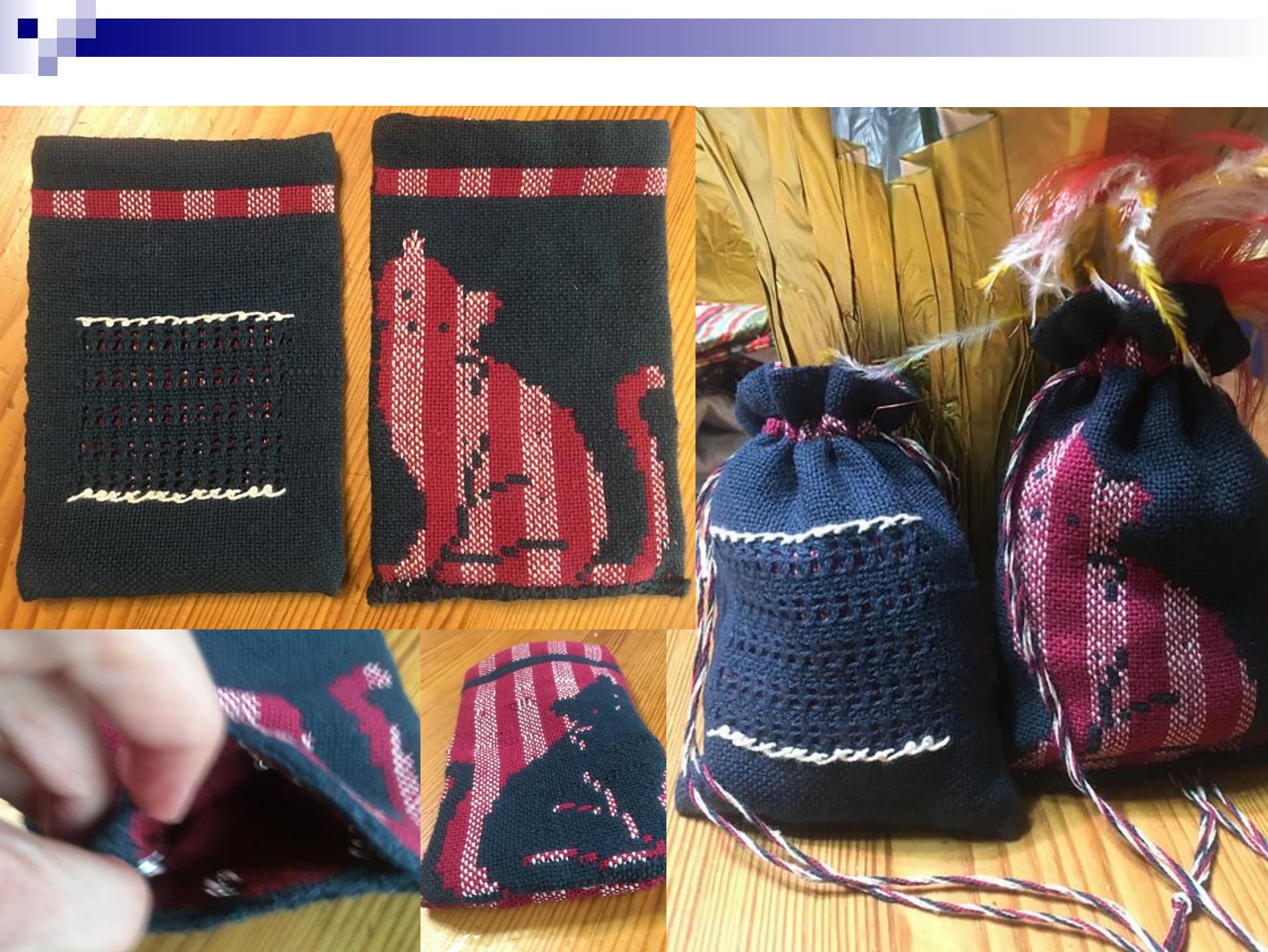
- Remove 1 and 2 from 3 and 4 so the top two layers can be moved independently



3415
19

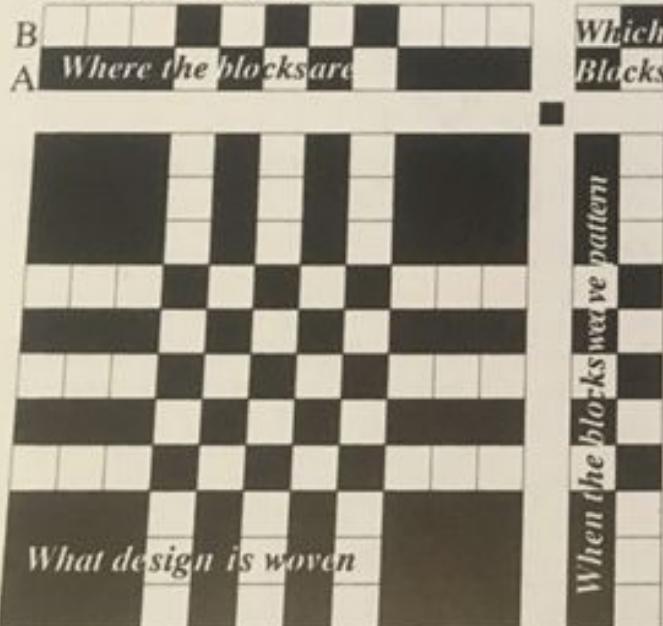
- ① L1+3+4 Pick up Red/White or pattern dark
Laces
1 - Green
- ② 7+9 Green
- ③ L1+1+2 Pick up Green or pattern light
Laces
3 - Red
- ④ 5+9 Red
- ⑤ L1+3+4 Pick up Red/white or pattern dark
Laces
2 - Green
- ⑥ 8+9 Green
- ⑦ 11+1+2 Pick up Green or pattern light
Laces
4 - Red
- ⑧ 6+9 Red





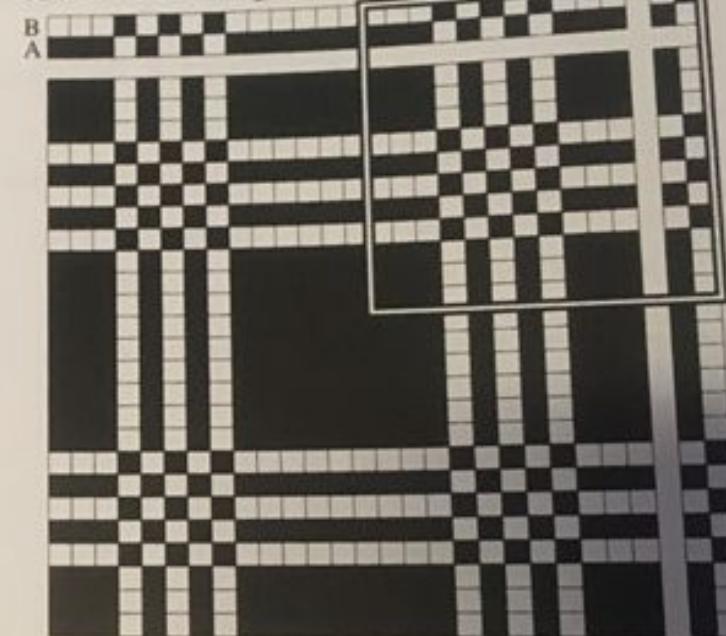
Reading a Profile Draft

4a. Profile draft format



The profile threading tells where the blocks are, the profile tie-up tells which blocks weave pattern (black squares) and which weave background (white squares), the profile treadling tells when the blocks weave pattern, the profile drawdown shows what design is produced.

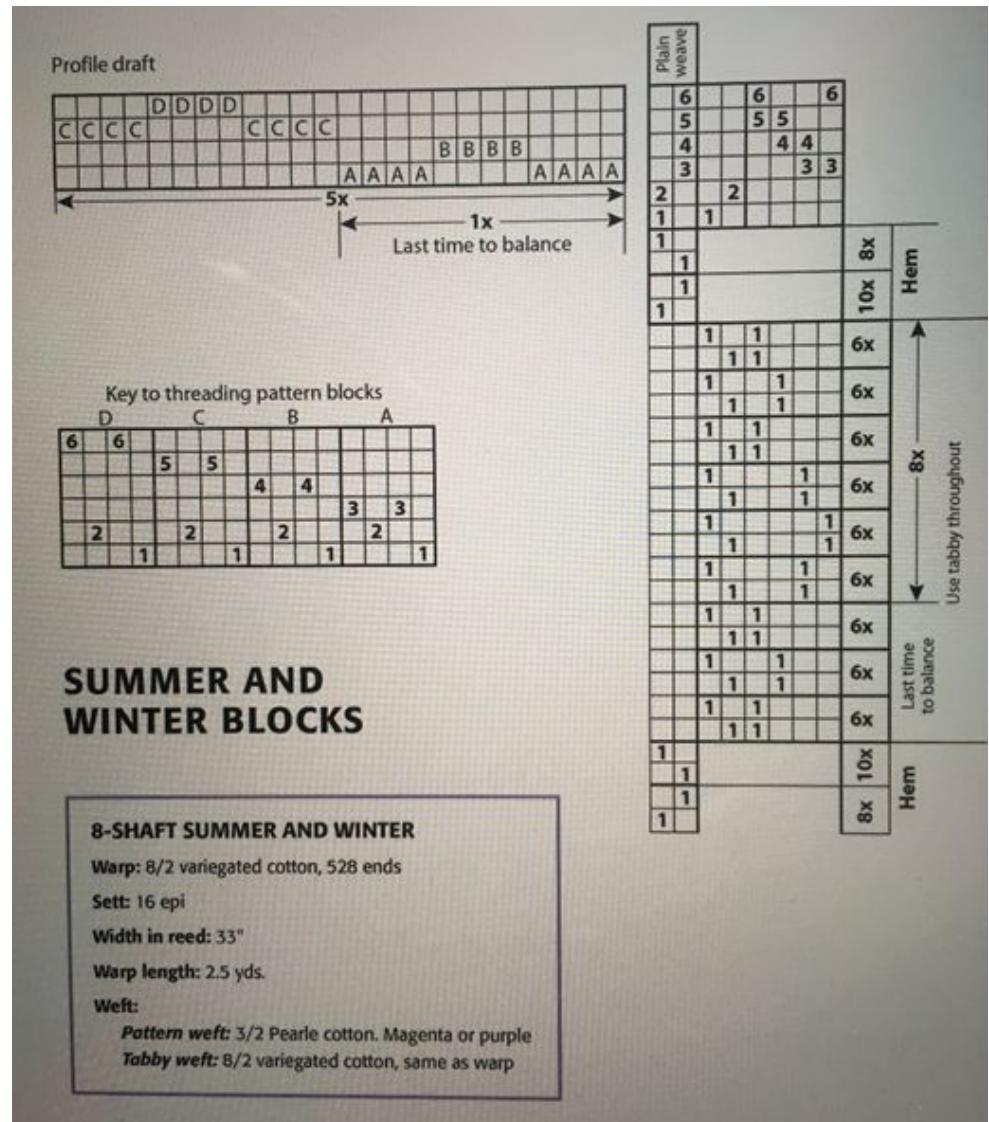
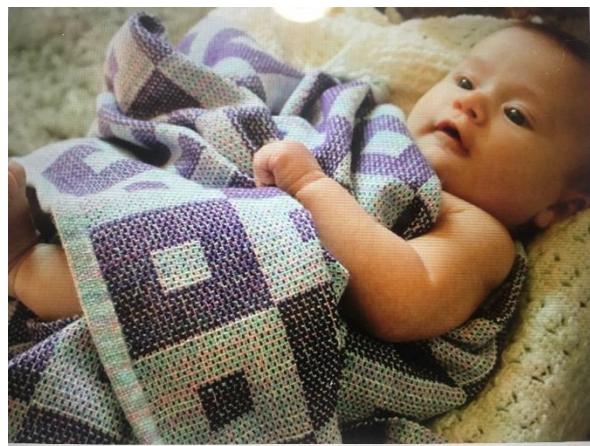
4b. Two-block profile draft



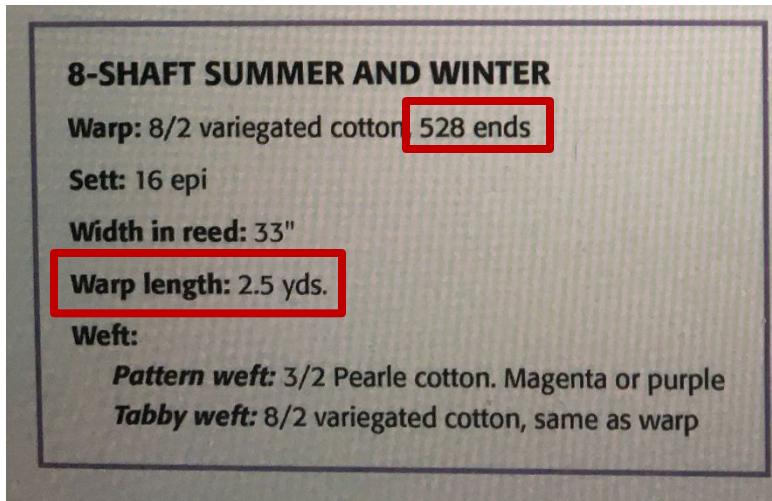
Write a profile draft exactly as you write a thread-by-thread draft. The threading rows represent blocks instead of shafts. Black squares in the profile drawdown represent pattern instead of raised warp threads; white squares represent background instead of weft threads.

Summer and Winter Blocks

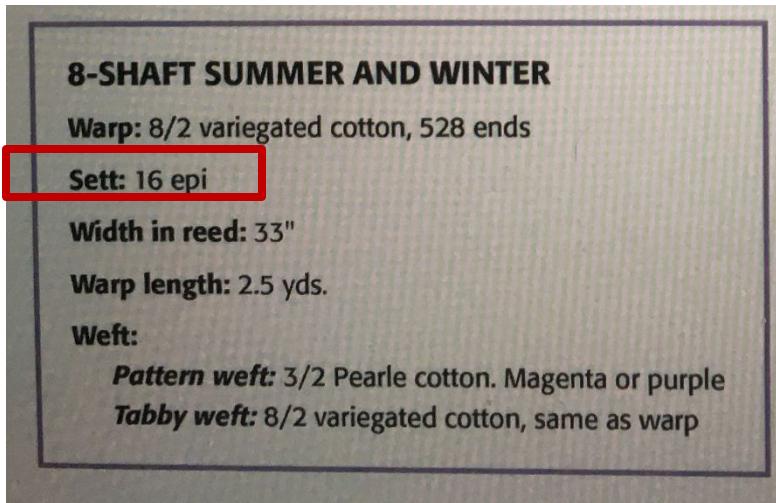
Tom Kinsley (2016) *Handwoven Baby Blankets*, Stackpole Books



Planning for Warping



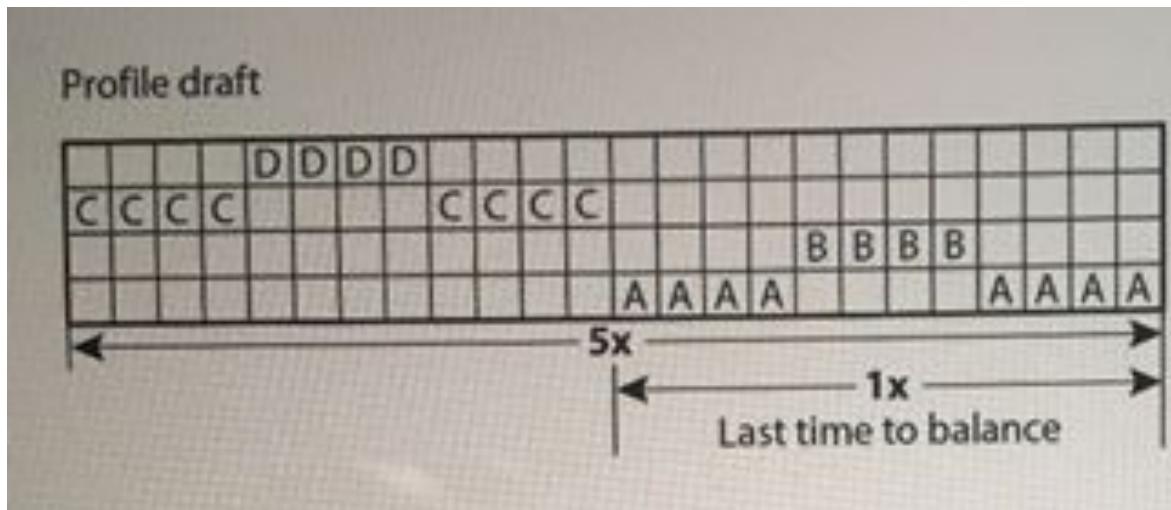
Planning for Warping



For 16 epi, I'll thread 2
threads through each slot
on an 8 dent reed

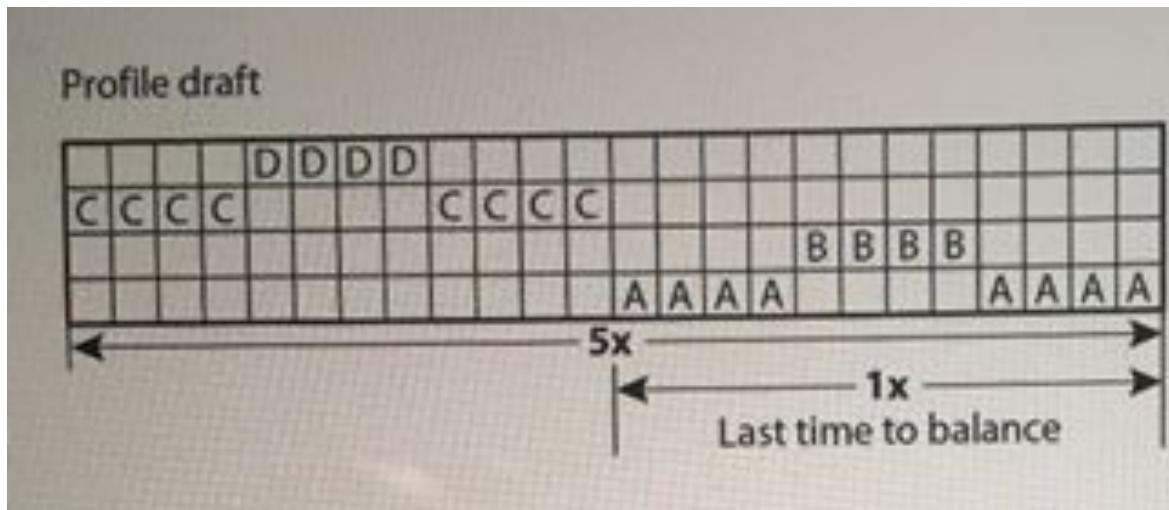


Reading a Profile Draft



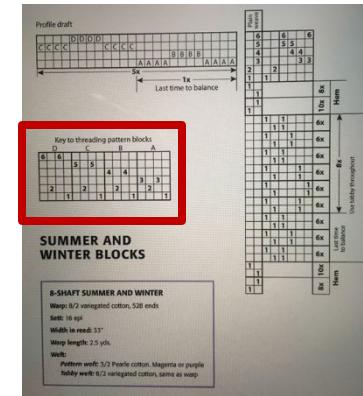
- The profile is a short hand for your threading
- That's how the strands of warp will go through your heddles

Reading a Profile Draft



- Start at the left and move to the right
 - This says you will have 4 blocks of A, then 4 blocks of B, then 4 blocks of A, then 4 blocks of C then 4 blocks of D then four blocks of C
 - Repeat this 5 times
 - Then repeat the A-B-A sequence one more time
- But what is a block?

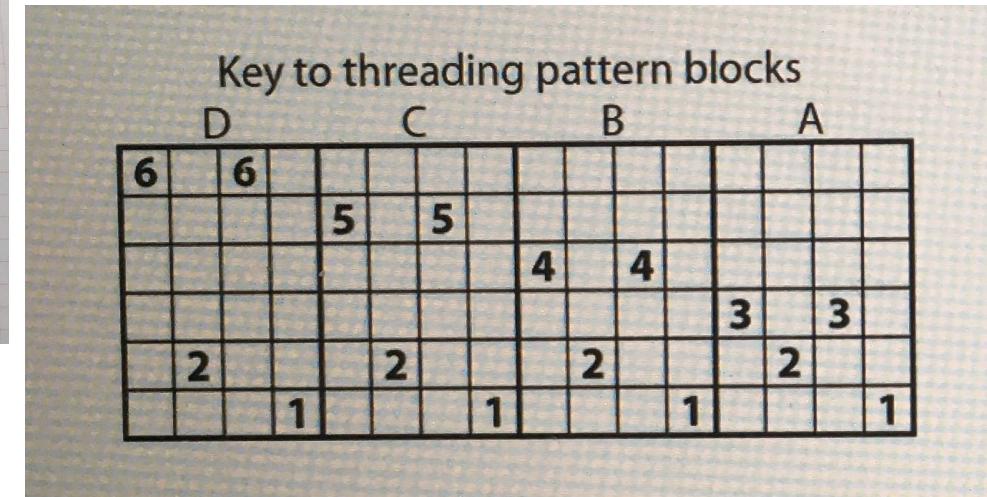
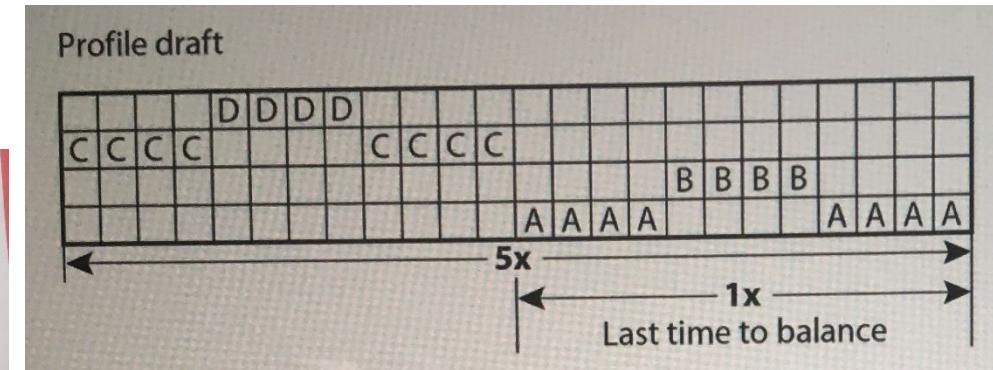
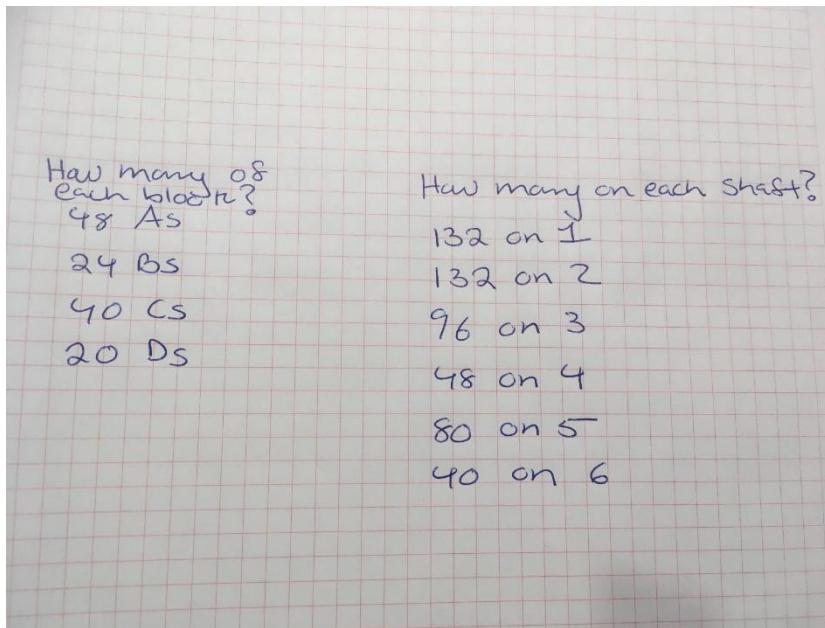
Defining Blocks



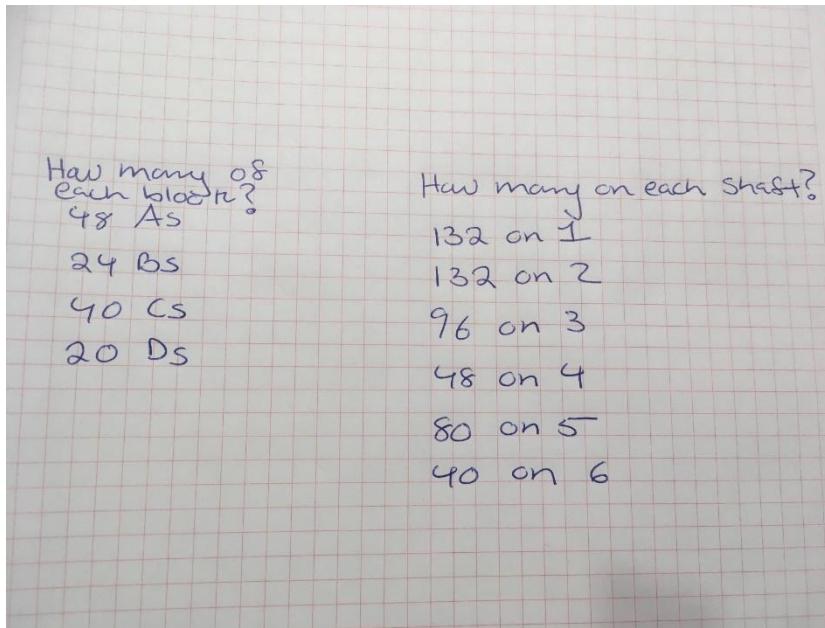
Key to threading pattern blocks

D	C	B	A
6	6		
	5	5	
		4	4
2	2	2	3
1	1	1	2
			1

Count how many heddles you need on each shaft for the threading



Count how many heddles you need on each shaft for the threading

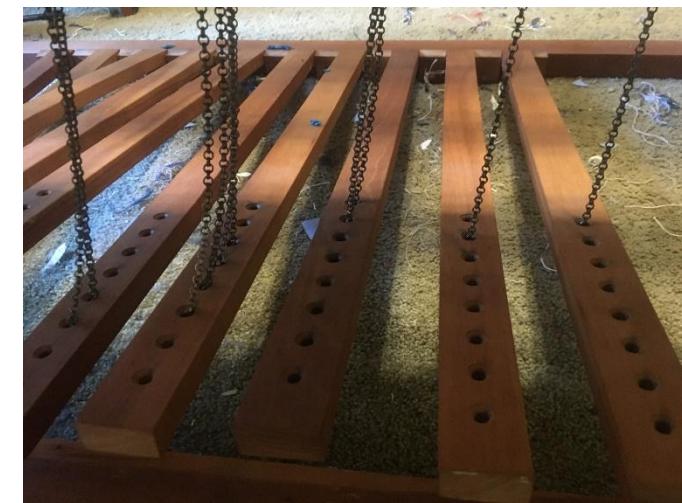
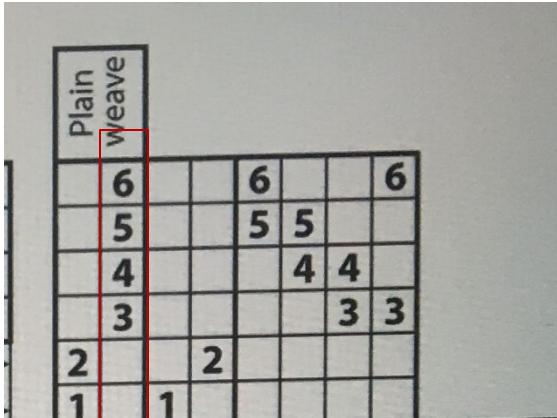


The tie up is just like before, but it's a good idea to put the pedals that have the most shafts in the middle where you have more leverage

Plain weave	
6	6 6
5	5 5
4	4 4
3	3 3
2	2
1	1



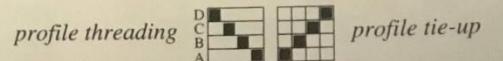
But it's a good idea to put the pedals that have the most shafts in the middle where you have more leverage



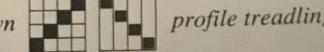
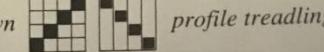
Translate the treadling to something easy to follow

Hem	
$\frac{3}{4} \times 8$	
$\frac{4}{3} \times 10$	
<hr/>	
$ \begin{array}{r} 3 \\ 1 \underset{\text{E}}{2} 5 \\ 4 \\ 2 \underset{\text{E}}{2} 5 \end{array} $	$\times 6$ ground pattern $\times 6$ ground pattern
$ \begin{array}{r} 3 \\ 1 \underset{\text{E}}{2} 6 \\ 4 \\ 2 \underset{\text{E}}{2} 6 \end{array} $	$\times 6$ Dodius underlay $8 \times$ Then do $1 + 3$ one more true
$ \begin{array}{r} 3 \\ 1 \underset{\text{E}}{2} 5 \\ 4 \\ 2 \underset{\text{E}}{2} 5 \end{array} $	$\times 6$ Then do Hem again
$ \begin{array}{r} 3 \\ 1 \underset{\text{E}}{2} 7 \\ 4 \\ 2 \underset{\text{E}}{2} 7 \end{array} $	$\times 6$
$ \begin{array}{r} 3 \\ 1 \underset{\text{E}}{2} 8 \\ 4 \underset{\text{E}}{2} 8 \\ 2 \underset{\text{E}}{2} 8 \end{array} $	$\times 6$ MOQUELUS $7 \text{ bad } 07 \times 6$

3. One profile draft interpreted in four different weave structures

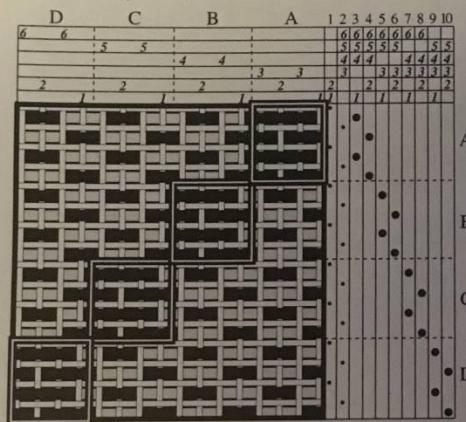


Compare the profile drawdown with the cloth diagrams in a-d.



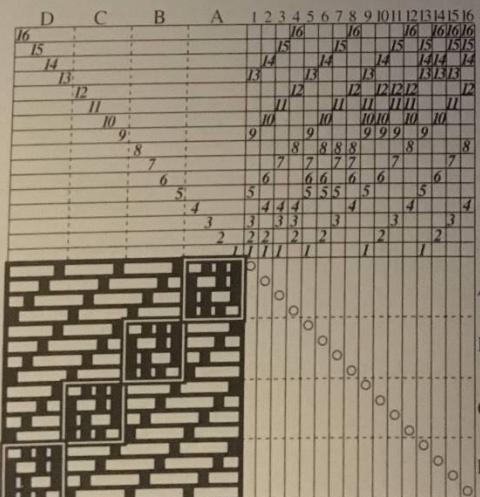
a. Summer and winter

Pattern: the supplementary weft floats over three warp ends, under one.
Background: the supplementary weft floats under three warp ends, over one.



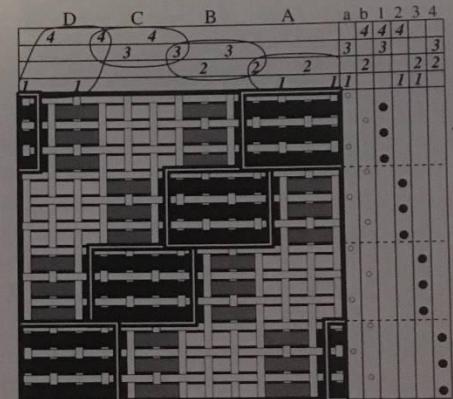
c. Turned twill

Pattern: 3/1 warp twill
Background: 1/3 weft twill



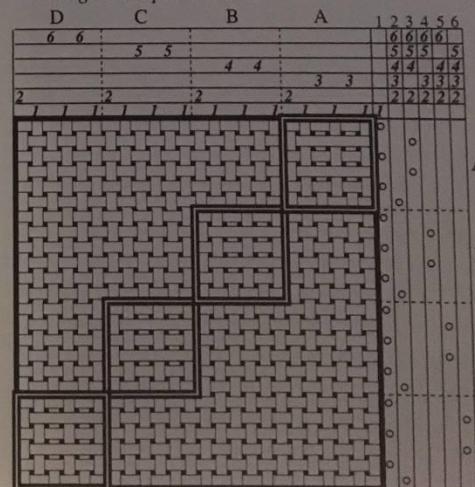
b. Overshot

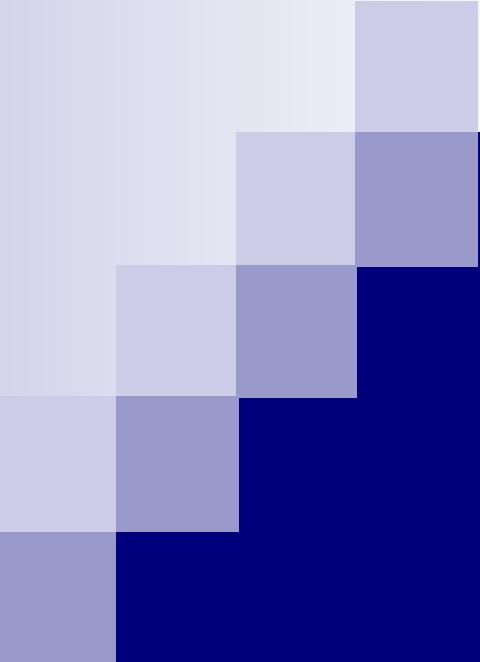
Pattern: the supplementary weft floats over all of the ends in one block.
Background: the supplementary weft floats under all of the ends in one block and forms halftones in the other two blocks.



d. Bronson lace

Pattern: the second and fourth weft threads float over five ends and under one.
Background: plain weave

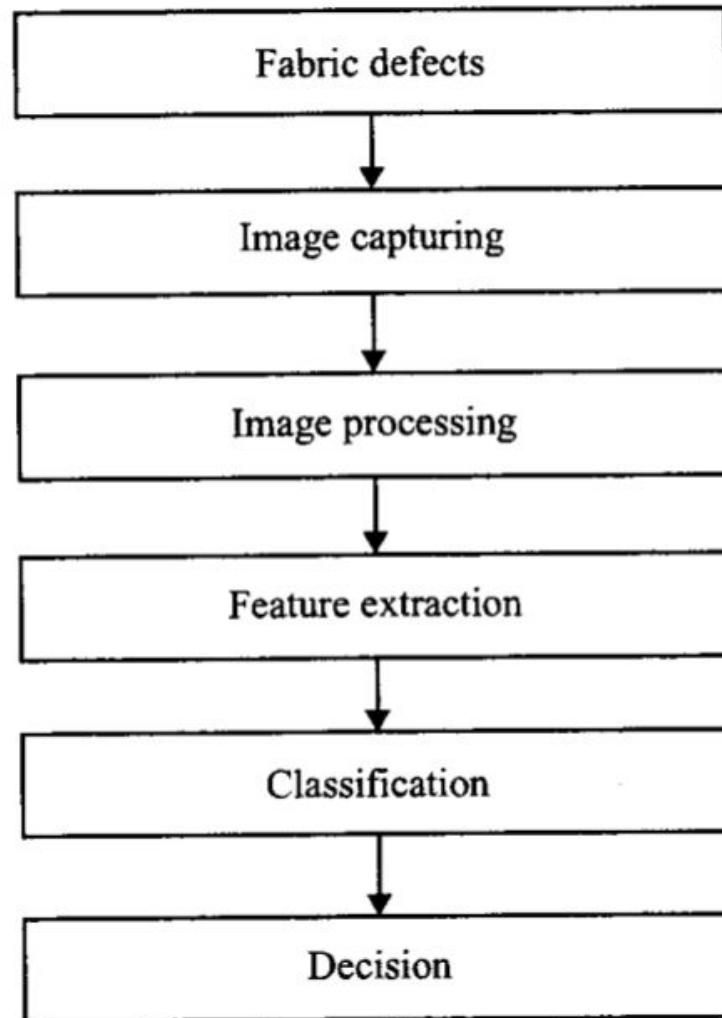




Machine Learning and Textiles

How is machine learning used in Textiles?

- Detecting fabric defects from images



How is machine learning used in Textiles?

- Predicting material quantity needs relative to product production needs
 - Note that there is some level of unpredictable loss from waste along the way at every stage
 - Process optimization is important for cost effectiveness



How is machine learning used in Textiles?

- Predicting fabric qualities from complex interplay of many decisions
 - Weave structure
 - Warp sett
 - Warp and weft properties
 - Fiber and fiber prep
 - Spinning and Plying process
 - Thickness

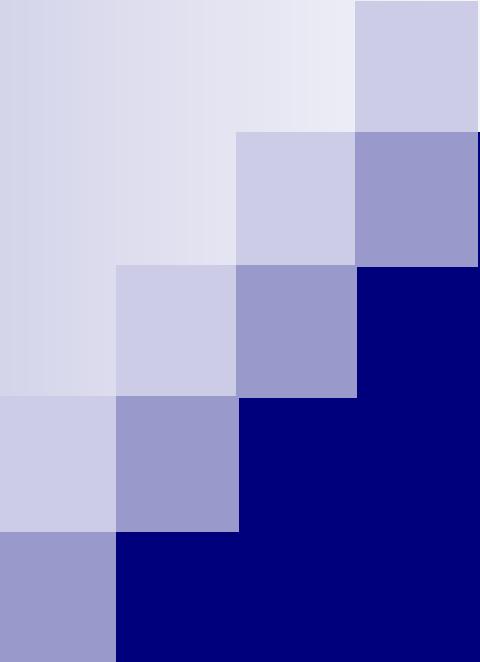


Same warp, different weft, different treadeling



Questions?





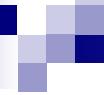
RH Looms





4 Shaft Weaving on RH





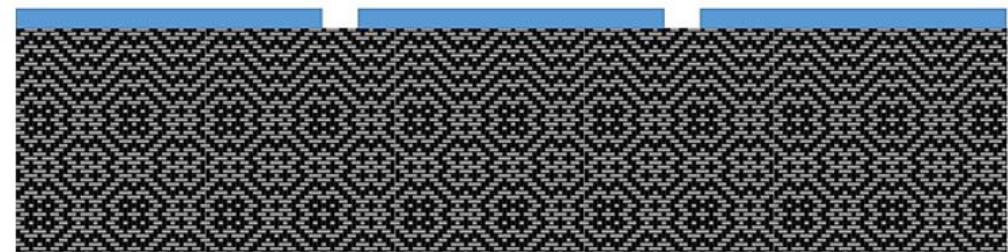
72

8

72

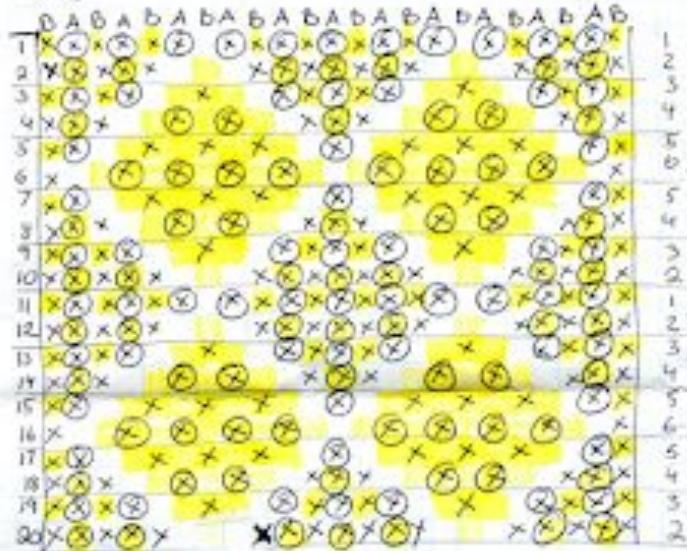
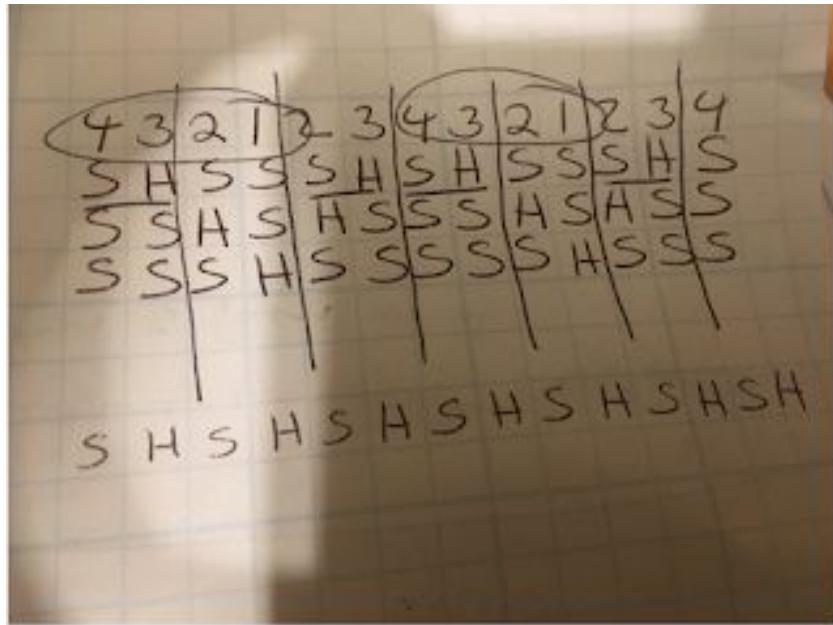
8

72



Ms and Ws draft
44X5+12 = 232

Side Panels
 $4 + 32 + 4 + 32 + 4 + 33$
The 4 is the light color from inside that faces it



123456
134142

Pichape en Pichape Quile

- A Past 2 So pattern
B Past 3 were you wet pattern
C Past 4 So Please were you not wet pattern

- plus 1 for positive
plus 2 if friend where you want positive
 plus 3 for placement where you don't want positive

