Bridge II

Outline

bridge2(Ea,W,nos)

    -add second story to last week's adjacency matrix

    -add second story to last week's coordinate matrix

    -add second story to last week's length matrix

    -apply forces, calling on gauss and trisolve

    -deform coordinates and plot

x=gauss(S,f)

    -put S into upper triangular form, call trisolve

x=trisolve(S,f)

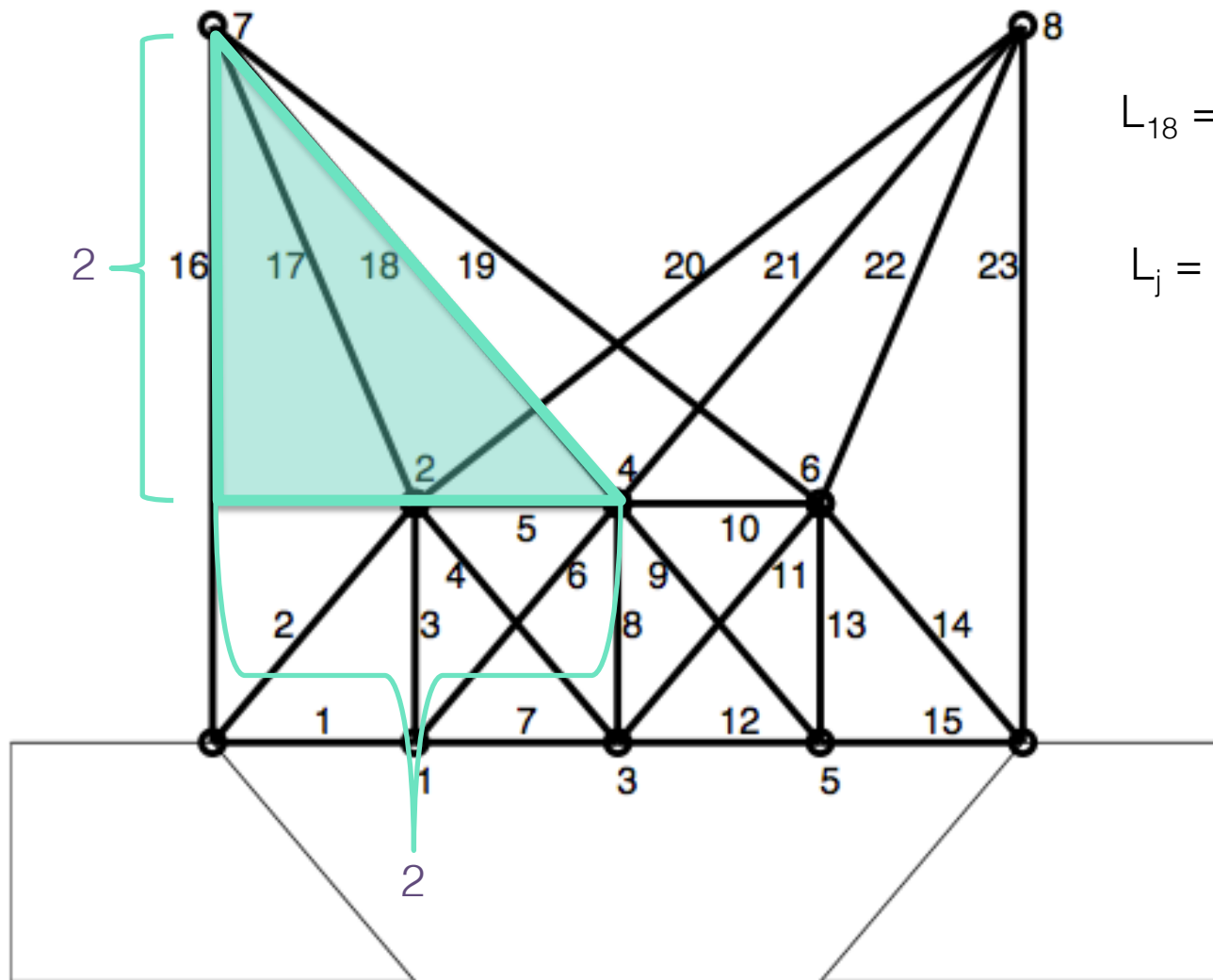   -solve upper triangular arrangement for x

1. Draw bridge on piece of paper
2. Label nodes
3. Label fibers
4. Label degrees of freedom
5. Label coordinates
6. Label lengths of new fibers
7. Write down the elongations of all the *new* fibers
→ Doing all of this tells you how to update last week's automation to account for new structure.

The *stylin'* bridge
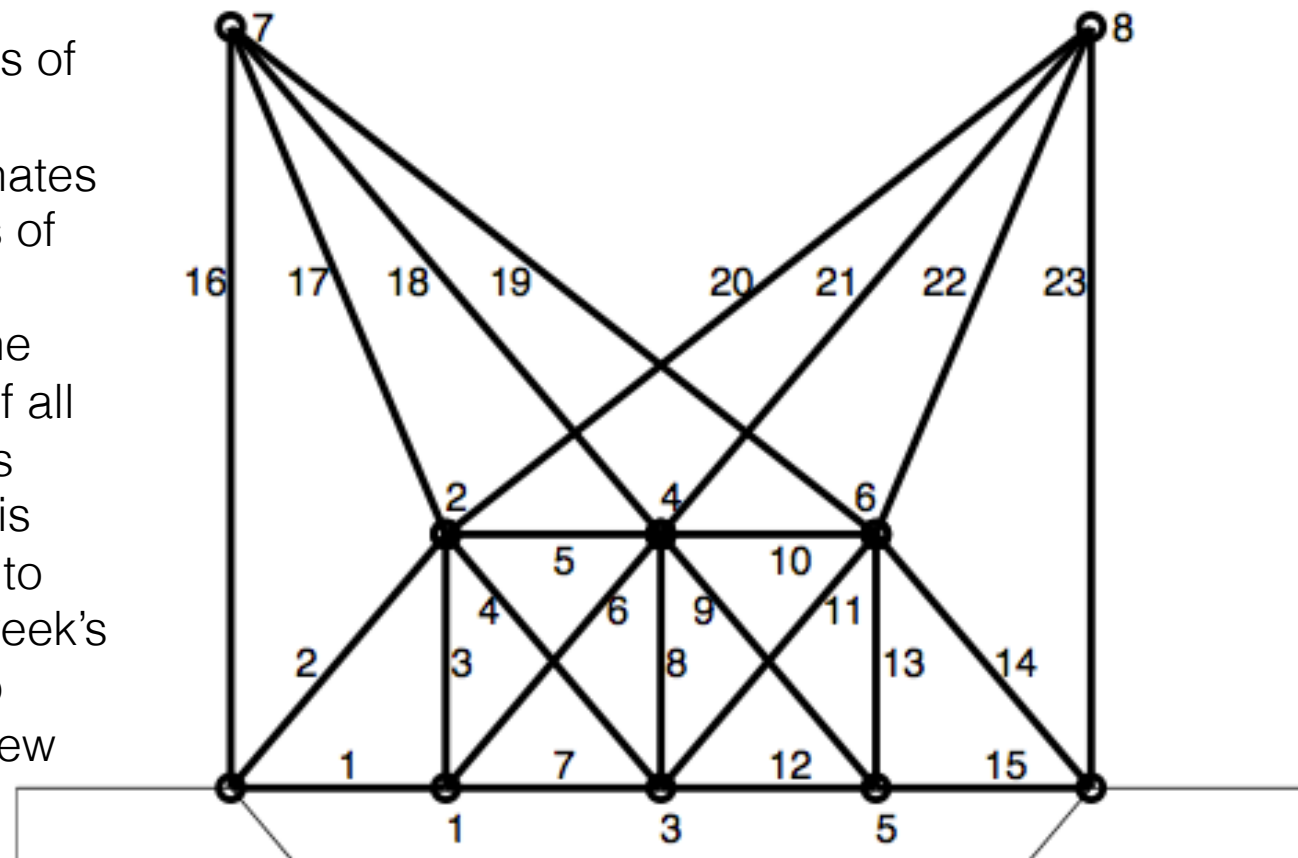
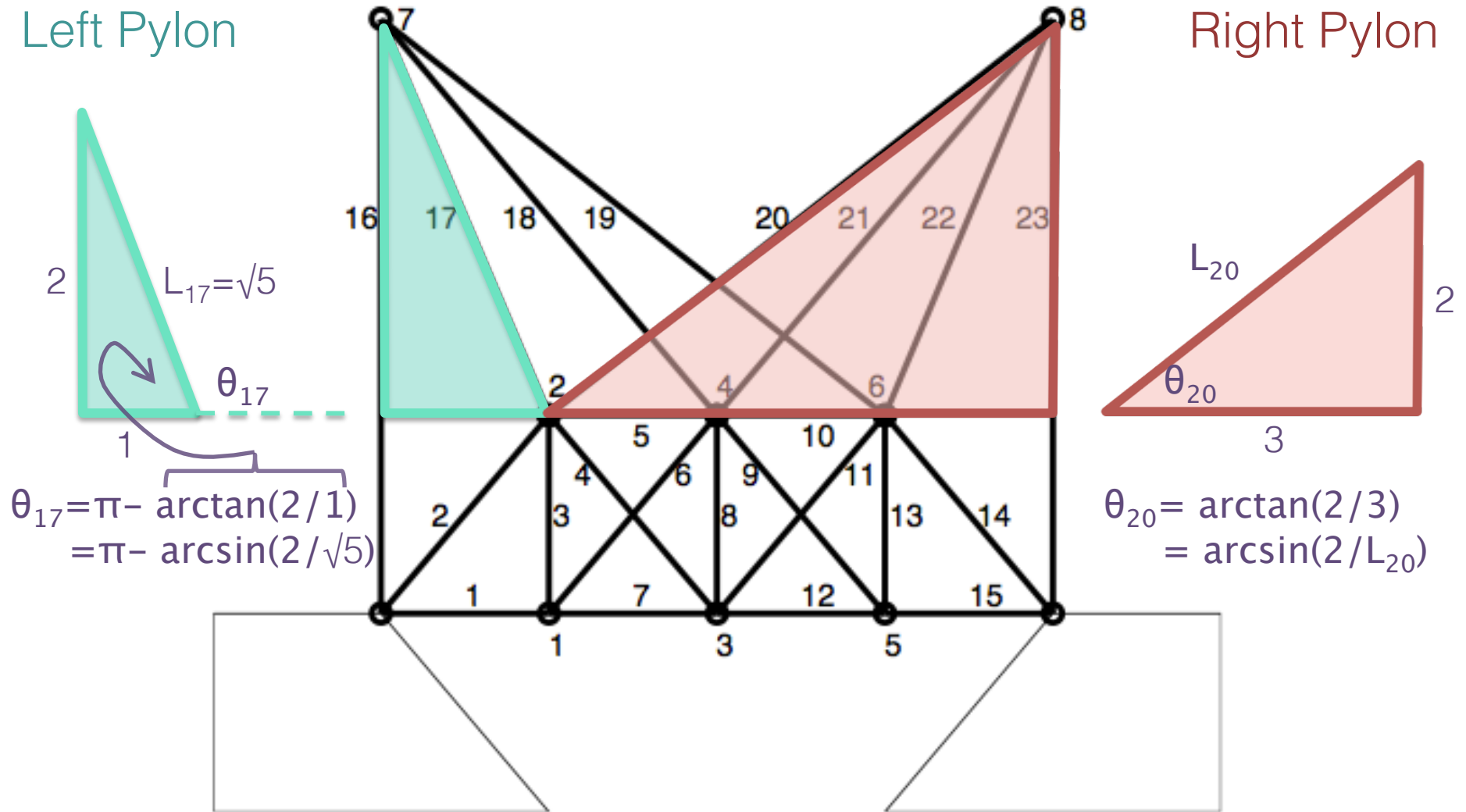$$e \approx (x_3 - x_1) \cos \theta + (x_4 - x_2) \sin \theta.$$

Pylon fiber *lengths*

$L_{18} = \text{sqrt}(2^2 + 2^2) = \text{sqrt}(8)$

$L_j = \text{sqrt}(2^2 + ?^2)$

Pylon fiber *angles*

Left Pylon

Right Pylon

$L_{17} = \sqrt{5}$

θ_{17}

$\theta_{17} = \pi - \arctan(2/1)$
$= \pi - \arcsin(2/\sqrt{5})$

L_{20}

θ_{20}

$\theta_{20} = \arctan(2/3)$
$= \arcsin(2/L_{20})$

x = gauss(S,f)

```
function x = gauss(S,f)
n = length(f);
★ S = [S | f]        Augment S with f
for k=1:n-1      k counts columns
★    1. r = row number, larger than or equal to k,
          with largest value (in magnitude) in column k
     2. if this largest value is really small then warn the user
★    3. swap row r and row k  ───→  S([j k],:) = S([k j],:)
        for j=k+1:n
            ★ mix row k into row j in order to eliminate S(j,k)
        end
end
                      < eps
1. if S(n,n) is really small then warn the user
2. strip off the changed f, i.e., copy column n+1 of S onto f
3. x = trisolve(S,f)
   return
```

⭐ **1. r = row number, larger than or equal to k, with largest value (in magnitude) in column k**

Quiz #7: If A is an n-by-n matrix and I look down column k and ask for the row number, at or below the diagonal, that contains the largest element, then I should type which one of the following choices to get the correct row number: rnum?

███████████████████████████████████████ 5 Responses

[y, rnum] = max(abs(A(k:n,k)))

0 Responses

[y, rnum] = max(abs(A(k:k:n)))

✓███████████████ 2 Responses

[y, rnum] = max(abs(A(k:n,k)));
rnum = rnum + k - 1;

Responses   7
% Students All Correct 28

★ **1. r = row number, larger than or equal to k, with largest value (in magnitude) in column k**

```
Saug =

     4    2    1    1
     2    4    2    2
     1    2    4    3

>> k

k =

     2

>> n

n =

     3

>> [y,i] = max(abs(Saug(k:n,k)))

y =

     4


i =

     1
```

```
Saug =

     4    2    1    1
     2    4    2    2
     1    2    4    3
```

Row 1 *of the submatrix
we are considering!!*

⭐ `mix row k into row j in order to eliminate S(j,k)`

`for j=k+1:n`

`    S(j,:) = S(j,:) + magicnumber*S(k,:)`

`end`

before the following line, we need to calculate this magic number. What is it? (I claim it is a one-liner)

row$_j$ (where we are trying to eliminate something) = row$_j$ + (some multiple, m, of) row$_k$

$$\begin{array}{cccc} ④ & 2 & 1 & 1 \\ ① & 2 & 4 & 3 \\ 2 & 4 & 2 & 2 \end{array}$$

$\overset{m}{\text{row}_2 = \text{row}_2 + (-1/4)\text{row}_1}$

k = 1
j = 2

$$\begin{array}{cccc} 4 & 2 & 1 & 1 \\ 0 & 3/2 & 15/4 & 11/4 \\ 0 & 3 & 3/2 & 3/2 \end{array}$$

x = gauss(S,f)

```
function x = gauss(S,f)
n = length(f);
★ S = [S | f]        Augment S with f
  for k=1:n-1        k counts columns
★   1. r = row number, larger than or equal to k,
           with largest value (in magnitude) in column k
    2. if this largest value is really small then warn the user
                                    └──┬──┘
★   3. swap row r and row k          < eps
       for j=k+1:n
         ★ mix row k into row j in order to eliminate S(j,k)
       end
  end
1. if S(n,n) is really small then warn the user
2. strip off the changed f, i.e., copy column n+1 of S onto f
3. x = trisolve(S,f)
  return
```

x = trisolve(S,f)

Backsubstitution code given in notes! Observe that S must be triangular.

```
x = zeros(n,1);
x(n) = f(n)/S(n,n);
for j=n-1:-1:1
    tmp = 0;
    for k=j+1:n
        tmp = tmp + S(j,k)*x(k);
    end
    x(j) = (f(j) - tmp)/S(j,j);
end
```

Question:

The loaded stylin bridge has a vehicle of weight W at each lower node. We can code this via f = zeros(dof,1) and

- A. f(2:2:dof-4) = -W
- B. f(2:4:dof) = -W
- C. f(2:4:dof-6) = -W

A note about work

- What is work?
  - Force applied over a distance
  - What is that force in our case?
  - Over what distance is the force being applied?

  - Remember to calculate and display the work as the bridge title!

A note about work

- What is work?
  - Force applied over a distance
  - What is that force in our case? *f*
  - Over what distance is the force being applied? *x*

  - Remember to calculate and display the work as the bridge title!