HW2.1

Nodal Displacements:

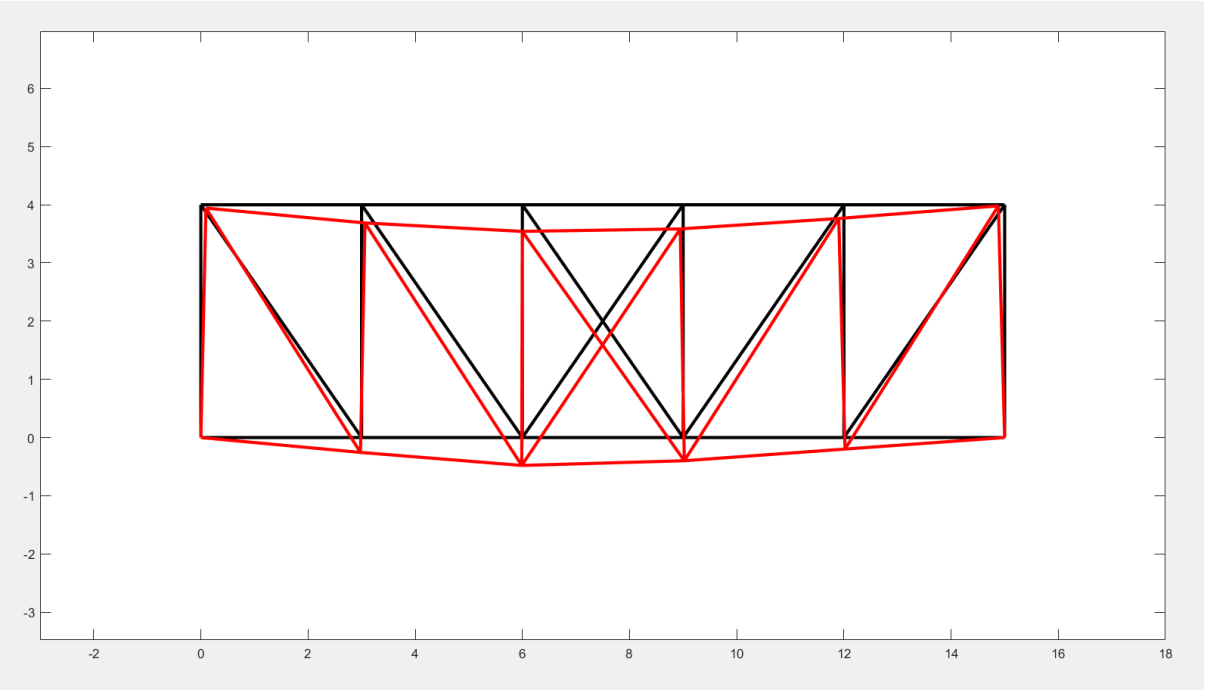
```
>> U

U =

   1.0e-04 *

  -0.042531645569621
  -0.502235232067512
  -0.022063291139241
  -0.941869198312239
   0.043063291139240
  -0.783202531645572
   0.042531645569620
  -0.388485232067512
  -0.231226441631506
  -0.037333333333333
  -0.189226441631506
  -0.463151898734179
  -0.105226441631506
  -0.815810126582281
  -0.002884669479607
  -0.899810126582281
   0.123115330520394
  -0.614235232067513
   0.186115330520394
  -0.112000000000000
```

Stress:

```
>> stress'

ans =

   1.0e+03 *

  -2.126582278482096
   1.023417721517816
   3.256329113922707
  -0.026582278485065
  -2.126582278473362
  -1.400000000000568
   2.100000000005764
   4.199999999994061
   5.117088607597816
   6.299999999999825
   3.150000000001822
  -4.199999999998427
  -4.200000000000830
   1.577215189874187
  -1.222784810127003
  -2.799999999998405
  -1.400000000000567
   5.250000000000656
   5.249999999999342
  -1.971518987342002
  -1.528481012657161
  -3.500000000002885
  -3.500000000000876
```

Deformed Structure

Mag = 100



HW2.2a

Displacements:

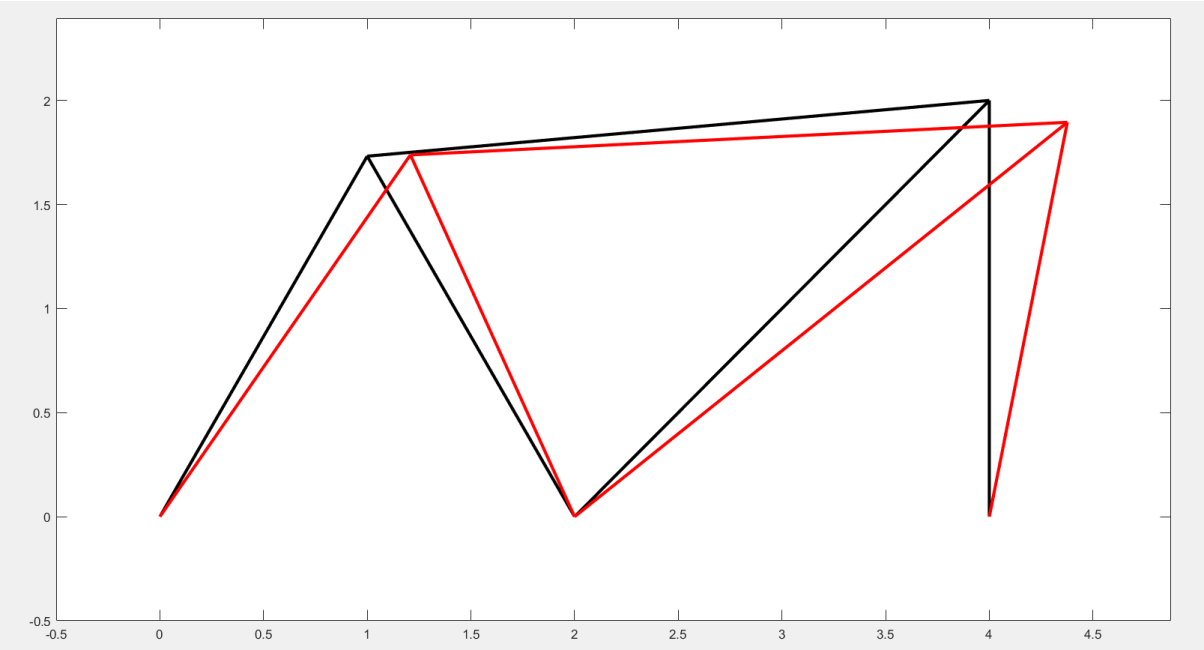
```
>> U

U =

   1.0e-05 *

   0.208275821819401
   0.006200815362160
   0.376302245151378
  -0.105163312133539
```

Stress:

```
>> stress'

ans =

   1.0e+04 *

   5.475398727113060
  -4.938392363455780
   6.778473326529701
  -5.258165606258916
   5.227623084314644
```

Visualization

Mag = 100000



HW2.2b

Displacement:

```
>> U

U =

   1.0e-05 *

   0.042242298924079
  -0.242242298924079
  -0.446206160860737
  -0.403963861936658
```

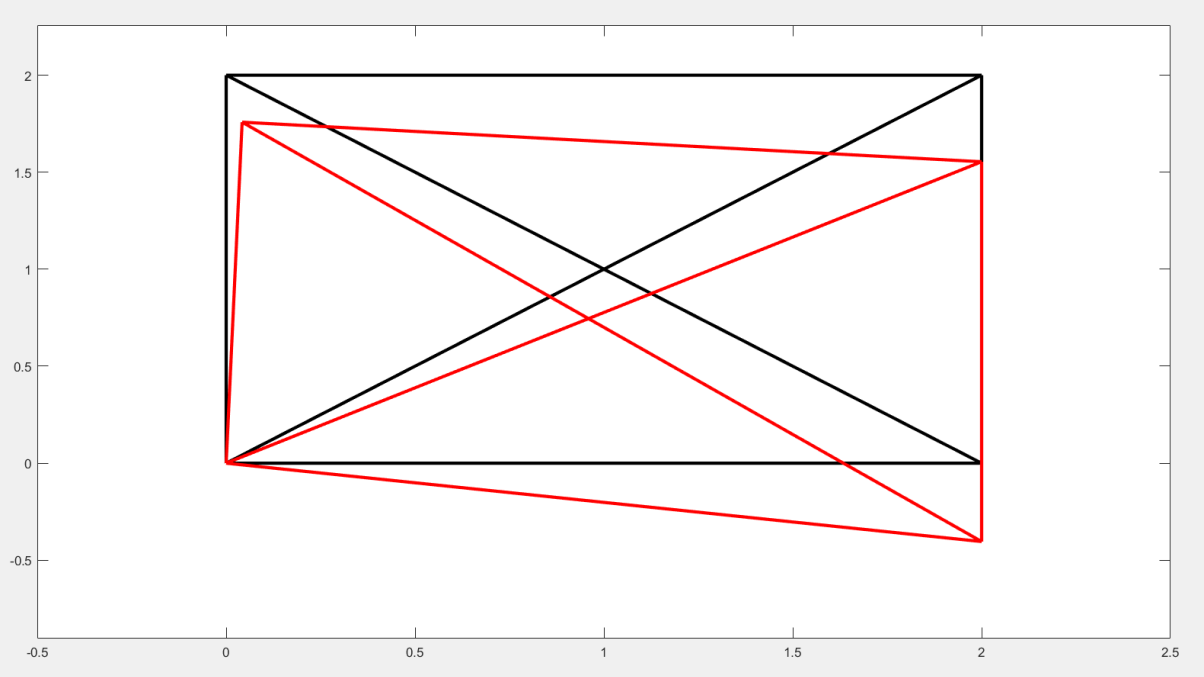
Stress:

```
>> stress'

ans =

   1.0e+05 *

  -0.211211494639450
  -0.211211494620394
   0.298698160203407
  -1.211211494656084
                   0
  -1.115515402161371
```

Visualization:

Mag = 100000

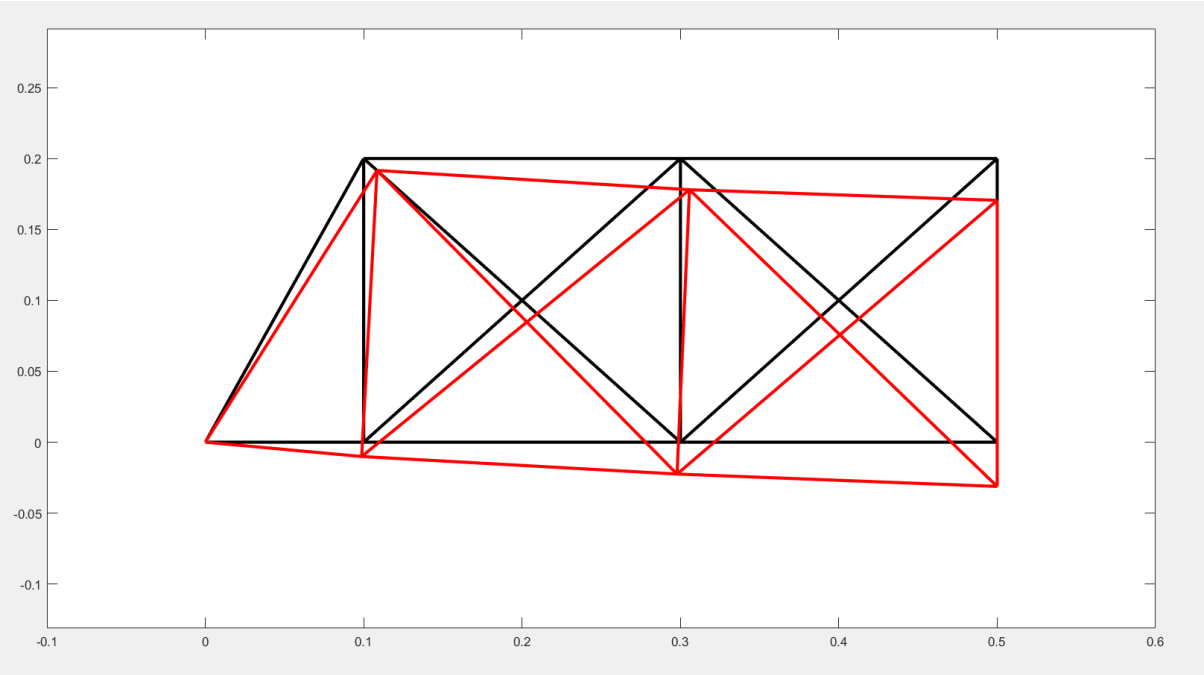
Note: Structure has been redrawn with roller supports on the right side to exploit the symmetry



HW2.3

First, let's try drawing the original structure and iterate from there:

Structure V1 (Mag = 100)



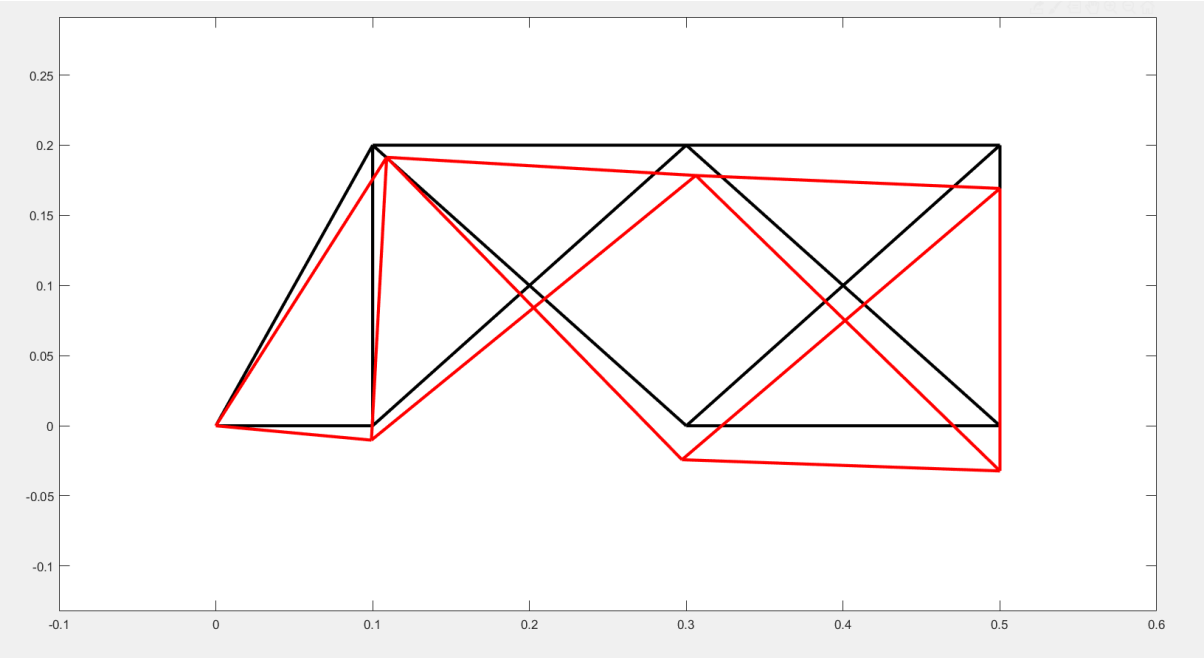
Weight and Optimization Criteria:

```
>> weight

weight =

   7.175341443212363

>> op_criteria

op_criteria =

   0.010131239840431
```

From the stress distribution, we can see that elements 5 and 10 experience the least stress while elements 1 and 3 experience the most stress. Thus, we remove elements 5 and 10 to get version 2 of our structure:

```
>> stress'

ans =

   1.0e+07 *

  -3.491195275461987
  -2.869182535415876
  -5.991802518877098
  -2.700845945209918
  -0.886098505429589
   2.236521478034548
   1.814747439778554
   1.849611089132269
  -2.566440441617358
   0.506874896096730
   1.849611089133996
  -2.566440441617823
   1.814747439778179
```

Structure V2



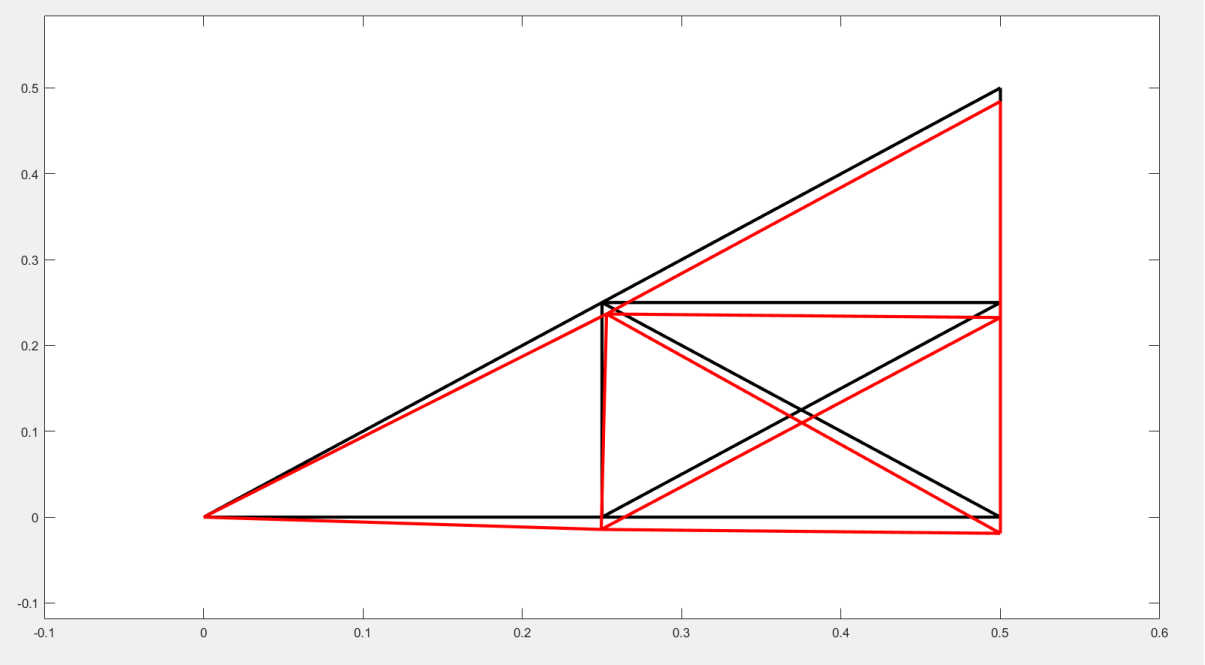
We see a significant reduction in both weight and optimization criteria:

```
>> weight

weight =

   6.170031794063630

>> op_criteria

op_criteria =

   0.009016700410598
```

Members 4, 6 (previously 7), and 11 (previously 13) are experiencing the least stress. The other members seem to be carrying more of the load. Let us redesign a structure more similar to V2.

```
>> stress'

ans =

   1.0e+07 *

  -3.491195275461987
  -3.004420758532662
  -6.363439191856834
  -1.679509216663544
   2.886221533601185
   1.679509216661744
   2.040866818413909
  -2.375184712335654
   2.375184712335399
  -2.040866818415314
   1.443110766798973
```

Structure V3:



Our weight has increased slightly, however, our optimization criteria is much lower (better):

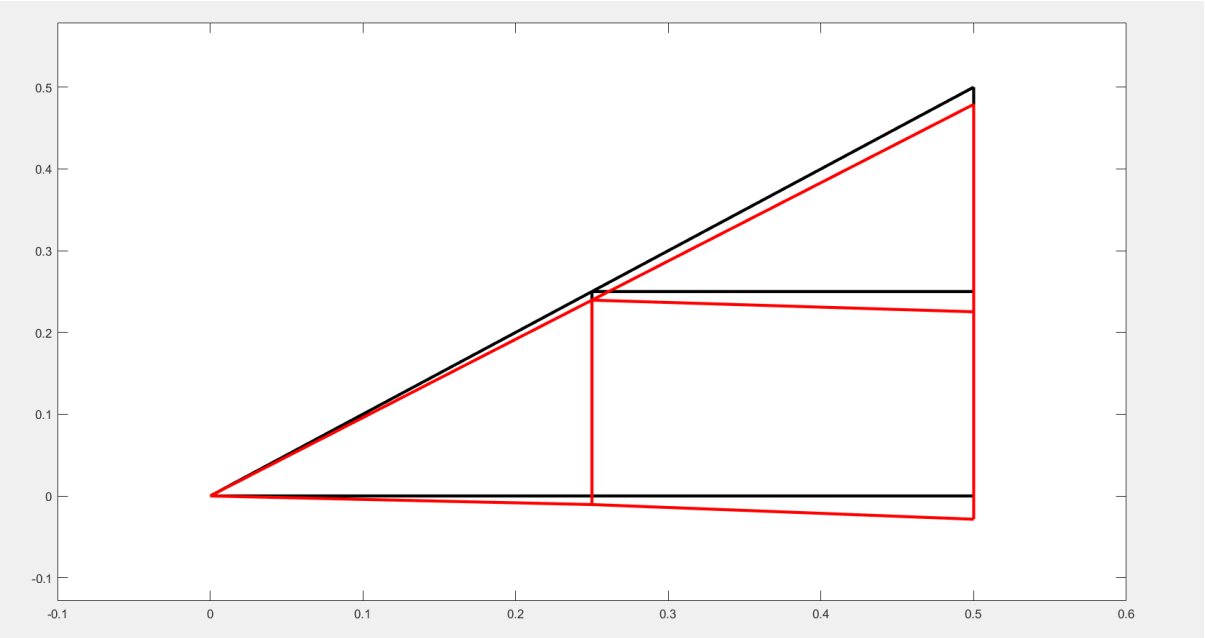
```
>> weight

weight =

   7.952536065552404

>> op_criteria

op_criteria =

   0.006600306954689
```

Stress:

```
>> stress'

ans =

   1.0e+07 *

  -0.400344536313768
   0.400344536313768
   1.164725303548363
   1.528761534464906
  -2.161995295676011
  -4.416051530751251
   0.800689072628276
   1.121710889318715
  -1.132345345755477
  -2.387027825363930
   1.164725303548363
```

Now, we iterate by removing members that bear little load and are not fundamental to the bridge structure. Those are members 8 and 9:

Structure V4:



Both our weight and optimization criteria are lower (better):

```
>> weight

weight =

   5.547064359571098

>> op_criteria

op_criteria =

   0.005284548511385
```

However, the stress is less evenly distributed.

```
>> stress'

ans =

   1.0e+07 *

                    0
                    0
   3.122619983462676
   3.122619983465302
  -4.416051530750085
  -4.416051530750085
   0.000000000001001
                    0
```