

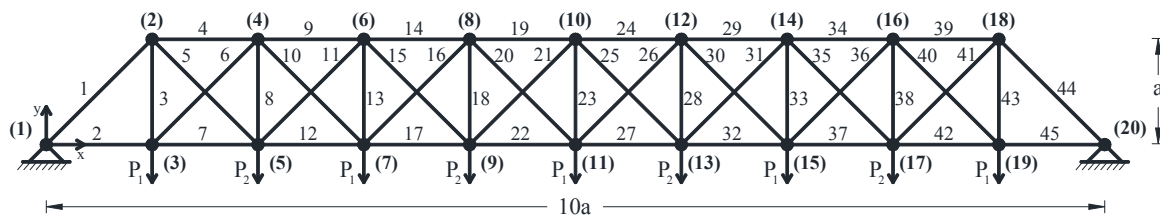
Optimization problem of the ISCSO 2011

Consider the sizing optimization of the 45-bar planar truss structure, shown below. The geometry and topology of the truss is assumed to be fixed. Nine vertical loads are applied simultaneously to the structure as follows:

Five loads of $P_1 = 20$ kips are applied at nodes 3, 7, 11, 15 and 19

Four loads of $P_2 = 15$ kips are applied at nodes 5, 9, 13 and 17

The stress limit is 30 ksi in both tension and compression for all the members. The displacement of all nodes in both horizontal and vertical directions is limited to ± 2.0 in. The material density is 0.283 lb/in.^3 and the modulus of elasticity is 30,000 ksi. The truss members are linked, according to the symmetry of the structure, into 23 groups, considered as 23 sizing variables. The cross-sectional areas of truss members should be selected from the list $A = \{0.1, 0.2, 0.3, \dots, 14.8, 14.9, 15\} \text{ in.}^2$ Thus, the available cross-sectional areas are from 0.1 to 15 in.^2 (including both 0.1 and 15) with 0.1 in.^2 increments.



Forty five-bar truss structure, $a = 200$ in.

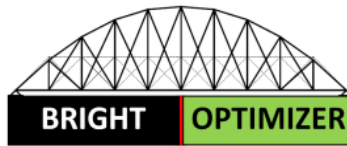
The member grouping is given below:

Sizing variables	Members
G_1	1, 44
G_2	2, 45
G_3	3, 43
G_4	4, 39
G_5	5, 41
G_6	6, 40
G_7	7, 42
G_8	8, 38
G_9	9, 34
G_{10}	10, 36
G_{11}	11, 35
G_{12}	12, 37

Sizing variables	Members
G_{13}	13, 33
G_{14}	14, 29
G_{15}	15, 31
G_{16}	16, 30
G_{17}	17, 32
G_{18}	18, 28
G_{19}	19, 24
G_{20}	20, 26
G_{21}	21, 25
G_{22}	22, 27
G_{23}	23

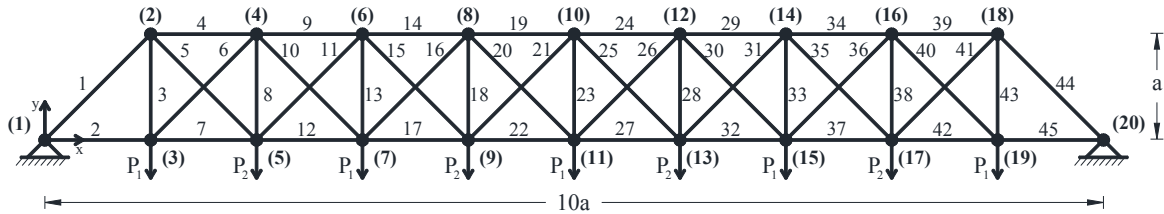
For sizing optimization of the given truss, find the sizing variables (G_1 to G_{23}) which minimize the weight of the structure according to the given constraints. For the sake of conformity, please solve the problem in British units. Submit your code, the final optimum design, and a description of the approach before the deadline.

Good Luck!



ISCSO 2011

The optimum design reported by the winner of ISCSO 2011, *Saartje Arnout*



Sizing variables	Members	Sections (in. ²)
G ₁	1, 44	9.1
G ₂	2, 45	6.8
G ₃	3, 43	4.6
G ₄	4, 39	8.2
G ₅	5, 41	2.5
G ₆	6, 40	5.2
G ₇	7, 42	3.1
G ₈	8, 38	0.1
G ₉	9, 34	15
G ₁₀	10, 36	5.1
G ₁₁	11, 35	1.7
G ₁₂	12, 37	0.1
G ₁₃	13, 33	0.1
G ₁₄	14, 29	15
G ₁₅	15, 31	1.8
G ₁₆	16, 30	3.2
G ₁₇	17, 32	6
G ₁₈	18, 28	0.1
G ₁₉	19, 24	15
G ₂₀	20, 26	2.9
G ₂₁	21, 25	0.1
G ₂₂	22, 27	7.6
G ₂₃	23	0.6
Mass (lb)	14341.21	