# Description of the 1300 Truss Cutting Problems

## Introduction.

There are 2 groups of sample data. The first set (files r___.txt) has several copies of each piece type and is based on assumptions relating to the real problem. The second set (files a___.txt) is more general in that each piece is different.

## File names.

The file names are of the form r*nwsob_xx*.txt or a*nwsob_xx*.txt where
*n* = total number of pieces in 100's (*n* = 1,2,3,4,5)
*w* = width in 100's of mm (*w* = 2,4). This is based on observations of real trusses.
*s* is a shape parameter for the distribution of frequencies of each type. (s = 0,1,2) When *s* = 0 the quantities are more spread, when *s* = 2 they are more concentrated around the mean.
*o* indicates whether the data is made up of one or more orders (*o* = 1,2) When *o* = 1 there is just one order, when *o* = 2 there is more than one. (We make this distinction because we put a limit on the number of angles relating to any single order)
*b* indicates whether or not the lengths are uniformly distributed (*b* = 1,2). When *b* = 1 lengths are uniform between 2 limits, when *b*= 2 at least one order in the set has 1 or 2 long piece types with the rest being shorter. This is an observed property of some roof designs.
*xx* = file index, *xx* = 1,10
For files a___.txt only *s*=0, *o*=2 and *b*=1 are relevant.

## File contents.

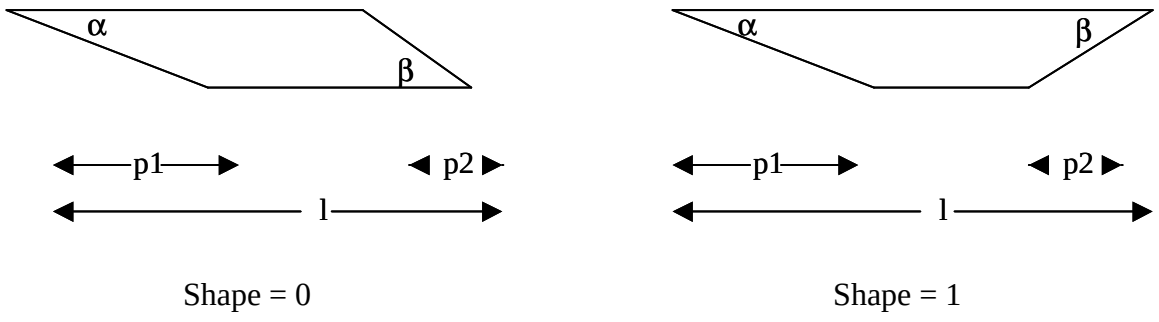
Line 1: number_of_pieces, number_of_piece_types, number_of_orders[1], seed_index[2].

1. This is included as it may be of interest when analysing the results. Note that information on which pieces belong to each order is not recorded.
2. Each data file is generated using a different seed. These seeds are stored in a file seed1000.txt. The value of seed-index points to the seed used so that data can be regenerated if required.

Lines 2 onwards (one line for each piece type): number_of_pieces, total_length[1,2], projected_length_1[1,2], projected_length_2[1,2], angle_1[1,3], angle_2[1,3], shape_indicator[1,4] .

1. Figure 1 indicates the meaning of these variables
2. All lengths in mm
3. Angles in degrees
4. Note that the shape is not relevant to the solution process

**Figure 1**




Shape = 0 Shape = 1

l = total_length, p*x* = projected_length_*x*, *x*= 1,2, α = angle_1, β = angle_2

## Generation details.

*Number of piece types.*
For the '**r**eal' data sets the number of piece types ranges from 10 to 30, for the '**a**rtificial' data sets the number of piece types is equal to the number of pieces.

*Number of orders.*
For 'real' datasets when $o = 1$ the number of orders = 1. When $o = 2$ the number of orders ranges from 2 to number_of_piece_types/5. The number of pieces, *q(i),* in each order is then generated according to the formula

$$q(i) = \min\left(1, \frac{r(i)}{\sum_{i=1}^{m} r(i)}.n\right)$$

where $r(i)$ =is a (0,1) random number, $m$ is the number of orders and $n$ the number of pieces. The correct number of the $q(i)$'s are then rounded up or down to ensure a set of integer values that sum to $n$. For artificial data sets the number of orders is equal to the number of pieces.

*Number of pieces of each type.*
The number of pieces of type $j$, b($j$) is generated according to the formula

$$b(j) = \min\left(1, \frac{r(j)+c}{\sum_{i=1}^{k} (r(j)+c)}.n\right)$$

where $r(j)$ is a (0,1) random number, $k$ is the number of piece types, $n$ the number of pieces and $c$ is a constant based on the 'shape' parameter $s$. $c$ is given by the formula

$$c = \frac{0.06 s^2 n}{k}$$

*Angles.*
Angles range from 30° – 90°. For each order the number of different angles is a random number between 3 and 10. One of these is always 90° and the remainder are chosen randomly between 30° and 89°. The projection associated with each angle is then calculated, based on the width parameter. The number of piece types in the order that have the same angle at both ends is a random percentage between 0% and 50% for the 'real' data and 0 for the 'artificial' data. For each piece type the angle(s) are generated after the length. The sum of the 2 projections is not allowed to exceed half the total piece length. Depending on whether the piece is to have equal or different angles one angle or a pair of angles is randomly selected from those available that also satisfy this constraint. If the piece length is too short for there to be any compatible angles then the angle(s) are selected randomly from the available set and the length is reset to the minimum that is consistent with the chosen angle(s).

*Lengths.*
Lengths are generated in the range 300mm to 3600mm. When $b = 1$ all length are selected uniformly from this range.

If $b = 2$ then at least one order in the data set will have one or two long piece types with the rest being considerably shorter. In this case the 'long' pieces are generated in the range 2700mm to 3600mm and the 'short' pieces in the range 300mm to 1800mm. For the first order long and short pieces are assumed. The number of 'long' piece types (1 or 2) is selected at random, as are the indices of these types. The lengths of the pieces are then generated in the appropriate range. For the remaining orders the number of long piece types is randomly selected from the set (0,1,2). If 0 then lengths are generated uniformly. Otherwise the procedure for the first order is used.

*Shape.*
As more pieces in truss diagrams appear to be of type shape = 1 than shape = 0, shape = 0 occurs with 10% probability. As this does not affect the solution this parameter is not important.

*General note.*
To avoid rounding differences, different accuracies of pi when converting to radians etc, we use the projected lengths rather than the angles so that all dimensions are integer numbers of millimetres.