> *restart*; *with*(*LinearAlgebra*) :

> $n := 10;$

$$n := 10 \tag{1}$$

> Theta := *Matrix*(*n*, *symbol* = theta)

$$\Theta := \begin{bmatrix} \theta_{1,1} & \theta_{1,2} & \theta_{1,3} & \theta_{1,4} & \theta_{1,5} & \theta_{1,6} & \theta_{1,7} & \theta_{1,8} & \theta_{1,9} & \theta_{1,10} \\ \theta_{2,1} & \theta_{2,2} & \theta_{2,3} & \theta_{2,4} & \theta_{2,5} & \theta_{2,6} & \theta_{2,7} & \theta_{2,8} & \theta_{2,9} & \theta_{2,10} \\ \theta_{3,1} & \theta_{3,2} & \theta_{3,3} & \theta_{3,4} & \theta_{3,5} & \theta_{3,6} & \theta_{3,7} & \theta_{3,8} & \theta_{3,9} & \theta_{3,10} \\ \theta_{4,1} & \theta_{4,2} & \theta_{4,3} & \theta_{4,4} & \theta_{4,5} & \theta_{4,6} & \theta_{4,7} & \theta_{4,8} & \theta_{4,9} & \theta_{4,10} \\ \theta_{5,1} & \theta_{5,2} & \theta_{5,3} & \theta_{5,4} & \theta_{5,5} & \theta_{5,6} & \theta_{5,7} & \theta_{5,8} & \theta_{5,9} & \theta_{5,10} \\ \theta_{6,1} & \theta_{6,2} & \theta_{6,3} & \theta_{6,4} & \theta_{6,5} & \theta_{6,6} & \theta_{6,7} & \theta_{6,8} & \theta_{6,9} & \theta_{6,10} \\ \theta_{7,1} & \theta_{7,2} & \theta_{7,3} & \theta_{7,4} & \theta_{7,5} & \theta_{7,6} & \theta_{7,7} & \theta_{7,8} & \theta_{7,9} & \theta_{7,10} \\ \theta_{8,1} & \theta_{8,2} & \theta_{8,3} & \theta_{8,4} & \theta_{8,5} & \theta_{8,6} & \theta_{8,7} & \theta_{8,8} & \theta_{8,9} & \theta_{8,10} \\ \theta_{9,1} & \theta_{9,2} & \theta_{9,3} & \theta_{9,4} & \theta_{9,5} & \theta_{9,6} & \theta_{9,7} & \theta_{9,8} & \theta_{9,9} & \theta_{9,10} \\ \theta_{10,1} & \theta_{10,2} & \theta_{10,3} & \theta_{10,4} & \theta_{10,5} & \theta_{10,6} & \theta_{10,7} & \theta_{10,8} & \theta_{10,9} & \theta_{10,10} \end{bmatrix} \tag{2}$$

> *LinearAlgebra*:-*Map*$\left[(i,j) \to evalb(i \leq j) \right](x \to 0, \text{Theta});$

$$\begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \theta_{2,1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \theta_{3,1} & \theta_{3,2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \theta_{4,1} & \theta_{4,2} & \theta_{4,3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \theta_{5,1} & \theta_{5,2} & \theta_{5,3} & \theta_{5,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ \theta_{6,1} & \theta_{6,2} & \theta_{6,3} & \theta_{6,4} & \theta_{6,5} & 0 & 0 & 0 & 0 & 0 \\ \theta_{7,1} & \theta_{7,2} & \theta_{7,3} & \theta_{7,4} & \theta_{7,5} & \theta_{7,6} & 0 & 0 & 0 & 0 \\ \theta_{8,1} & \theta_{8,2} & \theta_{8,3} & \theta_{8,4} & \theta_{8,5} & \theta_{8,6} & \theta_{8,7} & 0 & 0 & 0 \\ \theta_{9,1} & \theta_{9,2} & \theta_{9,3} & \theta_{9,4} & \theta_{9,5} & \theta_{9,6} & \theta_{9,7} & \theta_{9,8} & 0 & 0 \\ \theta_{10,1} & \theta_{10,2} & \theta_{10,3} & \theta_{10,4} & \theta_{10,5} & \theta_{10,6} & \theta_{10,7} & \theta_{10,8} & \theta_{10,9} & 0 \end{bmatrix} \tag{3}$$

> $A :=$
  ImportMatrix("/Users/polisank/Professionnel/Travaux/Recherche/Graphical models/graph-generation/marthyna/chordal_adj.txt", *delimiter* = " ");

$$A := \begin{bmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 1 & 1 & 0 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 1 & 1 & 1 \\ 0 & 1 & 1 & 1 & 0 & 0 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 1 & 1 & 1 & 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 & 1 & 0 & 0 & 1 & 0 & 1 \\ 0 & 1 & 1 & 1 & 1 & 0 & 0 & 1 & 1 & 0 \end{bmatrix}$$

(4)

> Theta := $LinearAlgebra$:-$Map\big[\,(i,j) \rightarrow evalb\,(A[i,j]=0 \textbf{ and } j < i\,)\,\big]\Big(x \rightarrow \dfrac{\text{Pi}}{2},\,\text{Theta}\Big);$

$$\Theta := \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \theta_{2,1} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \dfrac{\pi}{2} & \dfrac{\pi}{2} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \dfrac{\pi}{2} & \theta_{4,2} & \theta_{4,3} & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ \dfrac{\pi}{2} & \theta_{5,2} & \theta_{5,3} & \theta_{5,4} & 0 & 0 & 0 & 0 & 0 & 0 \\ \dfrac{\pi}{2} & \dfrac{\pi}{2} & \dfrac{\pi}{2} & \theta_{6,4} & \dfrac{\pi}{2} & 0 & 0 & 0 & 0 & 0 \\ \dfrac{\pi}{2} & \theta_{7,2} & \dfrac{\pi}{2} & \theta_{7,4} & \dfrac{\pi}{2} & \dfrac{\pi}{2} & 0 & 0 & 0 & 0 \\ \dfrac{\pi}{2} & \theta_{8,2} & \theta_{8,3} & \theta_{8,4} & \theta_{8,5} & \theta_{8,6} & \dfrac{\pi}{2} & 0 & 0 & 0 \\ \dfrac{\pi}{2} & \dfrac{\pi}{2} & \dfrac{\pi}{2} & \theta_{9,4} & \theta_{9,5} & \dfrac{\pi}{2} & \dfrac{\pi}{2} & \theta_{9,8} & 0 & 0 \\ \dfrac{\pi}{2} & \theta_{10,2} & \theta_{10,3} & \theta_{10,4} & \theta_{10,5} & \dfrac{\pi}{2} & \dfrac{\pi}{2} & \theta_{10,8} & \theta_{10,9} & 0 \end{bmatrix}$$

(5)

> $b := (i,j) \rightarrow \cos(\text{Theta}[i,j]) \cdot product(\sin('\text{Theta}[i,k]'),\, k=1 ..j-1)$

$$b := (i,j) \mapsto \cos\big(\Theta_{i,j}\big) \cdot \left(\prod_{k=1}^{j-1} \sin\big({}'\Theta_{i,k}{}'\big) \right)$$

(6)

> $B := Matrix(n,b)$

$B := \big[\, [\,1,\,0,\,0,\,0,\,0,\,0,\,0,\,0,\,0,\,0\,],$ **(7)**

$\quad [\,\cos(\theta_{2,1}),\,\sin(\theta_{2,1}),\,0,\,0,\,0,\,0,\,0,\,0,\,0,\,0\,],$

$\quad [\,0,\,0,\,1,\,0,\,0,\,0,\,0,\,0,\,0,\,0\,],$

$\quad [\,0,\,\cos(\theta_{4,2}),\,\cos(\theta_{4,3})\sin(\theta_{4,2}),\,\sin(\theta_{4,2})\sin(\theta_{4,3}),\,0,\,0,\,0,\,0,\,0,\,0\,],$

$\quad [\,0,\,\cos(\theta_{5,2}),\,\cos(\theta_{5,3})\sin(\theta_{5,2}),\,\cos(\theta_{5,4})\sin(\theta_{5,2})\sin(\theta_{5,3}),$

$\quad \sin(\theta_{5,2})\sin(\theta_{5,3})\sin(\theta_{5,4}),\,0,\,0,\,0,\,0,\,0\,],$

$\quad [\,0,\,0,\,0,\,\cos(\theta_{6,4}),\,0,\,\sin(\theta_{6,4}),\,0,\,0,\,0,\,0\,],$

$\quad [\,0,\,\cos(\theta_{7,2}),\,0,\,\cos(\theta_{7,4})\sin(\theta_{7,2}),\,0,\,0,\,\sin(\theta_{7,2})\sin(\theta_{7,4}),\,0,\,0,\,0\,],$

$\quad [\,0,\,\cos(\theta_{8,2}),\,\cos(\theta_{8,3})\sin(\theta_{8,2}),\,\cos(\theta_{8,4})\sin(\theta_{8,2})\sin(\theta_{8,3}),$

$\quad \cos(\theta_{8,5})\sin(\theta_{8,2})\sin(\theta_{8,3})\sin(\theta_{8,4}),\,\cos(\theta_{8,6})\sin(\theta_{8,2})\sin(\theta_{8,3})\sin(\theta_{8,4})\sin(\theta_{8,5}),$

$\quad 0,\,\sin(\theta_{8,2})\sin(\theta_{8,3})\sin(\theta_{8,4})\sin(\theta_{8,5})\sin(\theta_{8,6}),\,0,\,0\,],$

$\quad [\,0,\,0,\,0,\,\cos(\theta_{9,4}),\,\cos(\theta_{9,5})\sin(\theta_{9,4}),\,0,\,0,\,\cos(\theta_{9,8})\sin(\theta_{9,4})\sin(\theta_{9,5}),$

$\quad \sin(\theta_{9,4})\sin(\theta_{9,5})\sin(\theta_{9,8}),\,0\,],$

$\quad [\,0,\,\cos(\theta_{10,2}),\,\cos(\theta_{10,3})\sin(\theta_{10,2}),\,\cos(\theta_{10,4})\sin(\theta_{10,2})\sin(\theta_{10,3}),$

$\quad \cos(\theta_{10,5})\sin(\theta_{10,2})\sin(\theta_{10,3})\sin(\theta_{10,4}),\,0,\,0,$

$\quad \cos(\theta_{10,8})\sin(\theta_{10,2})\sin(\theta_{10,3})\sin(\theta_{10,4})\sin(\theta_{10,5}),$

$\quad \cos(\theta_{10,9})\sin(\theta_{10,2})\sin(\theta_{10,3})\sin(\theta_{10,4})\sin(\theta_{10,5})\sin(\theta_{10,8}),$

$\quad \sin(\theta_{10,2})\sin(\theta_{10,3})\sin(\theta_{10,4})\sin(\theta_{10,5})\sin(\theta_{10,8})\sin(\theta_{10,9})\,]\,\big]$

> $R := B \cdot B\verb|^%|T$

$R := \big[\,[\,1,\,\cos(\theta_{2,1}),\,0,\,0,\,0,\,0,\,0,\,0,\,0,\,0\,],$ **(8)**

$\quad [\,\cos(\theta_{2,1}),\,\cos(\theta_{2,1})^2+\sin(\theta_{2,1})^2,\,0,\,\sin(\theta_{2,1})\cos(\theta_{4,2}),\,\sin(\theta_{2,1})\cos(\theta_{5,2}),\,0,$

$\quad \sin(\theta_{2,1})\cos(\theta_{7,2}),\,\sin(\theta_{2,1})\cos(\theta_{8,2}),\,0,\,\sin(\theta_{2,1})\cos(\theta_{10,2})\,],$

$\quad [\,0,\,0,\,1,\,\cos(\theta_{4,3})\sin(\theta_{4,2}),\,\cos(\theta_{5,3})\sin(\theta_{5,2}),\,0,\,0,\,\cos(\theta_{8,3})\sin(\theta_{8,2}),\,0,$

$\quad \cos(\theta_{10,3})\sin(\theta_{10,2})\,],$

$\quad [\,0,\,\sin(\theta_{2,1})\cos(\theta_{4,2}),\,\cos(\theta_{4,3})\sin(\theta_{4,2}),\,\cos(\theta_{4,2})^2+\cos(\theta_{4,3})^2\sin(\theta_{4,2})^2$

$\quad +\sin(\theta_{4,2})^2\sin(\theta_{4,3})^2,\,\cos(\theta_{4,2})\cos(\theta_{5,2})+\cos(\theta_{4,3})\sin(\theta_{4,2})\cos(\theta_{5,3})\sin(\theta_{5,2})$

$\quad +\sin(\theta_{4,2})\sin(\theta_{4,3})\cos(\theta_{5,4})\sin(\theta_{5,2})\sin(\theta_{5,3}),\,\sin(\theta_{4,2})\sin(\theta_{4,3})\cos(\theta_{6,4}),$

$\quad \cos(\theta_{4,2})\cos(\theta_{7,2})+\sin(\theta_{4,2})\sin(\theta_{4,3})\cos(\theta_{7,4})\sin(\theta_{7,2}),\,\cos(\theta_{4,2})\cos(\theta_{8,2})$

$\quad +\cos(\theta_{4,3})\sin(\theta_{4,2})\cos(\theta_{8,3})\sin(\theta_{8,2})$

$+ \sin\left(\theta_{4,2}\right) \sin\left(\theta_{4,3}\right) \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right), \sin\left(\theta_{4,2}\right) \sin\left(\theta_{4,3}\right) \cos\left(\theta_{9,4}\right),$

$\cos\left(\theta_{4,2}\right) \cos\left(\theta_{10,2}\right) + \cos\left(\theta_{4,3}\right) \sin\left(\theta_{4,2}\right) \cos\left(\theta_{10,3}\right) \sin\left(\theta_{10,2}\right)$

$+ \sin\left(\theta_{4,2}\right) \sin\left(\theta_{4,3}\right) \cos\left(\theta_{10,4}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right) \bigr],$

$\bigl[0, \sin\left(\theta_{2,1}\right) \cos\left(\theta_{5,2}\right), \cos\left(\theta_{5,3}\right) \sin\left(\theta_{5,2}\right), \cos\left(\theta_{4,2}\right) \cos\left(\theta_{5,2}\right)$

$+ \cos\left(\theta_{4,3}\right) \sin\left(\theta_{4,2}\right) \cos\left(\theta_{5,3}\right) \sin\left(\theta_{5,2}\right)$

$+ \sin\left(\theta_{4,2}\right) \sin\left(\theta_{4,3}\right) \cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right), \cos\left(\theta_{5,2}\right)^2 + \cos\left(\theta_{5,3}\right)^2 \sin\left(\theta_{5,2}\right)^2$

$+ \cos\left(\theta_{5,4}\right)^2 \sin\left(\theta_{5,2}\right)^2 \sin\left(\theta_{5,3}\right)^2 + \sin\left(\theta_{5,2}\right)^2 \sin\left(\theta_{5,3}\right)^2 \sin\left(\theta_{5,4}\right)^2,$

$\cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \cos\left(\theta_{6,4}\right), \cos\left(\theta_{5,2}\right) \cos\left(\theta_{7,2}\right)$

$+ \cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right), \cos\left(\theta_{5,2}\right) \cos\left(\theta_{8,2}\right)$

$+ \cos\left(\theta_{5,3}\right) \sin\left(\theta_{5,2}\right) \cos\left(\theta_{8,3}\right) \sin\left(\theta_{8,2}\right)$

$+ \cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right)$

$+ \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \sin\left(\theta_{5,4}\right) \cos\left(\theta_{8,5}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right),$

$\cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \cos\left(\theta_{9,4}\right)$

$+ \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \sin\left(\theta_{5,4}\right) \cos\left(\theta_{9,5}\right) \sin\left(\theta_{9,4}\right), \cos\left(\theta_{5,2}\right) \cos\left(\theta_{10,2}\right)$

$+ \cos\left(\theta_{5,3}\right) \sin\left(\theta_{5,2}\right) \cos\left(\theta_{10,3}\right) \sin\left(\theta_{10,2}\right)$

$+ \cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \cos\left(\theta_{10,4}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right)$

$+ \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \sin\left(\theta_{5,4}\right) \cos\left(\theta_{10,5}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right) \sin\left(\theta_{10,4}\right) \bigr],$

$\bigl[0, 0, 0, \sin\left(\theta_{4,2}\right) \sin\left(\theta_{4,3}\right) \cos\left(\theta_{6,4}\right), \cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \cos\left(\theta_{6,4}\right), \cos\left(\theta_{6,4}\right)^2$

$+ \sin\left(\theta_{6,4}\right)^2, \cos\left(\theta_{6,4}\right) \cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right), \cos\left(\theta_{6,4}\right) \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right)$

$+ \sin\left(\theta_{6,4}\right) \cos\left(\theta_{8,6}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right) \sin\left(\theta_{8,5}\right), \cos\left(\theta_{6,4}\right) \cos\left(\theta_{9,4}\right),$

$\cos\left(\theta_{6,4}\right) \cos\left(\theta_{10,4}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right) \bigr],$

$\bigl[0, \sin\left(\theta_{2,1}\right) \cos\left(\theta_{7,2}\right), 0, \cos\left(\theta_{4,2}\right) \cos\left(\theta_{7,2}\right) + \sin\left(\theta_{4,2}\right) \sin\left(\theta_{4,3}\right) \cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right),$

$\cos\left(\theta_{5,2}\right) \cos\left(\theta_{7,2}\right) + \cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right),$

$\cos\left(\theta_{6,4}\right) \cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right), \cos\left(\theta_{7,2}\right)^2 + \cos\left(\theta_{7,4}\right)^2 \sin\left(\theta_{7,2}\right)^2 + \sin\left(\theta_{7,2}\right)^2 \sin\left(\theta_{7,4}\right)^2,$

$\cos\left(\theta_{7,2}\right) \cos\left(\theta_{8,2}\right) + \cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right) \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right),$

$\cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right) \cos\left(\theta_{9,4}\right), \cos\left(\theta_{7,2}\right) \cos\left(\theta_{10,2}\right)$

$+ \cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right) \cos\left(\theta_{10,4}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right) \bigr],$

$\bigl[0, \sin\left(\theta_{2,1}\right) \cos\left(\theta_{8,2}\right), \cos\left(\theta_{8,3}\right) \sin\left(\theta_{8,2}\right), \cos\left(\theta_{4,2}\right) \cos\left(\theta_{8,2}\right)$

$+ \cos\left(\theta_{4,3}\right) \sin\left(\theta_{4,2}\right) \cos\left(\theta_{8,3}\right) \sin\left(\theta_{8,2}\right)$

$+ \sin\left(\theta_{4,2}\right) \sin\left(\theta_{4,3}\right) \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right), \cos\left(\theta_{5,2}\right) \cos\left(\theta_{8,2}\right)$

$+ \cos\left(\theta_{5,3}\right) \sin\left(\theta_{5,2}\right) \cos\left(\theta_{8,3}\right) \sin\left(\theta_{8,2}\right)$

$+ \cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right)$

$+ \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \sin\left(\theta_{5,4}\right) \cos\left(\theta_{8,5}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right),$

$\cos\left(\theta_{6,4}\right) \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right)$

$+ \sin\left(\theta_{6,4}\right) \cos\left(\theta_{8,6}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right) \sin\left(\theta_{8,5}\right), \cos\left(\theta_{7,2}\right) \cos\left(\theta_{8,2}\right)$

$+ \cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right) \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right), \cos\left(\theta_{8,2}\right)^2 + \cos\left(\theta_{8,3}\right)^2 \sin\left(\theta_{8,2}\right)^2$

$+ \cos\left(\theta_{8,4}\right)^2 \sin\left(\theta_{8,2}\right)^2 \sin\left(\theta_{8,3}\right)^2 + \cos\left(\theta_{8,5}\right)^2 \sin\left(\theta_{8,2}\right)^2 \sin\left(\theta_{8,3}\right)^2 \sin\left(\theta_{8,4}\right)^2$

$+ \cos\left(\theta_{8,6}\right)^2 \sin\left(\theta_{8,2}\right)^2 \sin\left(\theta_{8,3}\right)^2 \sin\left(\theta_{8,4}\right)^2 \sin\left(\theta_{8,5}\right)^2$

$+ \sin\left(\theta_{8,2}\right)^2 \sin\left(\theta_{8,3}\right)^2 \sin\left(\theta_{8,4}\right)^2 \sin\left(\theta_{8,5}\right)^2 \sin\left(\theta_{8,6}\right)^2,$

$\cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \cos\left(\theta_{9,4}\right)$

$+ \cos\left(\theta_{8,5}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right) \cos\left(\theta_{9,5}\right) \sin\left(\theta_{9,4}\right)$

$+ \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right) \sin\left(\theta_{8,5}\right) \sin\left(\theta_{8,6}\right) \cos\left(\theta_{9,8}\right) \sin\left(\theta_{9,4}\right) \sin\left(\theta_{9,5}\right),$

$\cos\left(\theta_{8,2}\right) \cos\left(\theta_{10,2}\right) + \cos\left(\theta_{8,3}\right) \sin\left(\theta_{8,2}\right) \cos\left(\theta_{10,3}\right) \sin\left(\theta_{10,2}\right)$

$+ \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \cos\left(\theta_{10,4}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right)$

$+ \cos\left(\theta_{8,5}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right) \cos\left(\theta_{10,5}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right) \sin\left(\theta_{10,4}\right)$

$+ \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right) \sin\left(\theta_{8,5}\right) \sin\left(\theta_{8,6}\right) \cos\left(\theta_{10,8}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right)$

$\sin\left(\theta_{10,4}\right) \sin\left(\theta_{10,5}\right)\Big],$

$\Big[0, 0, 0, \sin\left(\theta_{4,2}\right) \sin\left(\theta_{4,3}\right) \cos\left(\theta_{9,4}\right), \cos\left(\theta_{5,4}\right) \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \cos\left(\theta_{9,4}\right)$

$+ \sin\left(\theta_{5,2}\right) \sin\left(\theta_{5,3}\right) \sin\left(\theta_{5,4}\right) \cos\left(\theta_{9,5}\right) \sin\left(\theta_{9,4}\right), \cos\left(\theta_{6,4}\right) \cos\left(\theta_{9,4}\right),$

$\cos\left(\theta_{7,4}\right) \sin\left(\theta_{7,2}\right) \cos\left(\theta_{9,4}\right), \cos\left(\theta_{8,4}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \cos\left(\theta_{9,4}\right)$

$+ \cos\left(\theta_{8,5}\right) \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right) \cos\left(\theta_{9,5}\right) \sin\left(\theta_{9,4}\right)$

$+ \sin\left(\theta_{8,2}\right) \sin\left(\theta_{8,3}\right) \sin\left(\theta_{8,4}\right) \sin\left(\theta_{8,5}\right) \sin\left(\theta_{8,6}\right) \cos\left(\theta_{9,8}\right) \sin\left(\theta_{9,4}\right) \sin\left(\theta_{9,5}\right),$

$\cos\left(\theta_{9,4}\right)^2 + \cos\left(\theta_{9,5}\right)^2 \sin\left(\theta_{9,4}\right)^2 + \cos\left(\theta_{9,8}\right)^2 \sin\left(\theta_{9,4}\right)^2 \sin\left(\theta_{9,5}\right)^2$

$+ \sin\left(\theta_{9,4}\right)^2 \sin\left(\theta_{9,5}\right)^2 \sin\left(\theta_{9,8}\right)^2, \cos\left(\theta_{9,4}\right) \cos\left(\theta_{10,4}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right)$

$+ \cos\left(\theta_{9,5}\right) \sin\left(\theta_{9,4}\right) \cos\left(\theta_{10,5}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right) \sin\left(\theta_{10,4}\right)$

$+ \cos\left(\theta_{9,8}\right) \sin\left(\theta_{9,4}\right) \sin\left(\theta_{9,5}\right) \cos\left(\theta_{10,8}\right) \sin\left(\theta_{10,2}\right) \sin\left(\theta_{10,3}\right) \sin\left(\theta_{10,4}\right) \sin\left(\theta_{10,5}\right)$

$+ \sin(\theta_{9,4}) \sin(\theta_{9,5}) \sin(\theta_{9,8}) \cos(\theta_{10,9}) \sin(\theta_{10,2}) \sin(\theta_{10,3}) \sin(\theta_{10,4}) \sin(\theta_{10,5})$

$\sin(\theta_{10,8})]$,

$[0, \sin(\theta_{2,1}) \cos(\theta_{10,2}), \cos(\theta_{10,3}) \sin(\theta_{10,2}), \cos(\theta_{4,2}) \cos(\theta_{10,2})$

$+ \cos(\theta_{4,3}) \sin(\theta_{4,2}) \cos(\theta_{10,3}) \sin(\theta_{10,2})$

$+ \sin(\theta_{4,2}) \sin(\theta_{4,3}) \cos(\theta_{10,4}) \sin(\theta_{10,2}) \sin(\theta_{10,3}), \cos(\theta_{5,2}) \cos(\theta_{10,2})$

$+ \cos(\theta_{5,3}) \sin(\theta_{5,2}) \cos(\theta_{10,3}) \sin(\theta_{10,2})$

$+ \cos(\theta_{5,4}) \sin(\theta_{5,2}) \sin(\theta_{5,3}) \cos(\theta_{10,4}) \sin(\theta_{10,2}) \sin(\theta_{10,3})$

$+ \sin(\theta_{5,2}) \sin(\theta_{5,3}) \sin(\theta_{5,4}) \cos(\theta_{10,5}) \sin(\theta_{10,2}) \sin(\theta_{10,3}) \sin(\theta_{10,4})$,

$\cos(\theta_{6,4}) \cos(\theta_{10,4}) \sin(\theta_{10,2}) \sin(\theta_{10,3}), \cos(\theta_{7,2}) \cos(\theta_{10,2})$

$+ \cos(\theta_{7,4}) \sin(\theta_{7,2}) \cos(\theta_{10,4}) \sin(\theta_{10,2}) \sin(\theta_{10,3}), \cos(\theta_{8,2}) \cos(\theta_{10,2})$

$+ \cos(\theta_{8,3}) \sin(\theta_{8,2}) \cos(\theta_{10,3}) \sin(\theta_{10,2})$

$+ \cos(\theta_{8,4}) \sin(\theta_{8,2}) \sin(\theta_{8,3}) \cos(\theta_{10,4}) \sin(\theta_{10,2}) \sin(\theta_{10,3})$

$+ \cos(\theta_{8,5}) \sin(\theta_{8,2}) \sin(\theta_{8,3}) \sin(\theta_{8,4}) \cos(\theta_{10,5}) \sin(\theta_{10,2}) \sin(\theta_{10,3}) \sin(\theta_{10,4})$

$+ \sin(\theta_{8,2}) \sin(\theta_{8,3}) \sin(\theta_{8,4}) \sin(\theta_{8,5}) \sin(\theta_{8,6}) \cos(\theta_{10,8}) \sin(\theta_{10,2}) \sin(\theta_{10,3})$

$\sin(\theta_{10,4}) \sin(\theta_{10,5}), \cos(\theta_{9,4}) \cos(\theta_{10,4}) \sin(\theta_{10,2}) \sin(\theta_{10,3})$

$+ \cos(\theta_{9,5}) \sin(\theta_{9,4}) \cos(\theta_{10,5}) \sin(\theta_{10,2}) \sin(\theta_{10,3}) \sin(\theta_{10,4})$

$+ \cos(\theta_{9,8}) \sin(\theta_{9,4}) \sin(\theta_{9,5}) \cos(\theta_{10,8}) \sin(\theta_{10,2}) \sin(\theta_{10,3}) \sin(\theta_{10,4}) \sin(\theta_{10,5})$

$+ \sin(\theta_{9,4}) \sin(\theta_{9,5}) \sin(\theta_{9,8}) \cos(\theta_{10,9}) \sin(\theta_{10,2}) \sin(\theta_{10,3}) \sin(\theta_{10,4}) \sin(\theta_{10,5})$

$\sin(\theta_{10,8}), \cos(\theta_{10,2})^2 + \cos(\theta_{10,3})^2 \sin(\theta_{10,2})^2 + \cos(\theta_{10,4})^2 \sin(\theta_{10,2})^2 \sin(\theta_{10,3})^2$

$+ \cos(\theta_{10,5})^2 \sin(\theta_{10,2})^2 \sin(\theta_{10,3})^2 \sin(\theta_{10,4})^2$

$+ \cos(\theta_{10,8})^2 \sin(\theta_{10,2})^2 \sin(\theta_{10,3})^2 \sin(\theta_{10,4})^2 \sin(\theta_{10,5})^2$

$+ \cos(\theta_{10,9})^2 \sin(\theta_{10,2})^2 \sin(\theta_{10,3})^2 \sin(\theta_{10,4})^2 \sin(\theta_{10,5})^2 \sin(\theta_{10,8})^2$

$+ \sin(\theta_{10,2})^2 \sin(\theta_{10,3})^2 \sin(\theta_{10,4})^2 \sin(\theta_{10,5})^2 \sin(\theta_{10,8})^2 \sin(\theta_{10,9})^2]]$

> **for** i **from** 1 **to** n **do**
   for j **from** 1 **to** $i-1$ **do**
   if $A[i,j] = 0$ **then**
   $lprint(i, j, B[i,j], R[i,j])$
   end if
   end do
   end do

```
3, 1, 0, 0
3, 2, 0, 0
4, 1, 0, 0
5, 1, 0, 0
6, 1, 0, 0
6, 2, 0, 0
6, 3, 0, 0
6, 5, 0, cos(theta[5,4])*sin(theta[5,2])*sin(theta[5,3])*cos(theta[6,4]
)
7, 1, 0, 0
7, 3, 0, 0
7, 5, 0, cos(theta[5,2])*cos(theta[7,2])+cos(theta[5,4])*sin(theta[5,2]
)*sin(
theta[5,3])*cos(theta[7,4])*sin(theta[7,2])
7, 6, 0, cos(theta[6,4])*cos(theta[7,4])*sin(theta[7,2])
8, 1, 0, 0
8, 7, 0, cos(theta[7,2])*cos(theta[8,2])+cos(theta[7,4])*sin(theta[7,2]
)*cos(
theta[8,4])*sin(theta[8,2])*sin(theta[8,3])
9, 1, 0, 0
9, 2, 0, 0
9, 3, 0, 0
9, 6, 0, cos(theta[6,4])*cos(theta[9,4])
9, 7, 0, cos(theta[7,4])*sin(theta[7,2])*cos(theta[9,4])
10, 1, 0, 0
10, 6, 0, cos(theta[6,4])*cos(theta[10,4])*sin(theta[10,2])*sin(theta
[10,3])
10, 7, 0, cos(theta[7,2])*cos(theta[10,2])+cos(theta[7,4])*sin(theta[7,
2])*cos(
theta[10,4])*sin(theta[10,2])*sin(theta[10,3])
```