V W H

$p \times n$ $p \times k$ $k \times n$

$$\begin{pmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{pmatrix} = \begin{pmatrix} w_{11} & w_{12} \\ w_{21} & w_{22} \end{pmatrix} \begin{pmatrix} h_{11} & h_{12} \\ h_{21} & h_{22} \end{pmatrix}$$

$$\begin{pmatrix} v_{11} - w_{11}h_{11} - w_{12}h_{21} & v_{12} - w_{11}h_{12} - w_{12}h_{22} \\ v_{21} - w_{21}h_{11} - w_{22}h_{21} & v_{22} - w_{21}h_{12} \quad w_{22}h_{22} \end{pmatrix}$$

$\Downarrow$

$$v_{ij} - \sum_k w_{ik} h_{kj}$$

lk : $2^2 \times 2$

(i) Figure out all $v_{ij} - \sum_k w_{ik} h_{kj}$

(ii) Assign : $x_q = w_{ik} h_{kj}$ for all i,j,k while incrementing q

(iii) For $(v_{ij} - \Sigma w_{ik} h_{kj})^2$

$\Downarrow$

Substitute with $x_q$

$\Downarrow$

make_qubo ( )

$\Downarrow$

The return qubo will expand the variable list.

Eg varnames = $[x_1, x_2, x_3]$

will expand to $[x_{1\_null}, x_{1\_2}, x_{1\_1}, x_{1\_0}$ ..... $x_{3\_null}, x_{3\_2}, x_{3\_1}, x_{3\_0}]$

Such that (for eg)

$x_{1\_null} = w_{11\_null} h_{11}$

$x_{1\_2} = w_{11\_2} h_{11}$

and so on for the

Assign penalties for each $x_q$

e.g. for $x_1\_null$

$$Q[w_{11}\_null, h_{11}] = 2 \times \delta$$
$$Q[x_1\_null, w_{11}] = -4 \times \delta$$
$$Q[x_1\_null, h_{11}] = -4 \times \delta$$

$$Q[x_1\_null, x_1\_null] = Q[x_1\_null, x_1\_null] + (6 \times \delta)$$

when $\delta$ is a penalty modifier

by default $\delta = 1$