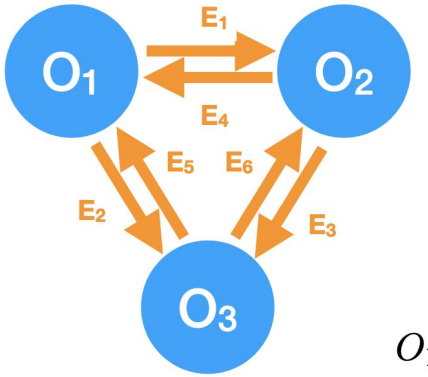
# Interaction Network

- “Interaction Networks for Learning about Objects, Relations and Physics”: https://arxiv.org/abs/1612.00222
- INs process a list of N0 X P inputs in paris, through Receiving and Sending matrices

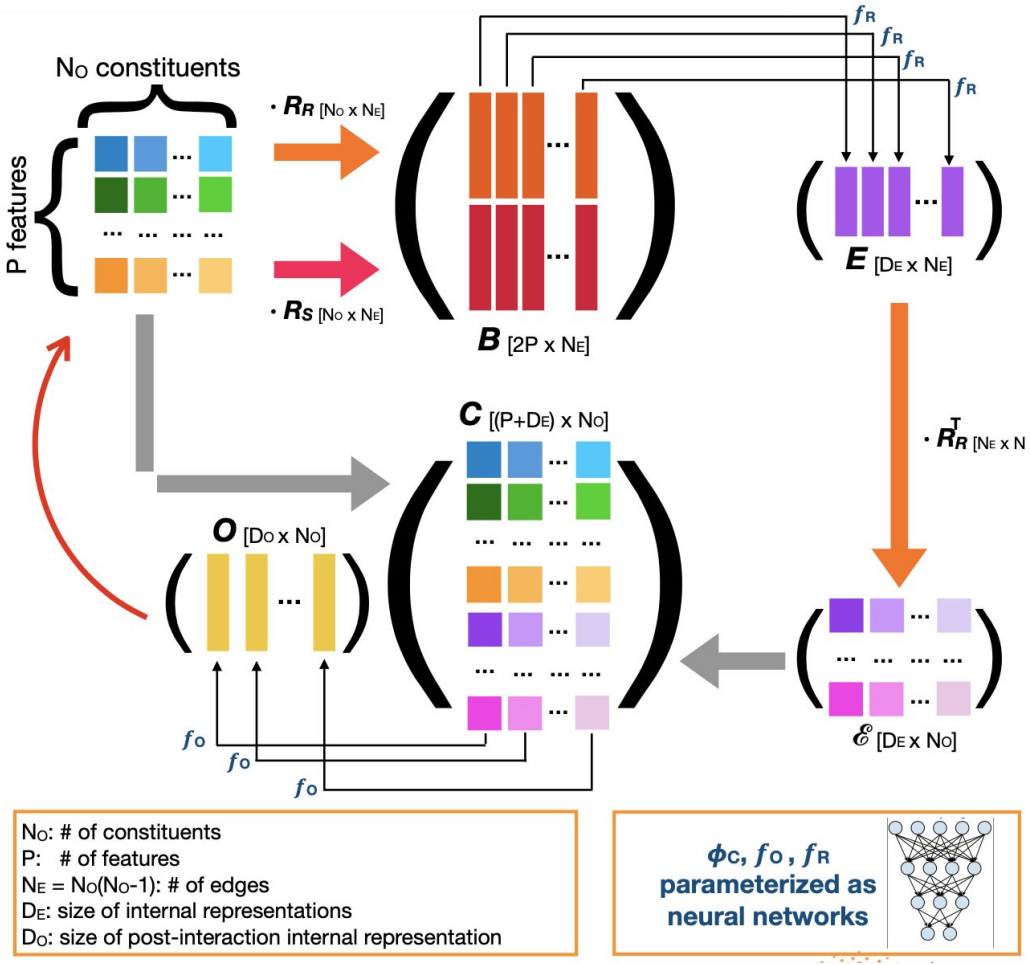



$$R_R = \begin{array}{c} \\ O_1 \\ O_2 \\ O_3 \end{array} \begin{array}{c} \begin{array}{cccccc} E_1 & E_2 & E_3 & E_4 & E_5 & E_6 \end{array} \\ \begin{pmatrix} 0 & 0 & 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 & 0 & 0 \end{pmatrix} \end{array}$$

$$R_S = \begin{array}{c} \\ O_1 \\ O_2 \\ O_3 \end{array} \begin{array}{c} \begin{array}{cccccc} E_1 & E_2 & E_3 & E_4 & E_5 & E_6 \end{array} \\ \begin{pmatrix} 1 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 1 \end{pmatrix} \end{array}.$$

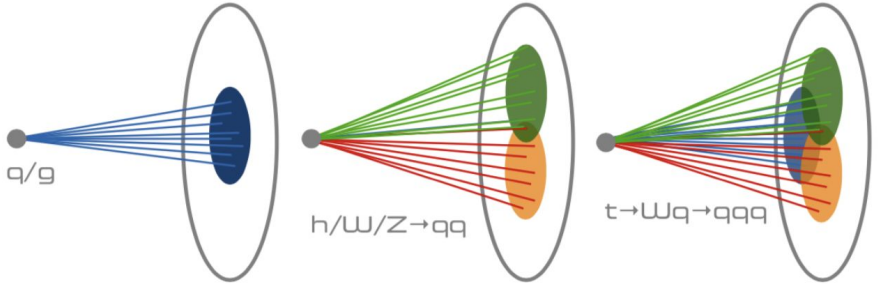
# Interaction Network

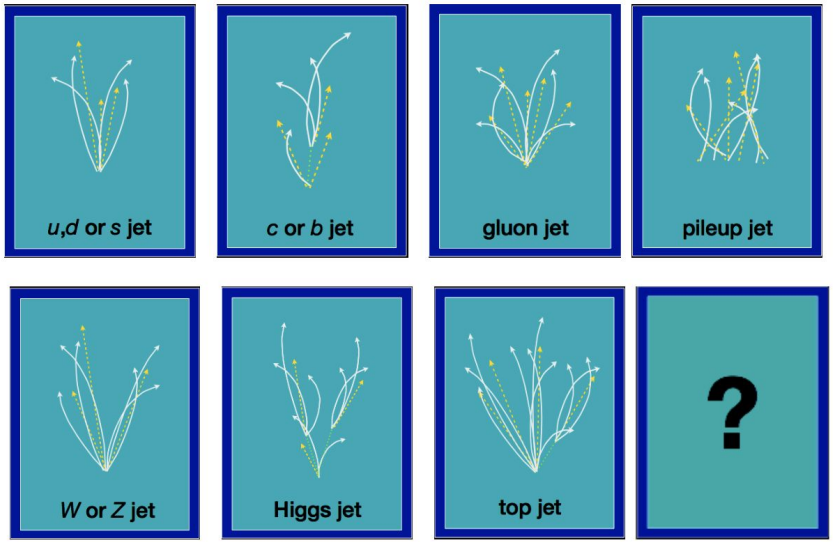
- INs process a list of N0 X P inputs in paris, through Receiving and Sending matrices
- The effect of interaction is learned by fR
- The procedure can be iterated



# Examples: Jet Tagging

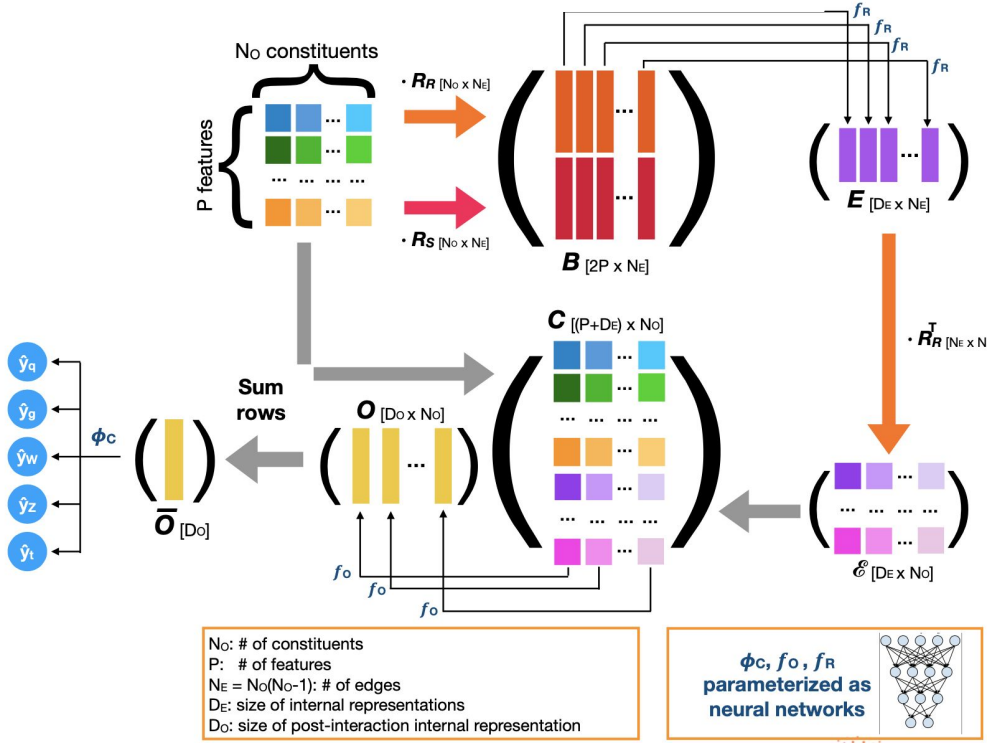
- You have a jet at LHC: spray of hadrons coming from a “shower” initiated by a fundamental particle of some kind (quark, gluon, W/Z/H bosons, top quark)
- You have a set of jet features whose distribution depends on the nature of the initial particle
- You can train a network to start from the values of these quantities and guess the nature of your jet
- To do this you need a sample for which you know the answer

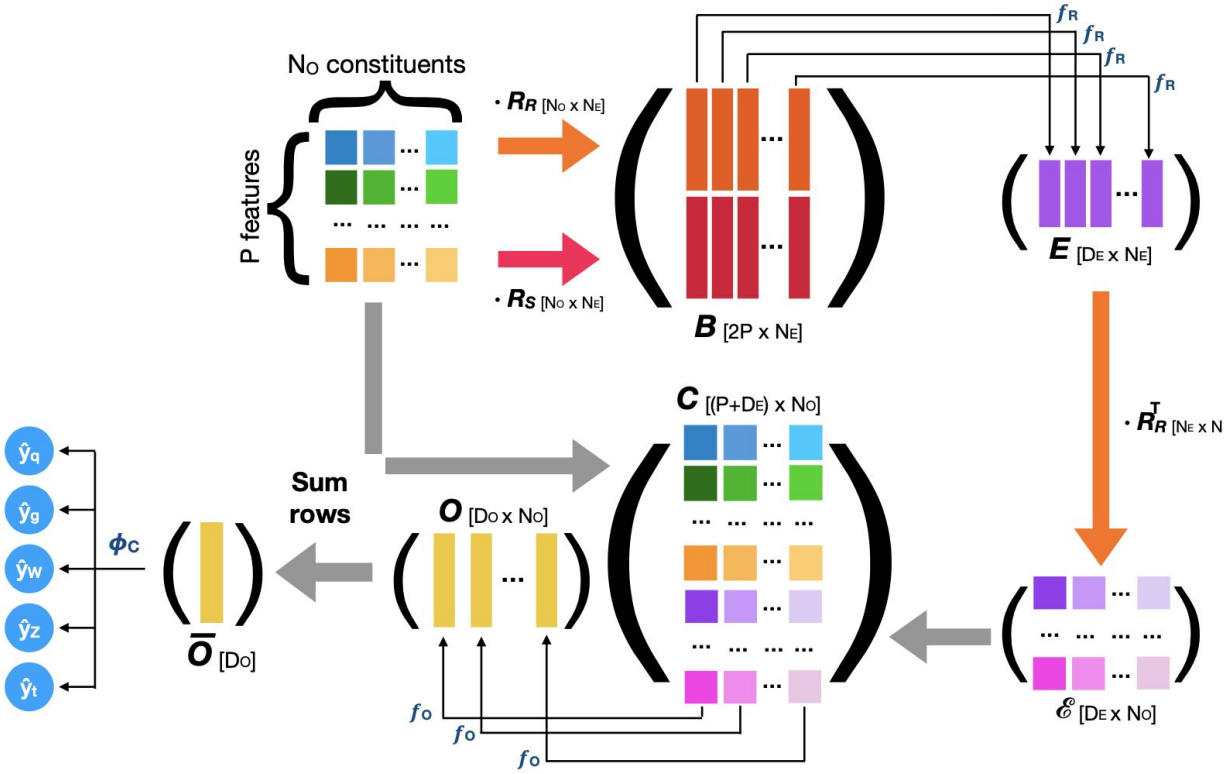


# Interaction Network

- INs process a list of N0 X P inputs in paris, through Receiving and Sending matrices
- The effect of interaction is learned by fR
- The procedure can be iterated




$N_O$ constituents
P features
$\cdot R_R$ [$N_O$ x $N_E$]
$\cdot R_S$ [$N_O$ x $N_E$]
$B$ [2P x $N_E$]
$f_R$
$E$ [$D_E$ x $N_E$]
$\cdot R_R^T$ [$N_E$ x N
$C$ [(P+$D_E$) x $N_O$]
$\bar{e}$ [$D_E$ x $N_O$]
$O$ [$D_O$ x $N_O$]
$f_O$
Sum rows
$\bar{O}$ [$D_O$]
$\phi_C$
$\hat{y}_q$
$\hat{y}_g$
$\hat{y}_w$
$\hat{y}_z$
$\hat{y}_t$
$N_O$: # of constituents
P: # of features
$N_E = N_O(N_O-1)$: # of edges
$D_E$: size of internal representations
$D_O$: size of post-interaction internal representation
$\phi_C$, $f_O$, $f_R$ parameterized as neural networks