Estudio y clasificación de sucesos $t\bar{t}$ aplicando M.L. en ATLAS

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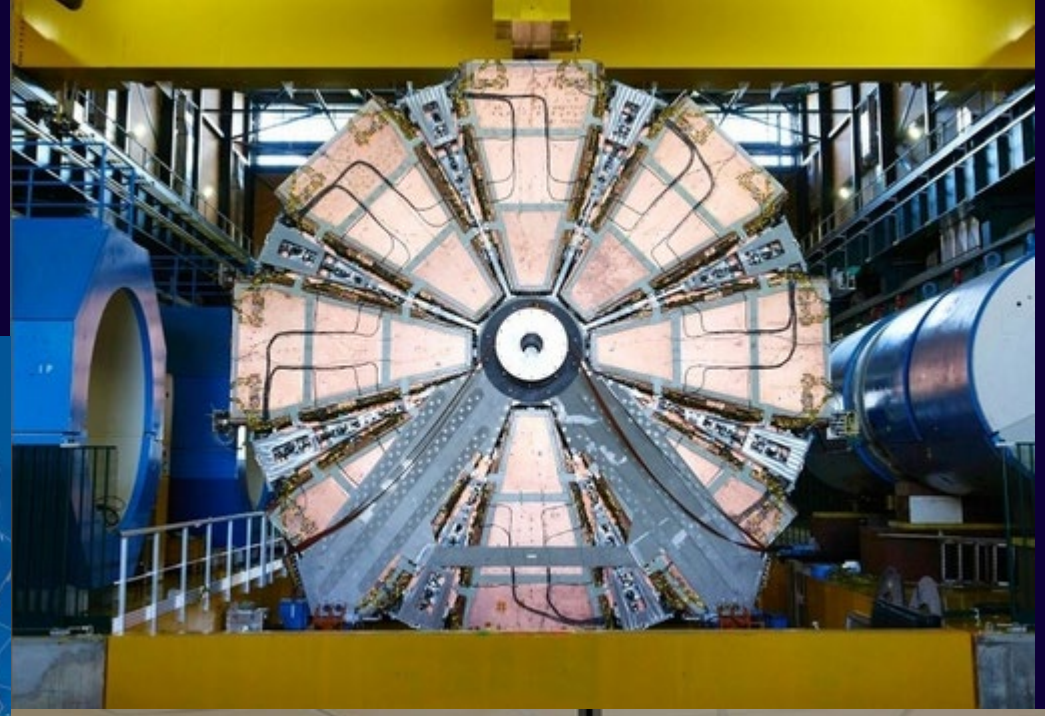
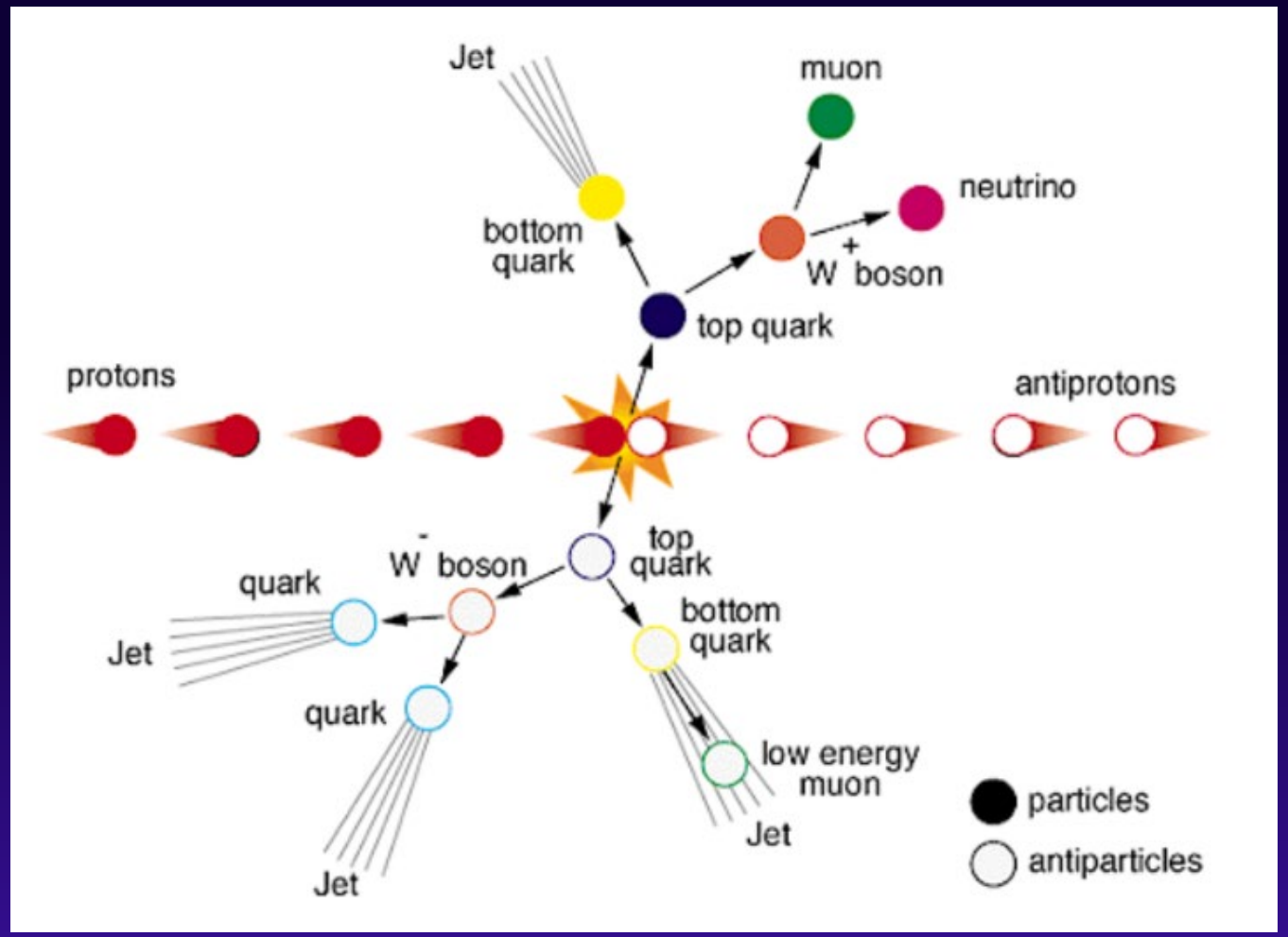
José F. Salt Cairols

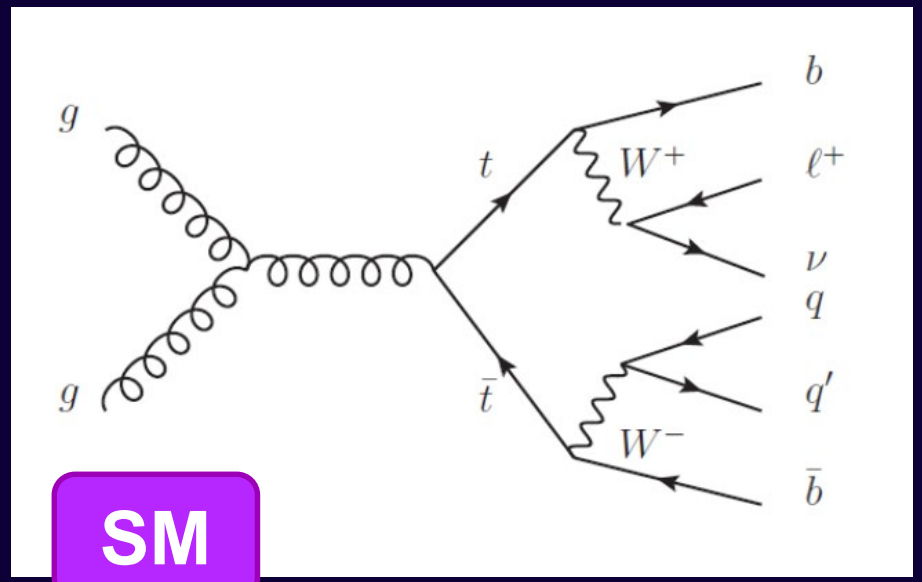
El proyecto ATLAS EXPERIMENT

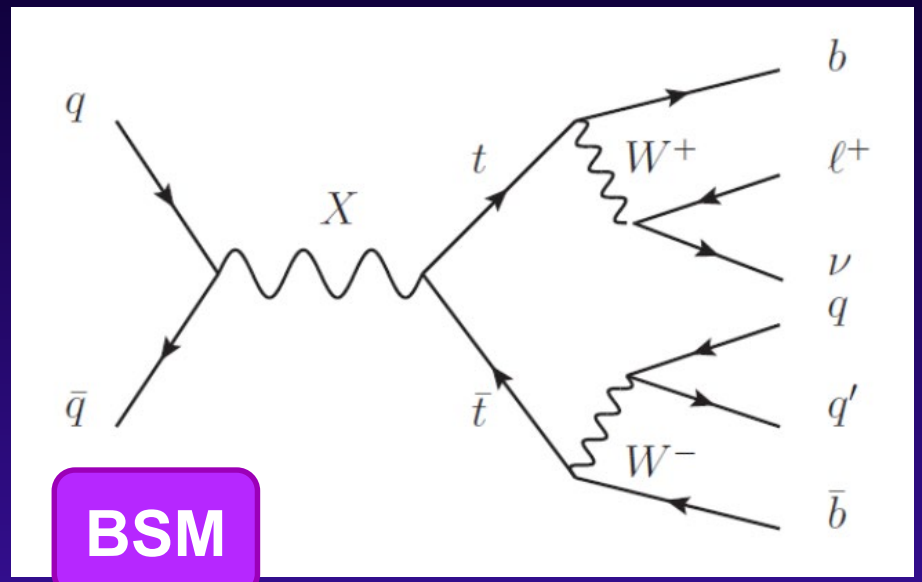
CERN



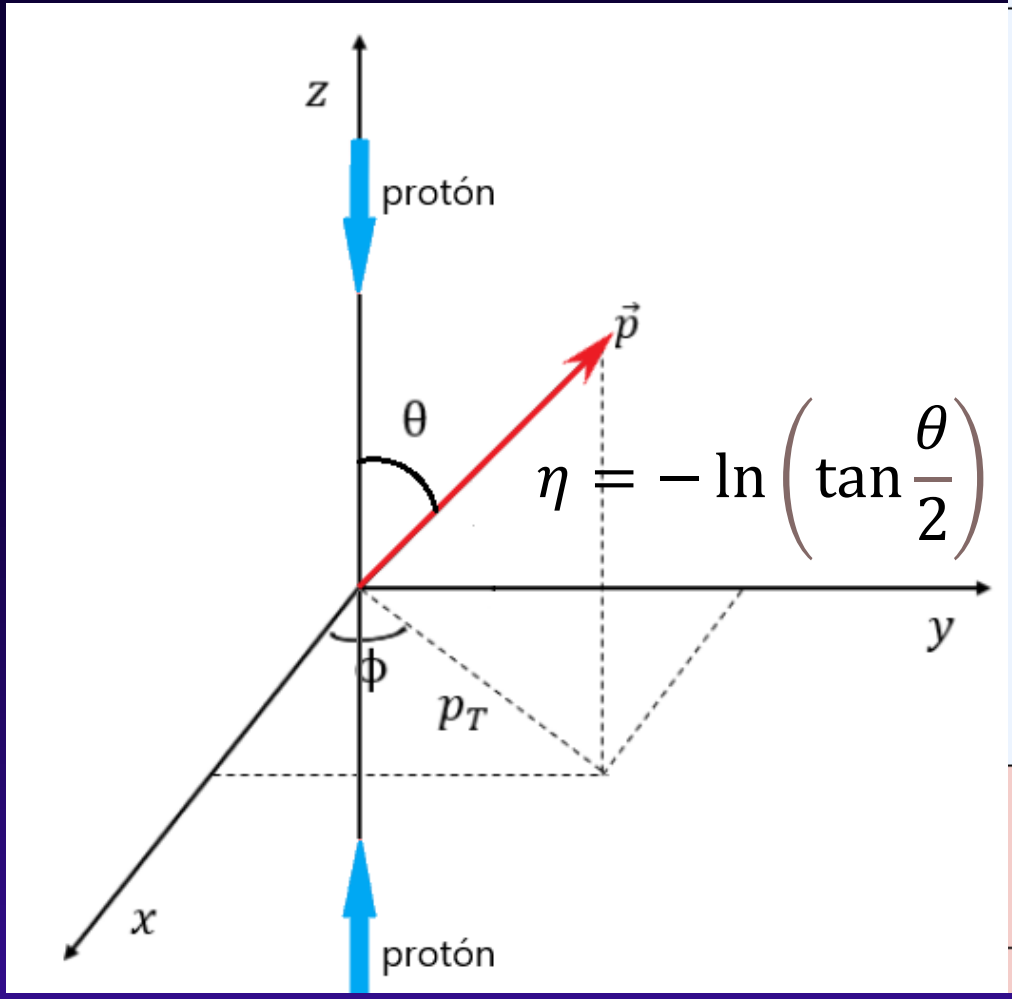
Colisiones protón-protón





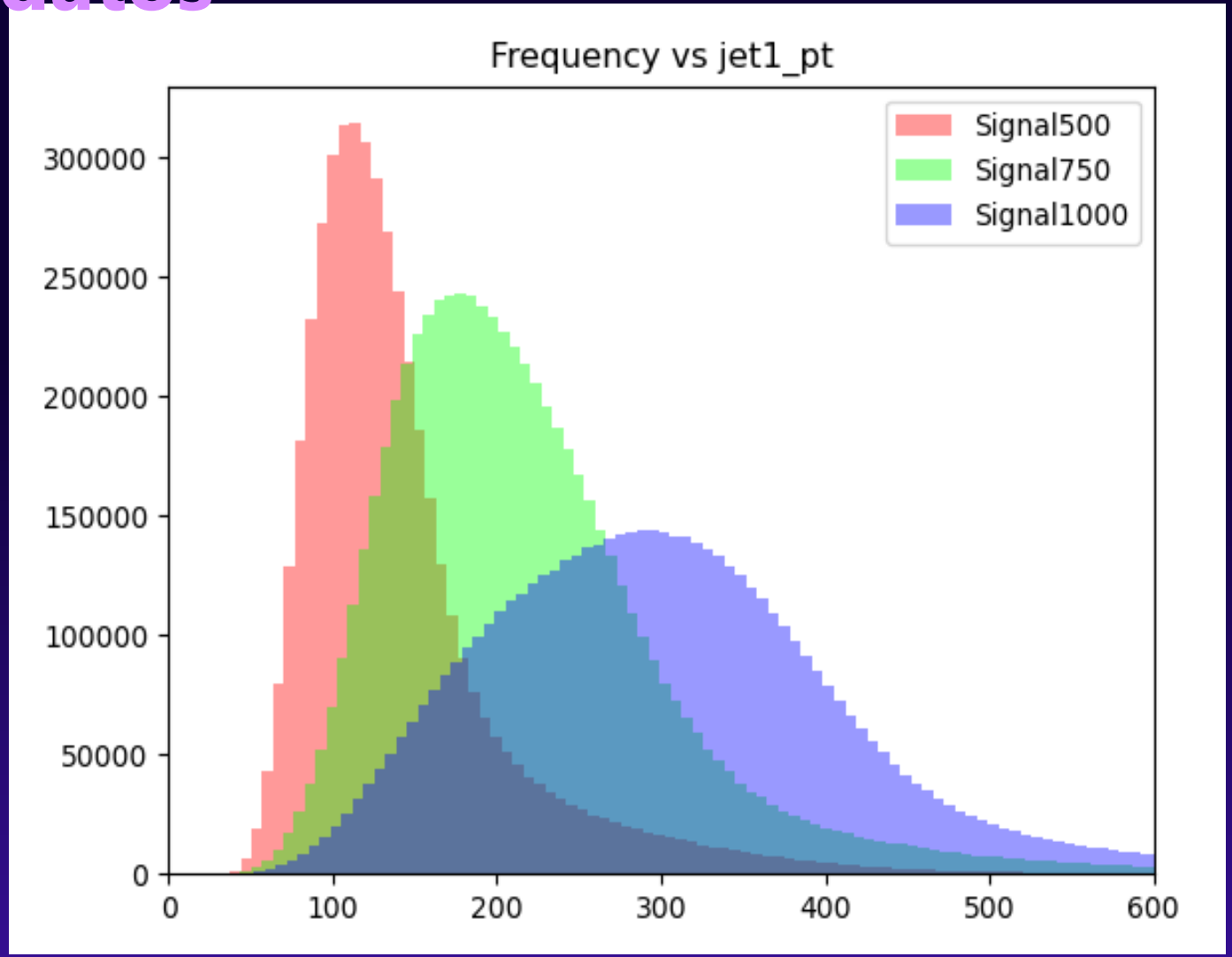


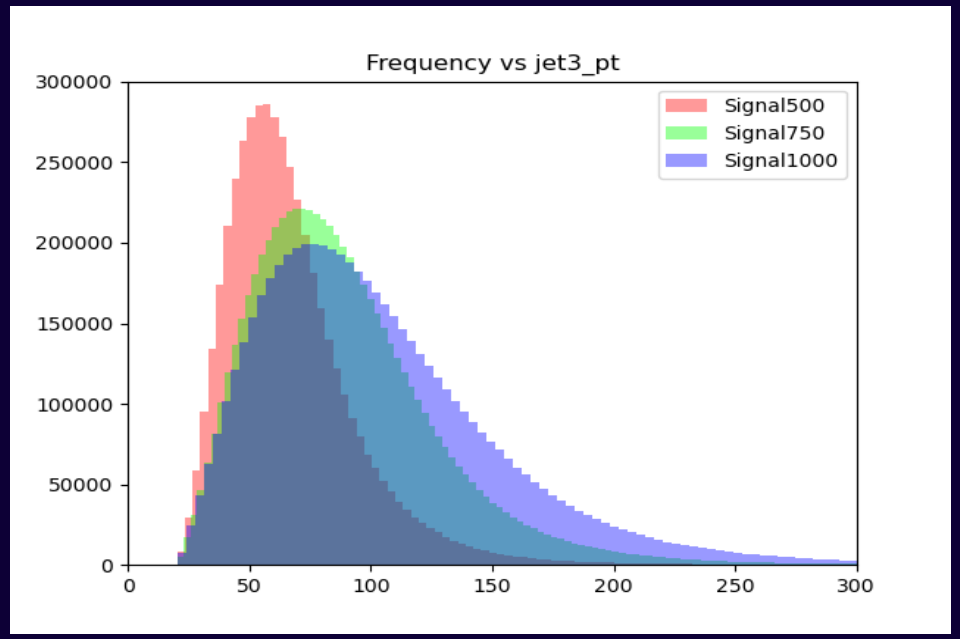
Estructura del *Dataset*

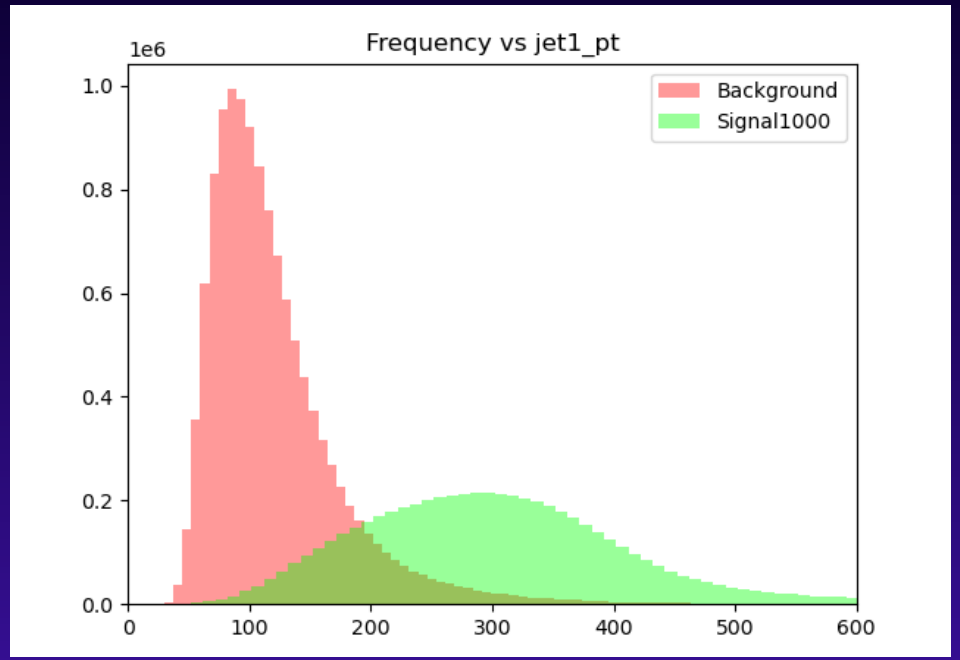


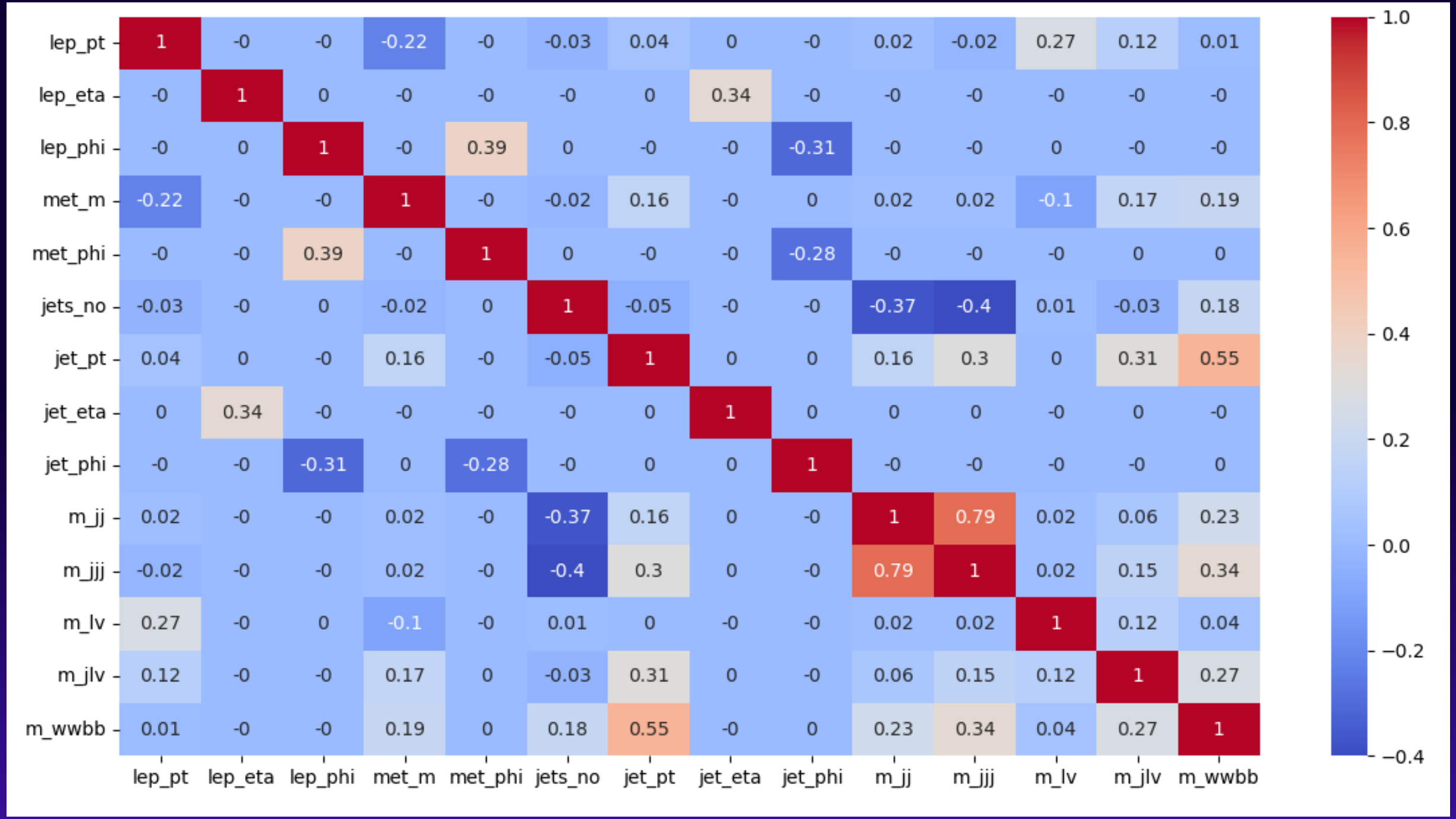
lep_pt	float	Momento transversal del leptón	Leptón
lep_eta	float	Pseudorapídity	
lep_phi	float	Azimut	
met_miss	float	Momento transversal faltante	Neutrino
met_phi	float	Azimut faltante	
jets_no	entero	Número de jets de la colisión	Jets resultantes
jet1_pt	float	Momento transversal	Jet más energético
jet1_eta	float	Pseudorapidity	
jet1_phi	float	Azimut	
jet1_btag	binaria	Correspondencia con un quark b	
jet2_pt	float	Momento transversal	Segundo jet más energético
jet2_eta	float	Pseudorapidity	
jet2_phi	float	Azimut	
jet2_btag	binaria	Correspondencia con un quark b	
jet3_pt	float	Momento transversal	Tercer jet más energético
jet3_eta	float	Pseudorapidity	
jet3_phi	float	Azimut	
jet3_btag	binaria	Correspondencia con un quark b	
jet4_pt	float	Momento transversal	Cuarto jet más energético
jet4_eta	float	Pseudorapidity	
jet4_phi	float	Azimut	
jet4_btag	binaria	Correspondencia con un quark b	
m_jj	float	Masa invariante	W^-
m_jjj	float	Masa invariante	$\bar{t}$
m_lv	float	Masa invariante	W^+
m_jlv	float	Masa invariante	t
m_wwbb	float	Masa invariante	X

Representación y análisis de datos

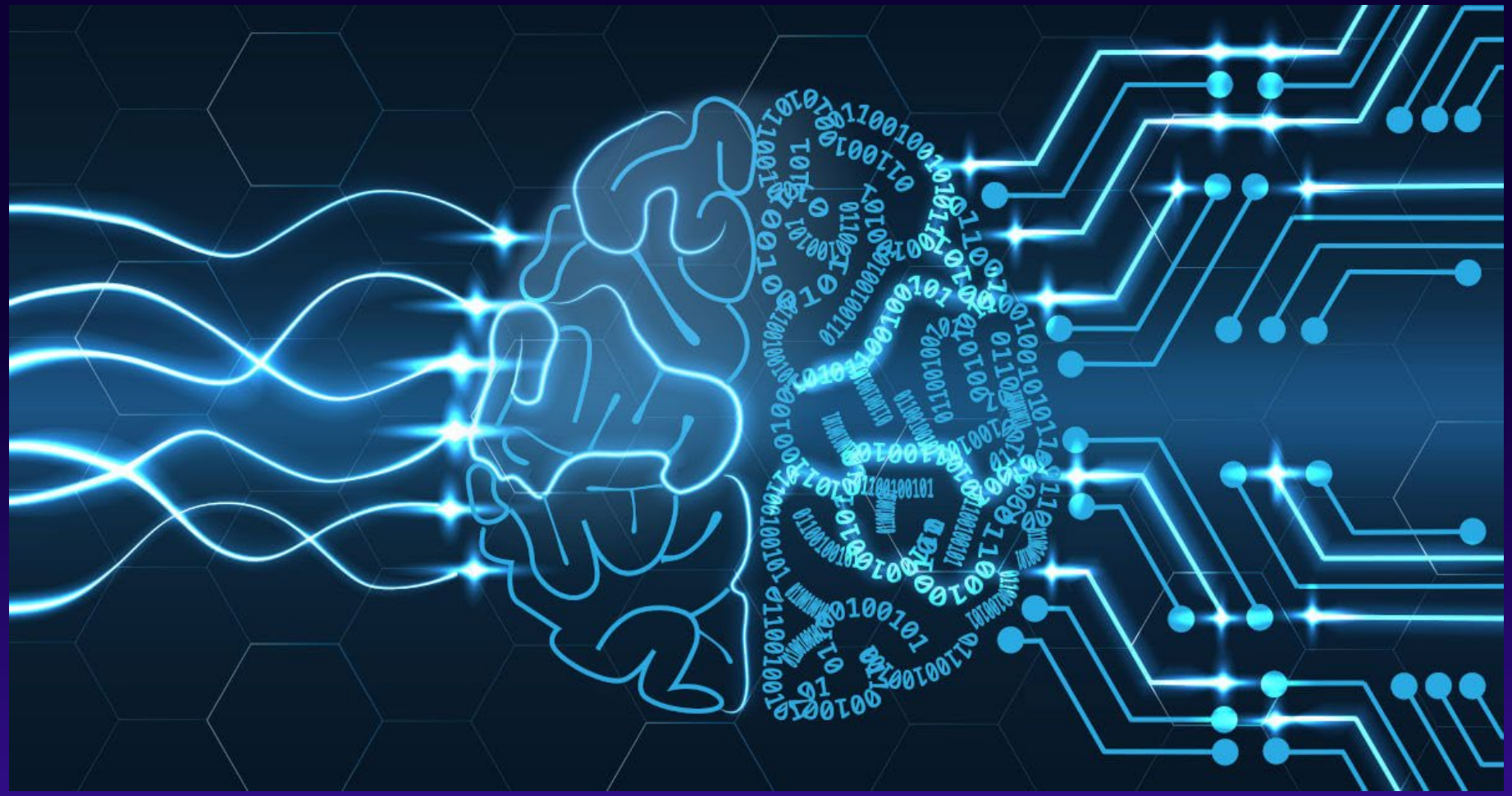




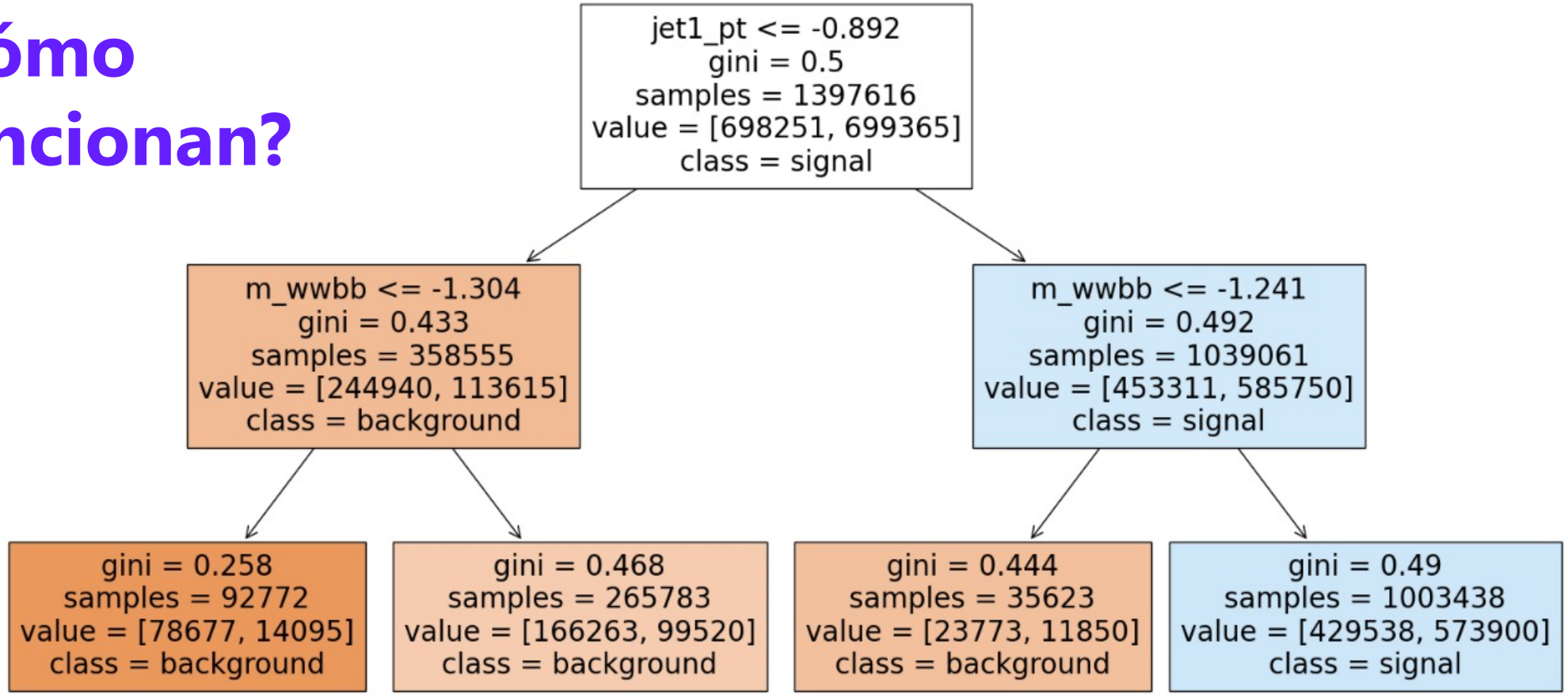



lep_pt 1 -0 -0 -0.22 -0 -0.03 0.04 0 -0 0.02 -0.02 0.27 0.12 0.01
lep_eta -0 1 0 -0 -0 -0 0 0.34 -0 -0 -0 -0 -0 -0
lep_phi -0 0 1 -0 0.39 0 -0 -0 -0.31 -0 -0 0 -0 -0
met_m -0.22 -0 -0 1 -0 -0.02 0.16 -0 0 0.02 0.02 -0.1 0.17 0.19
met_phi -0 -0 0.39 -0 1 0 -0 -0 -0.28 -0 -0 -0 0 0
jets_no -0.03 -0 0 -0.02 0 1 -0.05 -0 -0 -0.37 -0.4 0.01 -0.03 0.18
jet_pt 0.04 0 -0 0.16 -0 -0.05 1 0 0 0.16 0.3 0 0.31 0.55
jet_eta 0 0.34 -0 -0 -0 -0 0 1 0 0 0 -0 0 -0
jet_phi -0 -0 -0.31 0 -0.28 -0 0 0 1 -0 -0 -0 -0 0
m_jj 0.02 -0 -0 0.02 -0 -0.37 0.16 0 -0 1 0.79 0.02 0.06 0.23
m_jjj -0.02 -0 -0 0.02 -0 -0.4 0.3 0 -0 0.79 1 0.02 0.15 0.34
m_lv 0.27 -0 0 -0.1 -0 0.01 0 -0 -0 0.02 0.02 1 0.12 0.04
m_jlv 0.12 -0 -0 0.17 0 -0.03 0.31 0 -0 0.06 0.15 0.12 1 0.27
m_wwbb 0.01 -0 -0 0.19 0 0.18 0.55 -0 0 0.23 0.34 0.04 0.27 1
lep_pt lep_eta lep_phi met_m met_phi jets_no jet_pt jet_eta jet_phi m_jj m_jjj m_lv m_jlv m_wwbb
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4

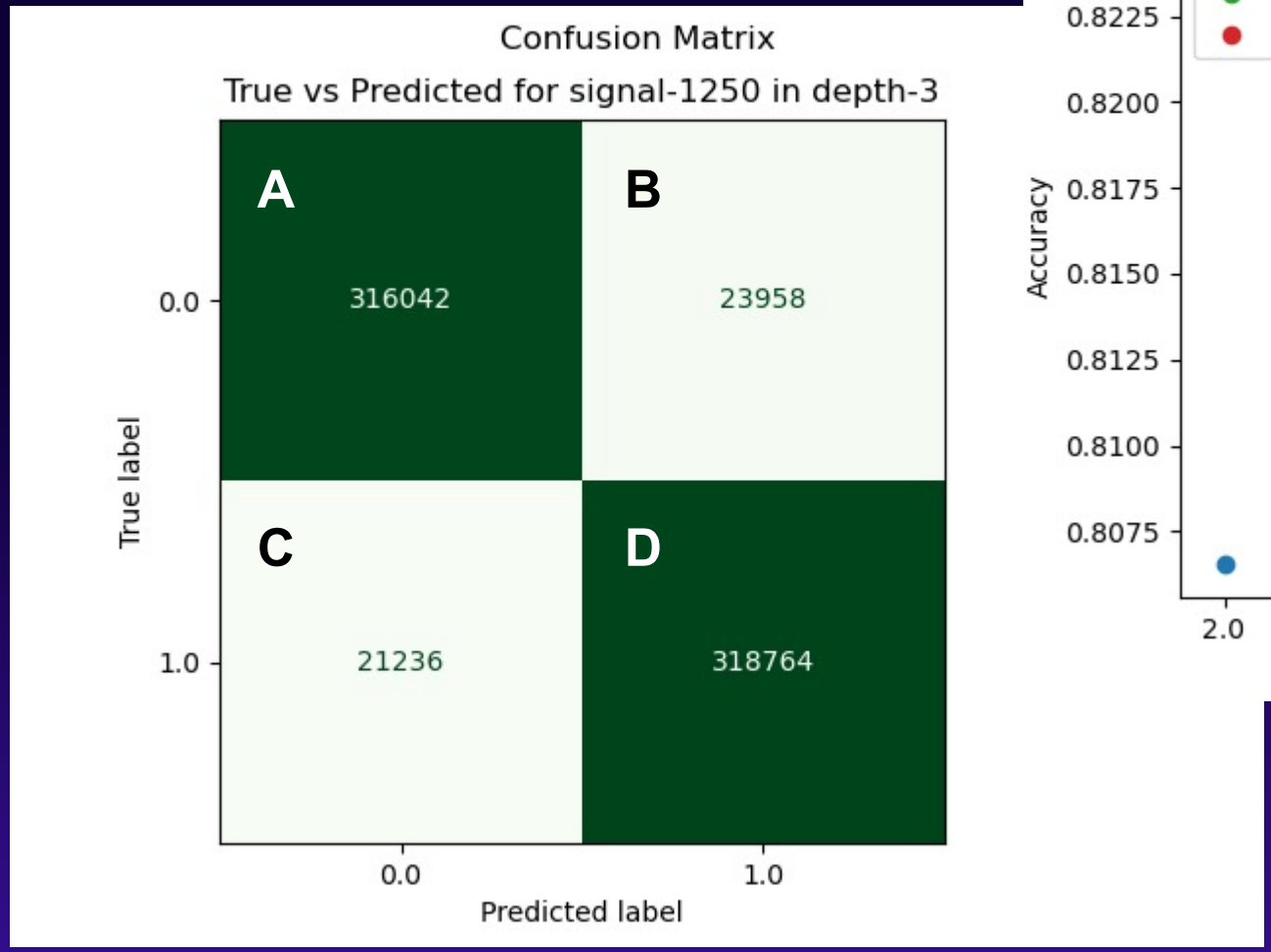
Machine Learning: ¿qué es?

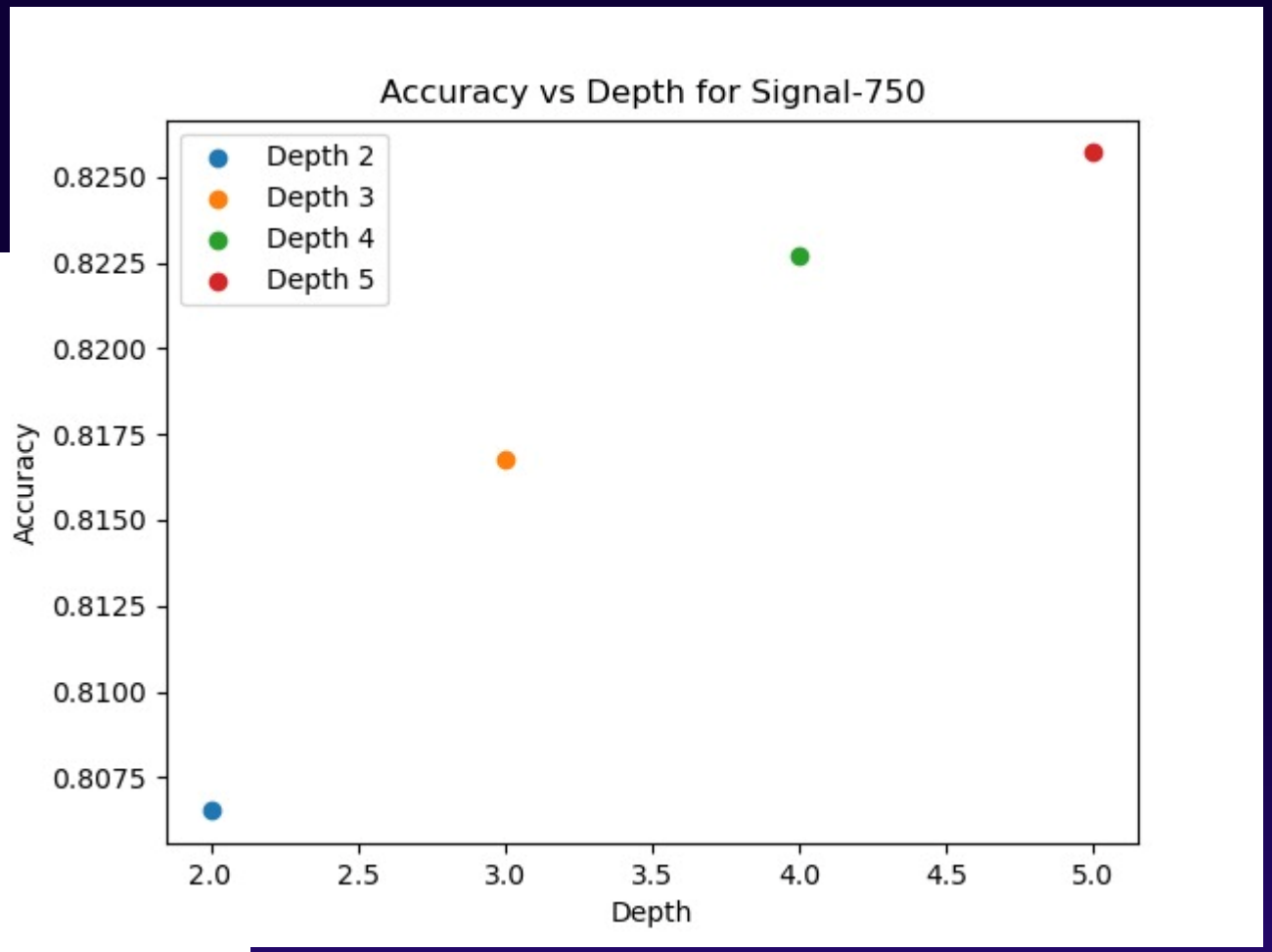


Decision Trees: ¿cómo funcionan?



Confusion matrix





$$\text{Accuracy} = \frac{A+D}{A+B+C+D}$$

Conclusiones

- No podemos detectar cada quark de forma individual, sino en forma de ráfagas o *jets.*
- Las técnicas de ML nos permiten nos permitirían distinguir entre ruido y señal.
- Para ello, es necesario elegir qué variables serán discriminantes.
- Los *Decision Trees* buscan patrones en los datos introducidos (*input* y *output).*
- El proceso no nos asegura al 100% que el resultado obtenido coincida con la realidad.
- La precisión del modelo aumenta a medida que añadimos niveles de profundidad.