

$$\begin{array}{ccc}
\pi_1(X, x_0) \times \pi_1(Y, y_0) & \xrightarrow{\varphi_{X,Y}} & \pi_1(X \times Y, (x_0, y_0)) \\
\pi_1(f) \times \pi_1(g) \downarrow & & \downarrow \pi_1(f \times g) \\
\pi_1(W, w_0) \times \pi_1(Z, z_0) & \xrightarrow{\varphi_{W,Z}} & \pi_1(W \times Z, (w_0, z_0))
\end{array}$$