1. Consider an <u>arbitrary</u> transformation

$$\phi \to \phi + \delta\phi$$

$$\delta \mathcal{L} = \frac{\partial \mathcal{L}}{\partial \phi} \delta\phi + \frac{\partial \mathcal{L}}{\partial(\partial_\mu \phi)} \partial_\mu \delta\phi$$

$$= \underbrace{\left[\frac{\partial \mathcal{L}}{\partial \phi} - \partial_\mu \frac{\partial \mathcal{L}}{\partial(\partial_\mu \phi)} \right] \delta\phi}_{\text{E.O.M.}\ \varnothing}$$

$$+ \partial_\mu \left(\frac{\partial \mathcal{L}}{\partial(\partial_\mu \varphi)} \delta\phi \right)$$

2. Transf. is a symmetry of $\mathcal{L}$
if $\delta \mathcal{L} = \partial_\mu f^\mu$ i.e. total derivative

$$\Downarrow$$

$$\partial_\mu \underbrace{\left(\frac{\partial \mathcal{L}}{\partial(\partial_\mu \varphi)} \delta\varphi - f^\mu \right)}_{\text{conserved current } J^\mu :\ \partial_\mu J^\mu = 0} = 0$$

$$\Downarrow$$

3. <u>Find symmetries of $\mathcal{L}$ (i.e. such that $\delta\mathcal{L} = \partial_\mu f^\mu$ or 0)</u>

Translation $x^\mu \to x^\mu - \varepsilon^\mu$

$$\phi \to \phi(x+\varepsilon) = \phi + \varepsilon^\mu \partial_\mu \phi$$

$$\mathcal{L} \to \mathcal{L} + \underbrace{\varepsilon^\mu \partial_\mu \mathcal{L}}_{\text{Total } \partial}$$

$f^\mu = \mathcal{L} \varepsilon^\mu$

$$\Downarrow$$

$$\frac{\partial \mathcal{L}}{\partial(\partial_\mu \varphi)} \varepsilon^\nu \partial_\nu \varphi - \varepsilon^\mu \mathcal{L}$$

Arbitrary ε, arbitrary $\mathcal{L}$!

$$\boxed{T^{\mu\nu} = \frac{\partial \mathcal{L}}{\partial(\partial_\mu \varphi)} \partial^\nu \varphi - g^{\mu\nu} \mathcal{L} \quad \text{conserved}}$$

K-G $\Rightarrow$ $T^{\mu\nu} = \partial^\mu \varphi \, \partial^\nu \varphi - g^{\mu\nu} \mathcal{L}$

Dirac $\quad \mathcal{L} = \bar{\Psi} (i \partial_\mu \gamma^\mu - m) \Psi$

$$\downarrow$$

$$T^{\mu\nu} = \bar{\Psi} i \gamma^\mu \partial^\nu \Psi - g^{\mu\nu} \mathcal{L}$$

And so on