Model 1. Free field interacting with a fixed background.

\[ L = \psi \partial^\mu \partial_\mu \psi - m \psi^2 + g \psi \]
\( \psi \) vanishes at infinity.

Model 2. Same, but \( \psi \) is independent of time.

\[ L = g \psi \bar{\psi} \]

Model 3. \( \phi \) scalar, \( \psi \) charged scalar,

\[ L = \bar{\psi} \partial^\mu \psi - m \psi^2 - i \phi \psi \bar{\psi} \]
\[ + \frac{1}{2}(\partial \phi)^2 - \frac{\lambda}{2} \phi^2 \]

\[ T(A(x)B(y)) = \langle 0 | A(x)B(y) \rangle \]
\[ A(x)B(y) = \langle 0 | A(x)B(y) | 0 \rangle \]

\[ \phi(x) \partial_y = \int \frac{d^4p}{(2\pi)^4} \frac{e^{i(x-y)}}{p^2 - m^2 + i\epsilon} \]

\[ \psi(x) \psi(y) = \int \] 

Wick's Theorem.
\[ T(\phi_1, \ldots, \phi_n) = \psi_1 \psi_2 \phi_3 + \text{terms with one contracting} + \text{all terms with two contracting} + \ldots \]

Feynman rules for \( H = g f(t) \psi^\dagger \psi \phi \):

\[ \psi_1^\dagger \psi_2^\dagger \psi_1 \psi_2 \phi_3 \ldots \text{then contract.} \]

\[ \begin{array}{c}
\quad \\
\quad \\
\quad 
\end{array} \quad \rightarrow \quad \frac{(-1)^2}{2!} \int \psi_1^\dagger \psi_1 \phi_1^\dagger \phi_2 \phi_3 f(t_1) f(t_2) f(t_3) \cdot \]

\[ \begin{array}{c}
\quad \\
\quad \\
\quad 
\end{array} \quad \rightarrow \quad \frac{(-1)^2}{2!} \int dx_1 dx_2 f(t_1) f(t_2) \cdot \]

\[ \begin{array}{c}
\quad \\
\quad \\
\quad 
\end{array} \quad \rightarrow \quad \ldots \psi_1^\dagger \psi_2 \phi_1 \phi_2 \psi_3 \phi_4 \cdot \]

Combinatorial factors, the order of the automorphism group.

Connected & disconnected diagrams, log & \exp.
Back to model I: \( H_i = g(\theta(x), p(x)) \)