Algorithm 1 Genetic VANS

input: `initial circuit` $\mathcal{C}(\vec{\theta})$, alphabet of blocks $\mathcal{A}$`desired accuracy` ϵ
`converged` $\leftarrow$ False
set $E^* = E[\mathcal{C}(\vec{\theta^*})]$
while not `converged` **do**
    `pick a block` $B_i(\tilde{\theta})$ `from` $\mathcal{A}$ `with prob` p_i`, and randomly place it in` $\mathcal{C}$.
    `initialize` $\mathcal{C}_{B_i}(\vec{\theta} \sim \vec{\theta^*}, \tilde{\theta} \sim \epsilon)$ `and compute` $\hat{E} = E[\mathcal{C}_{B_i}(\vec{\theta^*}, \tilde{\theta^*})]$
    `if` $\hat{E} < E^*$:
        `accept` B_i `(now` $\mathcal{C}$ `has block` B_i `at the corresponding position)`
        `set` $\vec{\theta} \leftarrow (\vec{\theta^*}, \tilde{\theta^*})$
        `suppress 1-qubit unitaries if possible`
        `suppress consecutive CNOTs/1-qubit unitaries if possible`
    `if` $E^* - E_g < \epsilon$:
        `converged` $\leftarrow$ `False`
        `return`

Note:

$E[\mathcal{C}(\vec{\theta^*})$ is obtained from classical optimization routine, e.g. Adam.