* General form of an state $|\psi\rangle$ after applying $H^{\otimes n}$

We know $H|0\rangle = \frac{1}{\sqrt{2}}(|0\rangle + |1\rangle)$.

& $H|1\rangle = \frac{1}{\sqrt{2}}(|0\rangle - |1\rangle)$.

combining these two, we can write —

$$H|a\rangle = \frac{1}{\sqrt{2}}\left((-1)^0|0\rangle + (-1)^a|1\rangle\right).$$

$$= \frac{1}{\sqrt{2}} \sum_{x \in \{0,1\}} (-1)^{a \cdot x} |x\rangle$$

Now let $|x\rangle = |x_{n-1}, x_{n-2}, \cdots, x_0\rangle$ be an n-qubit.

So, therefore,

$$H^{\otimes n}|x\rangle = \frac{1}{2^{n/2}} \sum_{k_{n-1}=0}^{1} \cdots\cdots \sum_{k_0=0}^{1} (-1)^{\sum x_i k_i} |k_{n-1} \cdots k_0\rangle$$

and $x \cdot k = x_0 k_0 + x_1 k_1 + \cdots + x_{n-1} k_{n-1}$, Sum of bitwise product.