ghost(complex F)

$$
\begin{tikzcd}
0 \arrow[r] & F_n \arrow[r, "\partial_n"] & F_{n-1} \arrow[r, "\partial_{n-1}"] & \cdots \arrow[r] & F_2 \arrow[r, "\partial_2"] & F_1 \arrow[r, "\partial_1"] & F_0 \arrow[r] & 0 \\
 & & & & \ker\partial_2 \arrow[u] & \ker\partial_1 \arrow[u] & F_0 = \ker\partial_0 \arrow[u] & \\
0 \arrow[r] & Q_n \arrow[r] & \cdots \arrow[r] & & Q_2 \arrow[r, "0"] \arrow[u, two heads, "\pi_2"] & Q_1 \arrow[r, dashed, "0"] \arrow[u, two heads, "\pi_1"] & Q_0 \arrow[u, two heads, "\pi_0"] & Q
\end{tikzcd}
$$

$Q \in \text{thick}^{1} R$

$$
\begin{tikzcd}
Q \arrow[r, "\pi"] & F \arrow[dl] \\
\text{cone}(\pi) &
\end{tikzcd}
$$

$\text{cone}(\pi) \rightsquigarrow$ try using cone(ComplexMap

Return map $F \longrightarrow \text{cone}\,\pi$

Level of $\mathcal{F}$ (complex)

can we do this more efficiently?

approximation

$$\underline{\text{step 1}} \quad \underset{f_1}{\text{ghost}} \ \mathcal{F} = \left(\mathcal{F} \longrightarrow \operatorname{cone}\left(R^{n} \twoheadrightarrow \ker \partial_i \right)_i \right)$$

Stop if $f_1 = 0$

$$\begin{tikzcd}
0 \arrow[r] & \mathcal{F}_n \arrow[r, "\partial_n"] & \mathcal{F}_{n-1} \arrow[r, "\partial_{n-1}"] & \cdots \arrow[r] & \mathcal{F}_2 \arrow[r, "\partial_2"] & \mathcal{F}_1 \arrow[r, "\partial_1"] & \mathcal{F}_0 \arrow[r] & 0 \\
 & & & & \ker \partial_2 \arrow[u] & \ker \partial_1 \arrow[u] & \mathcal{F}_0 = \ker \partial_0 \arrow[u] & \\
0 \arrow[r] & Q_n \arrow[r] & \cdots \arrow[r] & {} & Q_2 \arrow[u, two heads, "\pi_2"] \arrow[r, "0"] & Q_1 \arrow[u, two heads, "\pi_1"] \arrow[r, dashed, "0"] & Q_0 \arrow[u, two heads, "\pi_0"] & \mathcal{F}_1
\end{tikzcd}$$