Place cells and receptive fields

Definitions

Definition

*Place cells* are neurons that become active in a preferred region with respect to the subject’s environment. A *receptive field* $U_i$ is the region where the $i$th neuron is active.
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The big question

Which codes can be idealized as receptive fields?
Neural Codes

Definition
Given neurons labelled \( \{1, ..., n\} = [n] \), define a neural code \( C \), to be a collection of binary words \( c = (c_1, ..., c_n) \). For any \( C \) and any \( c \in C \), define \( \text{supp}(c) \overset{\text{def}}{=} \{i \in \{1, ..., n\} \mid c_i = 1\} \) and, \( \text{supp}(C) \overset{\text{def}}{=} \{\text{supp}(c) \mid c \in C\} \).

Example
Let \( C = \{000, 010, 110, 001\} \). Then \( \text{supp}(C) = \{\emptyset, \{2\}, \{1, 2\}, \{3\}\} \).
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Definition
simplicial complex \(\Delta(\mathcal{C}) \overset{\text{def}}{=} \{\sigma \subseteq \text{supp}(c) | \sigma \subseteq c \text{ for some } c \in \mathcal{C}\}\).

Example
\(\Delta(\mathcal{C}) = \{\emptyset, \{1\}, \{2\}, \{1, 2\}, \{3\}\}\).