In vision, filling-in refers to a process of perceptual completion by which a coherent percept is produced by brain in lack of isomorphic visual feature representation of a surface stimulus.

Diffusive filling-in refers to a process of spreading neural activity representing visual features within a bounded region that corresponds to a visual image segment

The model of diffusive filling-in (Cohen & Grossberg, 1984) suggests computation of visual features and image boundaries performed separately by Boundary Contour System (BCS) and Feature Contour System (FCS) and subsequent gating of FCS activity by BCS signals The diffusion process obeys the following system of equations (Grossberg & Todorović, 1988)

Each potential S_{ij} at position (i,j) of the syncytium obeys a nonlinear diffusion equation

$$\frac{d}{dt} S_{ij} = -MS_{ij} + \sum_{(p,q)\in N_{ij}} (S_{pq} - S_{ij})P_{pqij} + X_{ij}. \quad \text{(A22)}$$

The diffusion coefficients that regulate the magnitude of cross influence of location (i,j) with location (p,q) depend on the BC signals Z_{pq} and Z_{ij} as follows:

$$P_{pqij} = \frac{\delta}{1+\epsilon(Z_{pq}+Z_{ij})}. \quad \text{(A23)}$$

The set N_{ij} of locations comprises only the lattice nearest neighbors of (i,j):

$$N_{ij} = \{(i,j-1),\ (i-1,j),\ (i+1,j),\ (i,j+1)\}. \quad \text{(A24)}$$

At lattice edges and corners, this set is reduced to the set of existing neighbors. According to Equation A22, each potential S_{ij} is activated by the on-cell output signal X_{ij} and thereupon engages in passive decay (term $-MS_{ij}$) and diffusive filling-in with its four nearest neighbors to the degree permitted by the diffusion coefficients P_{pqij}. At equilibrium, each S_{ij} is computed as the solution of a set of simultaneous equations

$$S_{ij} = \frac{X_{ij} + \Sigma_{(p,q)\in N_{ij}} S_{pq} P_{pqij}}{M + \Sigma_{(p,q)\in N_{ij}} P_{pqij}}, \quad \text{(A25)}$$

which is compared with properties of the brightness percept.