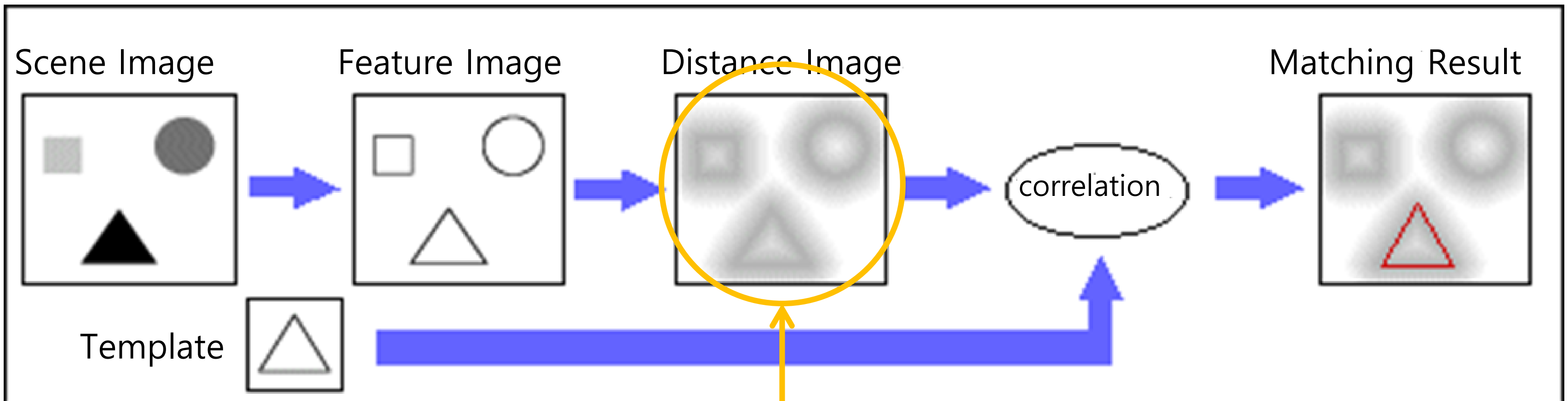
# Distance Transform

- Chamfer matching (binary shape matching)




Each pixel value denotes the distance to the nearest feature pixel

DT allows more variability between a template and an object of interest in the image because a distance image provides a smooth cost function.

D. M. Gavrila, "A Bayesian, exemplar-based approach to hierarchical shape matching," IEEE Trans. Pattern Anal. Mach. Intell., Vol.29, No.8, pp.1408-1421, 2007.

# Distance Transform

- Distance between $p = (x_1, y_1)$ and $q = (x_2, y_2)$
  - Manhattan distance
$$d_1(p, q) = |x_1 - x_2| + |y_1 - y_2|$$
  - Euclidean distance
$$d_2(p, q) = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

- We use $d_1$ in this application

- Distance transform
$$D(p) = \min_{\mathbf{B}(q)=0} d_1(q, p)$$
  - $\mathbf{B}(p) = 1$
  - Compute the distance to the nearest background pixel

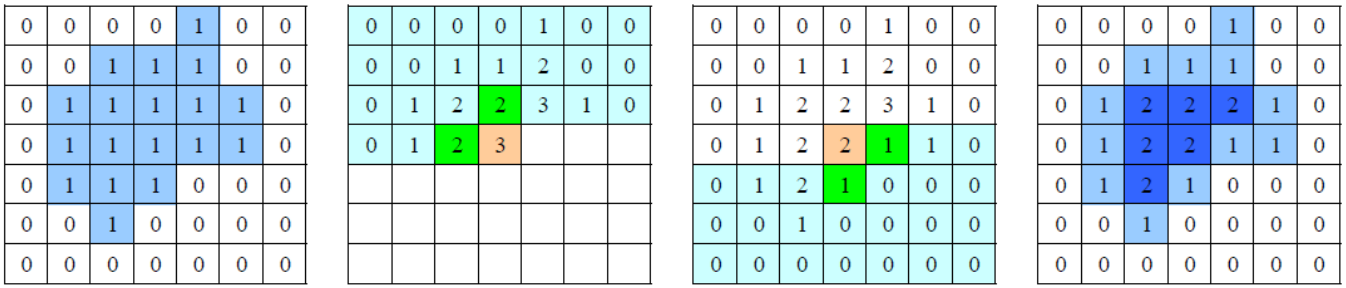
# Distance Transform

- Example

| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 1 | 1 | 0 |
| 0 | 1 | 1 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 0 | 0 | 1 | 1 | 1 | 0 | 0 |
| 0 | 1 | 2 | 2 | 2 | 1 | 0 |
| 0 | 1 | 2 | 2 | 1 | 1 | 0 |
| 0 | 1 | 2 | 1 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |

# Distance Transform



(a) (b) (c) (d)

- Procedure: Two sweeps for nonzero pixels only
  - (b) forward sweep

    $$D(r,c) = \min\{1 + D(r-1,c), 1 + D(r,c-1)\}$$

  - (c) backward sweep

    $$D(r,c) = \min\{D(r,c), 1 + D(r+1,c), 1 + D(r,c+1)\}$$