# A Measure Definitions

Measures which are not suitable for rotation are marked [order only]. As in section 3, $P$ and $P'$ refer to the point sets for drawings $D$ and $D'$, respectively, and $p' \in P'$ is the corresponding point for $p \in P$ (and vice versa). Let $d(p,q)$ be the Euclidean distance between points $p$ and $q$.

## A.1 Degree of Match

**Undirected Hausdorff Distance**

$$\text{haus}(P,P') = \max \{ \max_{p \in P} \min_{q' \in P'} \; d(p,q') \, , \; \max_{p' \in P'} \min_{q \in P} \; d(p',q) \, \}$$

**Paired Hausdorff Distance**

$$\text{phaus}(P,P') = \max_{p \in P} \; d(p,p')$$

## A.2 Position

**Average Distance**

$$\text{dist}(P,P') = \frac{1}{|P|} \sum_{p \in P} d(p,p')$$

**Nearest Neighbor Between**

$$\text{nnb}(P,P') = \frac{1}{\text{UB}} \sum_{p \in P} \text{weight}(\text{nearer}(p))$$

where

$$\text{nearer}(p) = \{ q \mid d(p,q') < d(p,p') \, , \; q \in P \, , \; q \neq p \}$$

**Unweighted**

$$\begin{aligned} \text{weight}(S) &= \begin{cases} 0 & \text{if } |S| = 0 \\ 1 & \text{otherwise} \end{cases} \\ \text{UB}(n) &= |P| \end{aligned}$$

**Weighted**

$$\begin{aligned} \text{weight}(S) &= |S| \\ \text{UB}(n) &= |P| \, (|P| - 1) \end{aligned}$$

## A.3 Relative Position

**Orthogonal Ordering** Let $\theta_{pq}$ be the counterclockwise angle between the positive $x$-axis and the vector $q - p$.

$$\text{order}(P,P') = \frac{1}{W} \min \left\{ \int_{\theta_{pq}}^{\theta_{p'q'}} \text{weight}(\theta) \, d\theta, \int_{\theta_{p'q'}}^{\theta_{pq}} \text{weight}(\theta) \, d\theta \right\}$$

**Constant-Weighted**

$$\begin{aligned} \text{weight}(\theta) &= 1 \\ W &= \pi \end{aligned}$$

**Linear-Weighted**

$$\begin{aligned} \text{weight}(\theta) &= \begin{cases} \frac{(\theta \bmod \pi/2)}{\pi/4} & \text{if } (\theta \bmod \pi/2) < \pi/4 \\ \frac{\pi/2 - (\theta \bmod \pi/2)}{\pi/4} & \text{otherwise} \end{cases} \\ W &= \pi/2 \end{aligned}$$

**Ranking** Let right($p$) and above($p$) be the number of points to the right of and above $p$, respectively.

$$\text{rank}(P, P') = \frac{1}{\text{UB}} \sum_{p \in P} \min\{\, |\, \text{right}(p) - \text{right}(p')\,| + |\,\text{above}(p) - \text{above}(p')\,|\,,\ \text{UB}\,\}$$

where

$$\text{UB} = 1.5\,(|P| - 1)$$

**Average Relative Distance [order only]**

$$\text{rdist}(P, P') = \frac{1}{|P|\,(|P| - 1)} \sum_{p,q \in P} |\, d(p,q) - d(p',q')\,|$$

**$\lambda$-Matrix [order only]** Let $\lambda(p,q)$ be the number of points in $P$ to the left of the directed line from $p$ to $q$.

$$\text{lambda}(P, P') = \frac{1}{\text{UB}} \sum_{p,q \in P} |\, \lambda(p,q) - \lambda(p',q')\,|$$

where the upper bound for a set of size $n$ is:

$$\text{UB}(n) = n \left\lfloor \frac{(n-1)^2}{2} \right\rfloor$$

## A.4 Neighborhood

**Nearest Neighbor Within [order only]** Let nn($p$) be the nearest neighbor of $p$ in the $p$'s point set and nn$(p)'$ be the corresponding point in $P'$ to nn($p$).

$$\text{nnw}(P, P') = \frac{1}{\text{UB}} \sum_{p \in P} \text{weight}(\text{nearer}(p))$$

where

$$\text{nearer}(p) = \{\, q \mid d(p', q') < d(p', \text{nn}(p)')\,,\ q \in P\,,\ q \neq p\,,\ q \neq \text{nn}(p)\,\}$$

**Unweighted**

$$\begin{aligned} \text{weight}(S) &= \begin{cases} 0 & \text{if } |S| = 0 \\ 1 & \text{otherwise} \end{cases} \\ \text{UB}(n) &= |P| \end{aligned}$$

**Weighted**

$$\begin{aligned} \text{weight}(S) &= |S| \\ \text{UB}(n) &= |P|\,(|P|-1) \end{aligned}$$

**$\epsilon$-Clustering [order only]**

$$\text{eclus} = 1 - \frac{|S_I|}{|S_U|}$$

where

$$\begin{aligned} \epsilon &= \max_{p \in P} \min_{q \in P, q \neq p} d(p,q) \\ S_I &= \{\, (p,q) \mid p \in P\,,\, q \in \text{clus}(p,P,\epsilon) \text{ and } q' \in \text{clus}(p',P',\epsilon')\,\} \\ S_U &= \{\, (p,q) \mid p \in P\,,\, q \in \text{clus}(p,P,\epsilon) \text{ or } q' \in \text{clus}(p',P',\epsilon')\,\} \\ \text{clus}(p,P,\epsilon) &= \{\, q \mid d(p,q) \leq \epsilon\,,\, q \in P\,,\, q \neq p\,\} \end{aligned}$$

**Separation-Based Clustering [order only]** For every point $p$ in cluster $C$ such that $|C| > 1$, there is a point $q \neq p \in C$ such that $d(p,q) < \delta$ and there is no point $r \notin C$ such that $d(p,r) < \delta$. If $C$ is a single point, only the second condition holds.

Let clus($p$) be the cluster to which point $p$ belongs.

$$\text{sclus} = 1 - \frac{|S_I|}{|S_U|}$$

where

$$\begin{aligned} S_I &= \{\, (p,q) \mid p,q \in P\,,\, \text{clus}(p) = \text{clus}(q) \text{ and } \text{clus}(p') = \text{clus}(q')\,\} \\ S_U &= \{\, (p,q) \mid p,q \in P\,,\, \text{clus}(p) = \text{clus}(q) \text{ or } \text{clus}(p') = \text{clus}(q')\,\} \end{aligned}$$

## A.5 Edges

**Shape** The *shape* measure treats the edges of the graph as sequences of north, south, east, and west segments and compares these sequences using the edit distance.

$$\text{shape} = \frac{1}{\text{UB}} \sum_{e \in E} \text{edits(e,e')}$$

**Regular** The edit distance is not normalized for the length of the sequence, and the upper bound is as follows:

$$\text{UB} = \sum_{e \in E} |\,\text{length}(e) - \text{length}(e')\,| + \min\{\,\text{length}(e)\,,\, \text{length}(e')\,\}$$

**Normalized** The edit distance is normalized for the length of the sequence using the algorithm of Marzal and Vidal [11], and the upper bound is as follows:

$$\text{UB} = |E|$$