Minutiae Matching: The RANSAC Method

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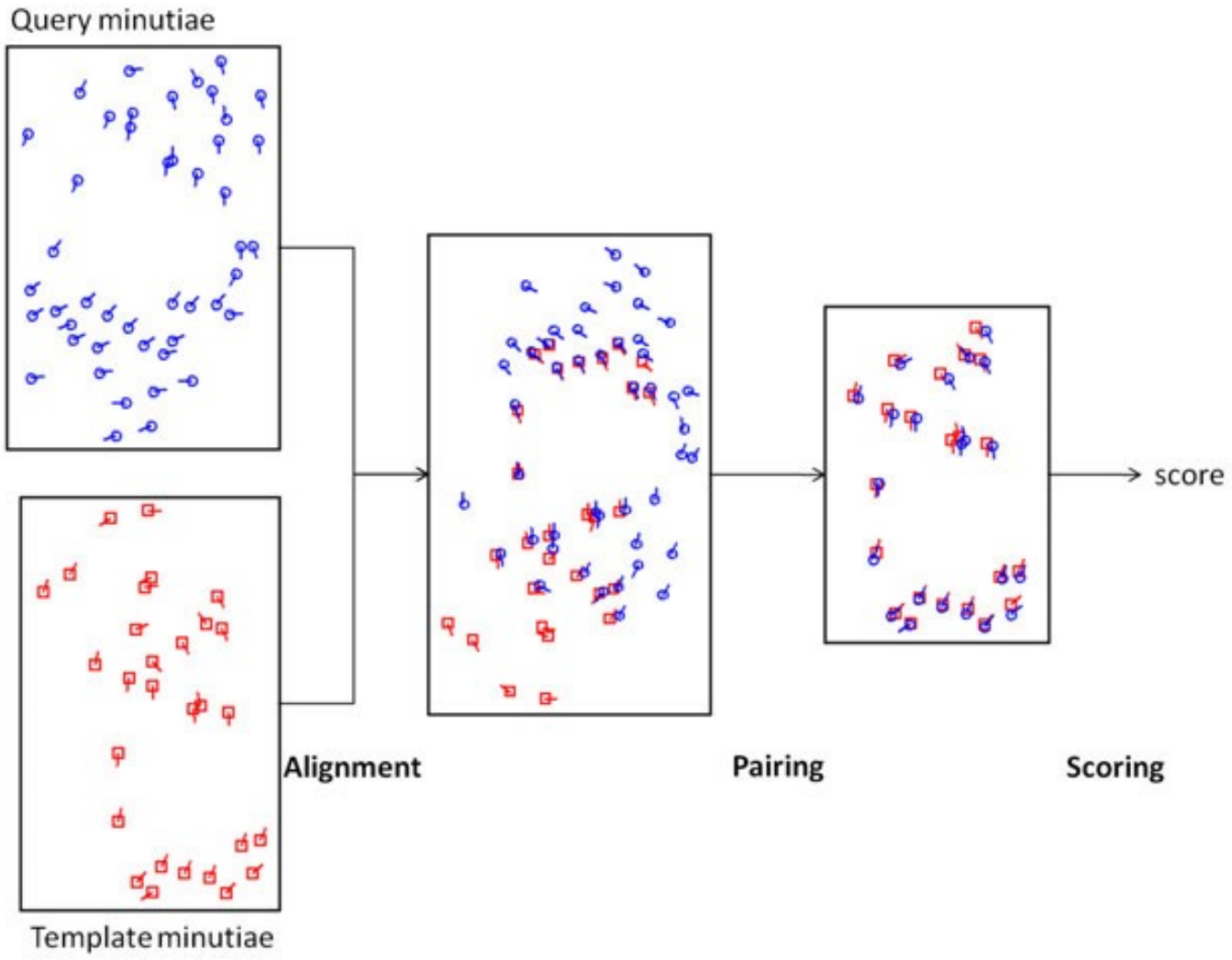
Minutiae matching

Almost all fingerprint matchers are based on minutiae matching.



Minutiae Matching Algorithm

- Let $P = \{p_1, p_2, \ldots p_m\}$ be the minutiae points in the first image
  - Let $p_i = \{x_i^p, y_i^p, \theta_i^p\}$ be the i^{th} minutia point in P, $i = 1..m$
- Let $Q = \{q_1, q_2, \ldots q_n\}$ be the minutiae points in the second image
  - Let $q_j = \{x_j^q, y_j^q, \theta_j^q\}$ be the j^{th} minutia point in Q, $j = 1..n$

Minutiae Matching Algorithm

- for $i = 1\ to\ m$
- for $j = 1\ to\ n$
  - (Assume p_i is in correspondence with q_j)
  - Compute transformation parameters
    - $t_x = x_j^q - x_i^p$
    - $t_y = y_j^q - y_i^p$
    - $t_r = \theta_j^q - \theta_i^p$
  - (Apply transformation to all points in P resulting in a new set P')
  - for $k = 1\ to\ m$
    - $x_k^{p\prime} = (x_k^p - x_i^p)\cos t_r + (y_k^p - y_i^p)\sin t_r + (x_i^p + t_x)$
    - $y_k^{p\prime} = -(x_k^p - x_i^p)\sin t_r + (y_k^p - y_i^p)\cos t_r + (y_i^p + t_y)$
  - Using a bounding box or bounding circle (with some radius), determine the number of corresponding **overlapping points** between P' and Q. Denote this as $\boldsymbol{c_{ij}}$

Minutiae Matching Algorithm

- After both loops end:
  - find the maximum value of $\{c_{ij}\}, i = 1..m, j = 1..n$
    - Let this be denoted as C
    - Note: store (t_x, t_y, t_r) corresponding to this maximum value
  - So final match score between P and Q

$$S = \frac{C \times C}{m \times n}$$

- This is referred to as **Brute Force** or **RANSAC (Random Sample Consensus)**, since there is consensus between minutiae pairs as to which **transformation** results in the maximum number of corresponding minutiae points