arbitrary orientations →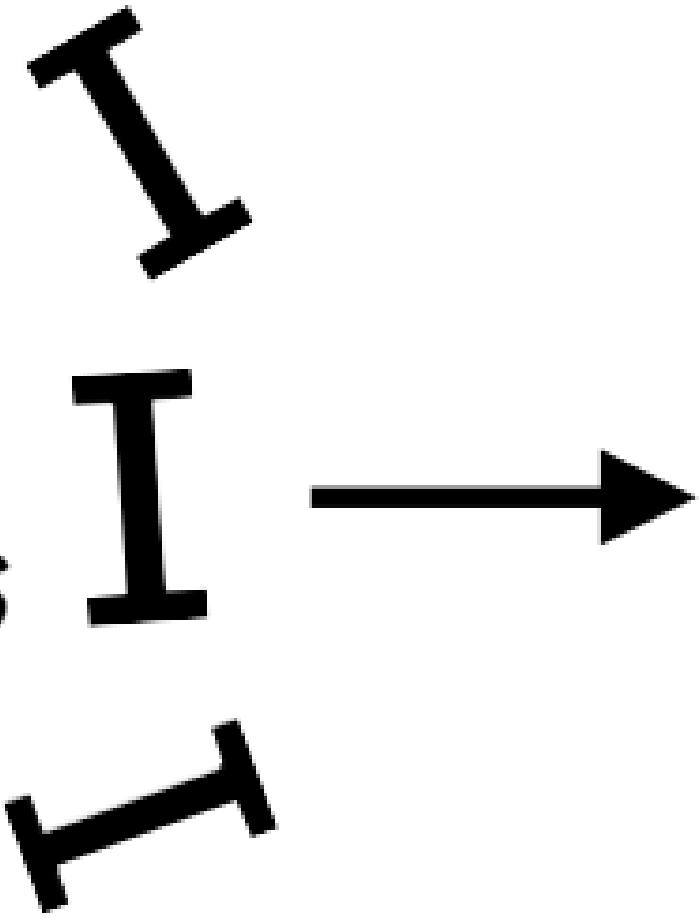 "canonical" orientation