

# Chapter 28

## Distances in Applied Social Sciences

In this chapter we present selected distances used in real-world applications of Human Sciences. In this and next chapter, the expression of distances ranges from numeric (say, in meters) to ordinal (as a degree assigned according to some rule). Depending on the context, the distances are either practical ones, used in daily life and work outside of science, or those used as a metaphor for remoteness (the fact of being apart, being unknown, coldness of manner, etc.).

### 28.1 Distances in Psychology and Sociology

- **Approximative human-scale distances**

An **arm's length** is a distance (about 0.7 m, i.e., within **personal distance**) sufficient to exclude intimacy, i.e., discouraging familiarity or conflict; its analogs are: Italian braccio, Turkish pik, and Old Russian sazhen. The **reach distance** is the difference between maximum reach and arm's length distance.

The **striking distance** is a short distance (say, through which an object can be reached by striking).

The **whiffing distance** (or **spitting distance**) is a very close distance.

The **shouting distance** is a short, easily reachable distance.

A **stone's throw** is a distance of about 25 fathoms (46 m).

The **hailing distance** is the distance within which the human voice can be heard.

The **walking distance** is the distance normally (depending on the context) reachable by walking. For example, some UK high schools define 2 and 3 miles as the statutory walking distance for children younger and older than 11 years. *Pace out* means to measure distance by pacing (walking with even steps).

The **acceptable commute distance**, in Real Estate, is the distance that can be covered in an acceptable travel time and increases with better connectivity.

- **Optimal eye-to-eye distance**

The **optimal eye-to-eye distance** between two persons was measured for some types of interaction. For example, such optimal viewing distance between a baby and its mother's face, with respect to immature motor and visual systems of the

newborn, is 20-30 cm. Haynes-White-Held, 1965, showed that during the first weeks of life the accommodation system does not yet function and the lens of the newborn is locked at the **focal distance** of about 19 cm.

- **Distances between people**

In [Hall69], four interpersonal bodily distances were introduced: the *intimate distance* for embracing, touching or whispering (15 – 45 cm), the *personal-casual distance* for conversations among good friends (45 – 120 cm), the *social-consultative distance* for conversations among acquaintances (1.2 – 3.6 m), and the *public distance* used for public speaking (over 3.6 m). Cf. **distances in Animal Behavior** in Chapter 23.

To each of those *proxemics distances* corresponds an intimacy/confidence degree and appropriated sound level. The distance which is appropriate for a given social situation depends on culture, gender and personal preference. For example, under Islamic law, proximity (being in the same room or secluded place) between a man and a woman is permitted only in the presence of their *mahram* (a spouse or anybody from the same sex or a pre-puberty one from the opposite sex). For an average westerner, personal space is about 70 cm in front, 40 cm behind and 60 cm on either side. In interaction between strangers, the interpersonal distance between women is smaller than between woman and man.

Example of other cues of nonverbal communication is given by angles of vision which individuals maintain while talking. The **people angular distance in a posture** is the spatial orientation, measured in degrees, of an individual's shoulders relative to those of another; the position of a speaker's upper body in relation to a listener's (for example, facing or angled away); the degree of body alignment between a speaker and a listener as measured in the coronal (vertical) plane which divides the body into front and back. This distance reveals how one feels about people nearby: the upper body unwittingly angles away from disliked persons and during disagreement.

Eye-contact decreases with spatial proximity. The persons stand closer to those whose eyes are shut. *Steinzor effect* is the finding that members of leaderless discussion groups seated in circles, are most apt to address remarks to or to get responses from persons seated opposite or nearly opposite them, while in the presence of a strong leader, it happens with persons seated alongside or nearly alongside.

Distancing behavior of people can be measured, for example, by the *stop distance* (when the subject stops an approach since she/he begins to feel uncomfortable), or by the *quotient of approach*, i.e., the percentage of moves made that reduce the interpersonal distance to all moves made.

Humans and monkeys with amygdala lesions have much smaller than average preferred interpersonal distance.

- **Psychological Size and Distance Scale**

The CID (*Comfortable Interpersonal Distance*) scale by Duke and Nowicky, 1972, consists of a center point 0 and eight equal lines emanating from it. Subjects are asked to imagine themselves on the point 0 and to respond to descriptions of imaginary persons by placing a mark at the point on a line at which they would like

the imagined person to stop, that is, the point at which they would no longer feel comfortable. CID is then measured in mm from 0.

The GIPSDS (**Psychological Size and Distance Scale**) by Grashma and Ichiyama, 1986, is a 22-item rating scale assessing interpersonal status and affect. Subjects are asked to draw circles, representing the drawer and other significant persons, so that the radii of the circles and the distances between them indicate the thoughts and feelings about their relationship. Then these distances and radii, measured in mm, represent **psychological distance** and status, respectively.

See [http://www.surveymonkey.com/s.aspx?sm=Nd8c\\_2fzxsMZfK9ryhvzPlw\\_3d\\_3d](http://www.surveymonkey.com/s.aspx?sm=Nd8c_2fzxsMZfK9ryhvzPlw_3d_3d) (related online questionnaire).

- **Psychological distance**

CLT (*construal level theory*) in Liberman-Trope, 2003, defines **psychological distance** from an event or object as a common meaning of spatial (“where”), temporal (“when”), social (“who”) and hypotheticality (“whether”) distance from it.

Expanding spatial, temporal, social and hypotheticality horizons in human evolution, history and child development is enabled by our capacity for *mental construals*, i.e., abstract mental representations. Any event or object can be represented at *lower-level* (concrete, contextualized, secondary) or *higher-level* (abstract, more schematic, primary) construal.

More abstract construals lead to think of more distant (spatially, temporally, socially and hypothetically) objects and vice versa. People construe events at greater, say, temporal distance in terms of their abstract, central, goal-related features and pro-arguments, while nearer events are treated situation-specifically at lower level of counter-arguments. Examples are: greater moral concern over a distant future event, more likely victim’s forgiveness of the earlier transgression, more intense affective consumer’s reaction when a positive outcome is just missed.

CLT implied that judgments along the four dimensions are conceptually related, i.e., the dimensions are functionally similar. For example, increase of distance in only one dimension leads to greater moral concern.

But Zhang and Wang, 2008, observed that stimulating people to consider spatial distance influences their judgments along three other dimensions, but the reverse is not true. It is consistent with a claim by Boroditsky, 2000, that the human cognitive system is structured around only concepts emerging directly out of experience, and that other concepts are then built in a metaphorical way. Williams and Bargh, 2008, also claim that psychological distance is a derivative of spatial distance. Spatial concepts such as “near/far” are present at 3 to 4 months of age since the relevant information is readily available to the senses, whereas abstract concepts related to internal states are more difficult to understand. Also, spatial relations between oneself, one’s caretakers and potential predators have primary adaptive significance.

- **Time-distance relation, in Psychology**

People often talk about time using spatial linguistic metaphors (a long vacation, a short concert) but much less talk about space in terms of time. This bidirectional but asymmetric relation suggests that spatial representations are primary, and are

later co-opted for other uses such as time. Casasanto and Boroditsky, 2008, showed that people, in tasks not involving any linguistic stimuli or responses, are unable to ignore irrelevant spatial information when making judgments about duration, but not the converse. So, the metaphorical space-time relationship observed in language also exists in our more basic representations of distance and duration. Mentally representing time as a linear spatial path may enable us to conceptualize abstract (as moving a meeting forward, pushing a deadline back) and impossible (as time-travel) temporal events.

In Psychology, the *Kappa effect* is that among two journeys of the same duration, one covering more distance appears to take longer, and the *Tau effect* is that among two equidistant journeys, one taking more time to complete appears to have covered more distance. Jones and Huang, 1982, consider them as effects of *imputed velocity* (subjects impute uniform motion to discontinuous displays) on judgements of both time and space, rather than direct effect of time (distance) on distance (time) judgement. In Physics, *velocity* is the rate of change of position; it is a vector (speed and direction) measuring change in distance over an interval of time.

Fleet, Hallet and Jepson, 1985, found spatio-temporal inseparability in early visual processing by retinal cells. Also, Maruya and Sato, 2002, reported new illusion (time difference of two motion stimuli is converted in the illusory spatial offset) indicating interchangeability of space and time in early visual processing. The differences appear at the level of higher processing because of different representations: space is represented in retinotopic maps within the visual system, while time is processed in cerebellum, basal ganglia and cortical structures. Evidence from lesion and human functional brain imaging/interference studies point towards the posterior parietal cortex as the main site where spatial and temporal information converge and interact with each other. Cf. also **spatial-temporal reasoning**.

- **Distance as a metaphor**

Lakoff and Núñez, 2000, claim that mathematics emerged via conceptual metaphors grounded in the human body, its motion through space and time, and in human sense perceptions. In particular, the mathematical idea of distance comes from the activity of measuring, and corresponding mathematical technique consists of rational number and metric space. The idea of proximity/connection comes from connecting and corresponds to topological space. The idea of symmetry comes from looking at objects and corresponds to invariance and isometries.

- **Metaphoric distance**

A **metaphoric distance** is any notion in which a degree of similarity between two difficult-to-compare things is expressed using spatial notion of distance as an implicate bidirectional and understandable metaphor. Some practical examples are:

*Internet and Web bring people closer*: proximity in subjective space is at-handness;

*Healthy professional distance* teacher-student, therapist-patient, manager-employee;

*Competitive distance* (uncomparability) between two airline product offerings;

*Metaphoric distance* that a creative thinker take the thinking away from the problem, i.e., degree of intuitivity, required to evolve/reshape concepts into new ideas.

The **distance-similarity metaphor** (Montello-Fabrikant-Ruocco-Middleton, 2003) is a design principle, where relatedness (say, similarity) in non-spatial data content is projected onto distance, so that semantically similar documents are placed closer to one another in an information space. It is the inverse of the *first law of geography* (Tobler, 1970); cf. **nearness principle**. This metaphor is used in Data Mining, Pattern Recognition and Spatialization (information display) of non-spatial data.

Comparing the linguistic conceptual metaphor *proximity*→*similarity* with its mental counterpart, Casasanto (2008), found that stimuli (pairs of words or pictures) presented closer together on the computer screen were rated more similar during conceptual judgments of abstract entities or unseen object properties but less similar during perceptual judgments of visual appearance of faces and objects.

- **Symbolic distance effect**

In Psychology, the brain compares two concepts (or objects) with higher accuracy and faster reaction time if they differ more on the relevant dimension. For example, the performance of subjects when comparing a pair of positive numbers ( $x, y$ ) decreases for smaller  $|x - y|$  (*behavioral numerical distance effect*).

The related *magnitude effect* (or Weber-Fechner law effect) is that performance decreases for larger  $\min\{x, y\}$ . Those effects are valid also for congenitally blind people; they learn spatial relation via tactile input (interpreting, say, numerical distance by placing pegs in a peg board).

A current explanation is that there exists a mental line of numbers, which is oriented from left to right (as 2,3,4) and non-linear (more mental space for smaller numbers). So, close numbers are easier to confuse since they are represented on the mental line at adjacent and not always precise locations. Possible mental lines, explaining such confusion, are *linear-scalar* (the psychologic distance  $d(a, a + 1)$  between adjacent values is constant but the amount of noise increases as  $ka$ ) or *logarithmic* (amount of noise is constant but  $d(a, a + 1)$  decreases logarithmically).

- **Distancing**

**Distancing** (from the verb *to distance*, i.e., to move away from) is any behavior or attitude causing to be or appearing to be at a distance.

**Distantness** is the state or quality of being distant or remote. A similar notion is **distancy**, which is also rare/obsolete word for **distance**. **Self-distance** is the ability to critically reflect on yourself and your relations from an external perspective; not to confound with mathematical notions of **self-distance** in Chapters 1 and 17. **Outdistancing** means to outrun, especially in a long-distance race, or, more generally, to surpass by a wide margin, especially through superior skill or endurance.

In Martial Arts, **distancing** is the selection of an appropriate *combat range*, i.e., distance from the adversary. For other examples of spatial distancing, see **distances between people** and, in Chapter 29, **safe distancing** from a risk factor.

In *Mediation* (a form of alternative dispute resolution), **distancing** is the impartial and non-emotive attitude of the mediator versus the disputants and outcome.

In Psychoanalysis, **distancing** is the tendency to put persons and events at a distance. It concerns both the patient and the psychoanalyst.

In Developmental Psychology, **distancing** (Werner-Kaplan, 1964, for deaf-blind patients) is the process of establishing the individuality of a subject individuality as an essential phase (prior to symbolic cognition and linguistic communication) in learning to treat symbols and referential language. For Sigel (1970, for preschool children), **distancing** is the process of the development of cognitive representation: cognitive demands by the teacher or the parent help to generate a child's representational competence. **Distancing from role identities** is the first step of 7th (individualistic) of 9 stages of ego development proposed by Loevinger, 1976.

In books by Kantor, **distancing** refers to APD (Avoidant Personality Disorder): fear of intimacy and commitment (confirmed bachelors, "femmes fatales", etc.) **As-sociational distancing** refers to individual's dissociation with those in the group inconsistent with his desired social identity.

The **distancing language** is phrasing used by a person to avoid thinking about the subject or content of his own statement (for example, referring to death).

**Distancing by scare quotes** is a placing quotation marks around an item (single word or phrase) to indicate that the item does not signify its literal or conventional meaning. The purpose could be to distance the writer from the quoted content, to alert the reader that the item is used in an unusual way, or to represent the writer's concise paraphrasing. **Neutral distancing** convey a neutral writer's attitude, while distancing him from item's terminology, in order to call attention to a neologism, jargon, a slang usage, etc; sometimes italics are used for it.

Cf. **technology-related distancing**, **antinomy of distance**, **distanciation**, **role distance**.

- **Distance education**

**Distance education** is the process of providing instruction when students and instructors are separated by physical distance, and technology is used to bridge the gap. *Distance learning* is the desired outcome of distance education.

The **transactional distance** (Moore, 1993) is a perceived degree of separation during interaction between students and teachers, and within each group. This distance decreases with *dialog* (a purposeful positive interaction meant to improve the understanding of the student), with larger autonomy of the learner, and with lesser predetermined structure of the instructional program.

Vygotsky's *zone of proximal development* is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers.

- **Distance supervision**

**Distance supervision** refers to the use of interactive distance technology (landline and cell phones, Email, chat, text messages to cell phone and instant messages, video teleconferencing, Web pages) for live (say, work, training, psychological umbrella, mental health worker, administrative) supervision.

Such supervision requires tolerance for ambiguity when interacting in an environment that is devoid of nonverbal information.

- **Moral distance**

The **moral distance** is a measure of moral indifference or empathy toward a person, group of people, or events.

The (moral) *distancing* is a separation in time or space that reduces the empathy that a person may have for the suffering of others, i.e., that increases moral distance. In particular, **distanciation** is the tendency to distance oneself (physically or socially, by segregation or congregation) those that one does not value. Cf. **distanciation**.

On the other hand, the term *good distancing* (Sartre, 1943, and Ricoeur, 1995) means the process of deciding how long a given ethical link should be.

- **Emotional distance**

The **emotional distance** (or *psychic distance*) is the degree of emotional detachment (toward a person, group of people or events), aloofness, indifference by personal withdrawal, reserve.

The Bogardus Social Distance Scale (cf. **social distance**) measures, in fact, not social but this emotional distance; it offers following eight response items: would marry, would have as a guest in my household, would have as next door neighbor, would have in neighborhood, would keep in the same town, would keep out of my town, would exile, would kill. Dodd and Nehnevasja attached, in 1954, increasing distances of  $10^t$  meters,  $0 \leq t \leq 7$ , to these 8 levels of the Bogardus scale.

The **propinquity effect** is the tendency for people to get emotionally involved, as to form friendships or romantic relationships, with those who have higher *propinquity* (physical/psychological proximity) with them, i.e., whom they encounter often. Walmsley, 1978, proposed that emotional involvement decreases as  $d^{-\frac{1}{2}}$  with increasing **subjective distance**  $d$ .

- **Social distance**

In Sociology, the **social distance** is the extent to which individuals or groups are removed or excluded from participating in one another's lives; a degree of understanding and intimacy which characterize personal and social relations generally. This notion was originated by Simmel in 1903; in his view, the social forms are the stable outcomes of distances interposed between subject and object. For example (Mulgan, 1991), the centers of global cities are socially closer to each other than to their own peripheries.

The Bogardus Social Distance Scale (cf. **emotional distance**) is scored so that the responses for each ethnic/racial group are averaged across all respondents which yields a RDQ (racial distance quotient) ranging from 1.00 to 8.00.

An example of relevant models: Akerlof ([Aker97]) defines an *agent*  $x$  as a pair  $(x_1, x_2)$  of numbers, where  $x_1$  represents the initial, i.e., inherited, social position, and the position expected to be acquired,  $x_2$ . The agent  $x$  chooses the value  $x_2$  so

as to maximize

$$f(x_1) + \sum_{y \neq x} \frac{e}{(h + |x_1 - y_1|)(g + |x_2 - y_1|)},$$

where  $e$ ,  $h$ ,  $g$  are parameters,  $f(x_1)$  represents the intrinsic value of  $x$ , and  $|x_1 - y_1|$ ,  $|x_2 - y_1|$  are the inherited and acquired *social distances* of  $x$  from any agent  $y$  (with the social position  $y_1$ ) of the given society.

- **Rummel sociocultural distances**

Rummel defined ([Rumm76]) the main sociocultural distances between two persons as follows.

1. **Personal distance**: one at which people begin to encroach on each other's territory of personal space.
2. **Psychological distance**: perceived difference in motivation, temperaments, abilities, moods, and states (subsuming *intellectual distance*).
3. **Interests-distance**: perceived difference in wants, means, and goals (including **ideological distance** on socio-political programs).
4. **Affine distance**: degree of sympathy, liking or affection between the two.
5. **Social attributes distance**: differences in income, education, race, sex, occupation, etc.
6. **Status-distance**: differences in wealth, power, and prestige (including **power distance**).
7. **Class-distance**: degree to which one person is in general authoritatively superordinate to the other.
8. **Cultural distance**: differences in meanings, values and norms reflected in differences in philosophy-religion, science, ethics-law, language, and fine arts.

- **Cultural distance**

The **cultural distance between countries**  $x = (x_1, \dots, x_5)$  and  $y = (y_1, \dots, y_5)$  (usually, US) is derived (in [KoSi88]) as the following composite index

$$\sum_{i=1}^5 \frac{(x_i - y_i)^2}{5V_i},$$

where  $V_i$  is the variance of the index  $i$ , and the five indices represent ([Hofs80]):

1. Power distance (preferences for equality);
2. Uncertainty avoidance (risk aversion);
3. Individualism versus collectivism;
4. Masculinity versus femininity (gender specialization);
5. Confucian dynamism (long-term versus short-term orientation).



The above **power distance** measures the extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally, i.e., how much a culture has respect for authority. For example, Latin Europe and Japan fall in the middle range.

But Shenkar, Luo and Yeheskel, 2008, claim that above cultural distance is merely a measure how much a country strayed from the core culture of the multinational enterprise. They propose instead (especially, as a regional construct) the *cultural friction* linking goal incongruity and the nature of cultural interaction.

Wirsing, 1973, defined *social distance* as a “symbolic gap” between rulers and ruled designed to set apart the political elite from the public. It consists of reinforced and validated ideologies (a formal constitution, a historical myth, etc.).

Davis, 1999, theorized social movements (in Latin America) in terms of their shared distance from the state: geographically, institutionally, socially (class position and its economic counterpart, income level) and culturally. For example, the groups distanced from the state on all four dimensions are more likely to engage in revolutionary action.

Henrikson, 2002, identified the following Political Geography distances between countries: *attributional distance* (according to cultural characteristics, say, democracy or not), *gravitational distance* (according to which political and other powers “decay”) and *topological distance* (remoteness of countries increases when others are located in between them).

## 28.2 Distances in Economics and Human Geography

- **Effective trade distance**

The **effective trade distance** between countries  $x$  and  $y$  with populations  $x_1, \dots, x_m$  and  $y_1, \dots, y_n$  of their main agglomerations is defined in [HeMa02] as

$$\left( \sum_{1 \leq i \leq m} \frac{x_i}{\sum_{1 \leq t \leq m} x_t} \sum_{1 \leq j \leq n} \frac{y_j}{\sum_{1 \leq t \leq n} y_t} d_{ij}^r \right)^{\frac{1}{r}},$$

where  $d_{ij}$  is the bilateral distance (in kilometers) of corresponding agglomerations  $x_i, y_j$ , and  $r$  measures the sensitivity of trade flows to  $d_{ij}$ .

As an **internal distance of a country**, measuring the average distance between producers and consumers, Head and Mayer ([HeMa02]) proposed  $0.67 \sqrt{\frac{\text{area}}{\pi}}$ .

- **Technology distances**

The **technological distance** between two firms is a distance (usually,  $\chi^2$ - or **cosine distance**) between their *patent portfolios*, i.e., vectors of the number of patents granted in (usually, 36) technological sub-categories. Other measures are based on the number of patent citations, co-authorship networks, etc.

Granstrand’s **cognitive distance** between two firms is the **Steinhaus distance**  $\frac{\mu(A \Delta B)}{\mu(A \cup B)} = 1 - \frac{\mu(A \cap B)}{\mu(A \cup B)}$  between their technological profiles (sets of ideas)  $A$  and  $B$  seen as subsets of a *measure space*  $(\Omega, \mathcal{A}, \mu)$ .

The economic model of Olsson, 2000, defines the metric space  $(I, d)$  of all ideas (as in human thinking),  $I \subset \mathbb{R}_+^n$ , with some *intellectual distance*  $d$ . The closed, bounded and connected *knowledge set*  $A_t \subset I$  extends with time  $t$ . New elements are, normally, convex combinations of previous ones: *innovations* within gradual technological progress. Exceptionally, breakthroughs (Kuhn's paradigm shifts) occur. The similar notion of *thought space* (an externalized mental space of ideas/knowledge and relationships among them in thinking) was used in Sumi-Hori-Ohsuga, 1997, for computer-aided thinking with text; they proposed a system of mapping text-objects into metric spaces.

Introduced in Patel, 1965, the **economic distance** between two countries is the time (in years) for a lagging country to catch up to the same per capita income level as the present one of an advanced country. Introduced in Fukuchi-Satoh, 1999, the **technology distance** between countries is the time (in years) when a lagging country realizes a similar technological structure as the advanced one has now. The basic assumption of the *Convergence Hypothesis* is that the technology distance between two countries is smaller than the economic one.

- **Production Economics distances**

In quantitative Economics, a *technology* is modeled as a set of pairs  $(x, y)$ , where  $x \in \mathbb{R}_+^m$  is an *input* vector,  $y \in \mathbb{R}_+^m$  is an *output* vector, and  $x$  can produce  $y$ . Such set  $T$  should satisfy standard economical regularity conditions.

The **technology directional distance function** of input/output  $x, y$  toward (projected and evaluated) a direction  $(-d_x, d_y) \in \mathbb{R}_-^m \times \mathbb{R}_+^m$  is

$$\sup\{k \geq 0 : ((x - kd_x), (y + kd_y)) \in T\}.$$

The **Shephard output distance function** is  $\sup\{k \geq 0 : (x, \frac{y}{k}) \in T\}$ .

The *frontier*  $f_s(x)$  is the maximum feasible output of a given input  $x$  in a given system (or year)  $s$ . The **distance to frontier** (Färe-Crosskopf-Lovell, 1994) of a production point  $(x, y)$ , where  $y = g_s(x)$ , is  $\frac{g_s(x)}{f_s(x)}$ .

The *Malmquist index* measuring the change in TFP (total factor productivity) between periods  $s, s'$  (or comparing to another unit in the same period) is  $\frac{g_{s'}(x)}{f_s(x)}$ . The term *distance to frontier* is also used for the inverse of TFP in a given industry (or of GDP per worker in a given country) relative to the existing maximum (the frontier, usually, US).

Consider a *production set*  $T \subset \mathbb{R}^{n_1} \times \mathbb{R}^{n_2}$  (input, output). The measure of the technical efficiency, given in Briec-Lemaire, 1999, is the point-set distance  $\inf_{y \in we(T)} \|x - y\|$  (in a given norm  $\|\cdot\|$  on  $\mathbb{R}^{n_1+n_2}$ ) from  $x \in T$  to the *weakly efficient set*  $we(T)$ . It is the set of minimal elements of the poset  $(T, \preceq)$  where the *partial order*  $\preceq$  ( $t_1 \preceq t_2$  if and only if  $t_2 - t_1 \in K$ ) is induced by the cone  $K = \text{int}(\mathbb{R}_{>0}^{n_1} \times \mathbb{R}_{>0}^{n_2}) + \{0\}$ .

- **Action distance**

The **action distance** is the distance between the set of information generated by the Active Business Intelligence system and the set of actions appropriate to a specific business situation. Action distance is the measure of the effort required to understand information and to effect action based on that information. It could be the physical distance between information displayed and action controlled.

- **Death of Distance**

**Death of Distance** is the title of the influential book [Cair01] arguing that the telecommunication revolution (the Internet, mobile telephones, digital television, etc.) initiated the “death of distance” implying fundamental changes: three-shift work, lower taxes, prominence of English, outsourcing, new ways of government control and citizens communication, etc. Physical distance (and so, Economic Geography) do not matter, we all live in a “global village”. Thomas Friedman, 2005, announced: “The World is flat”. Bill Gates claimed (Financial Times, 2006): “With the Internet having connected the world together, someone’s opportunity is not determined by geography”. The proportion of long-distance relationships in foreign relations increased.

Also the “death of distance” allows also both management-at-a-distance and concentration of elites within the “latte belt”.

Similarly (see [Ferg03]), steam-powered ships and the telegraph (as railroads previously and cars later) led, via falling transportation costs, to the “annihilation of distance” in the 19-th and 20-th centuries. Further in the past, archaeological evidence points out the appearance of systematic long-distance trade ( $\approx 140,000$  years ago), and the innovation of projectile weapons (40,000 years ago) which allowed humans to kill large game (and other humans) from a safe distance. Going deeper in the past, Parker, 2003, proposed that the sudden diversification in animal fossil forms at the start of the Cambrian Era, was due to the development of the vision faculty and the consequent intensification of predation.

But modern technology eclipsed distance only in that the time to reach a destination has shrunk (except where places previously well connected, say, by railroads have fallen off the beaten track). In fact, the distance (cultural, political, geographic, and economic) “still matters” for, say, a company’s strategy on the emerging markets, for political legitimacy, etc. Bilateral trade decreases with distance; Disdier-Head, 2004, report a slight increase, over the last century, of this negative impact of distance. Webb, 2007, claims that an average distance of trade in 1962 of 4,790 km changed only to 4,938 km in 2000. Partridge-Rickman-Ali-Olfert, 2007, report that proximity to higher-tiered urban centers (with their higher-order services, urban amenities, higher-paying jobs, lower-cost products) is an increasingly important positive determinant of local job growth.

Moreover, increased access to services and knowledge exchange requires more face-to-face interaction and so, an increase in the role of distance. Despite globalization, new communication technologies and the dematerialization of economy, economic and innovation activity are highly localized spatially and tend to agglomerate more. Also, the social influence of individuals, measured by the frequency of memorable interactions, is heavily determined by distance. Goldenberg-Levy, 2009, show that IT (Information Technology) revolution which occurred in the 1990s, actually increased effect of distance on the volume of such social interactions as email, Facebook communications and baby names diffusion. They argue that IT increased local communications to a greater degree than long-distance ones.

In military affairs, Boulding, 1965, and Bandow, 2004, argued that 20-th century technology reduced the value of proximity for the projection of military power because of “a very substantial diminution in the cost of transportation of armed forces”

and “an enormous increase in the range of the deadly projectile” (say, strategic bombardment). It was used as partial justification for the withdrawal of US forces from overseas bases in 2004. But Webb, 2007, counterargues that distance retains its importance: for example, any easing of transport is countered by increased strain put upon transport modes since both sides will take advantage of the falling costs to send more supplies. Also, by far the greatest movement of logistics continues to be conducted by sea, with little improvement in speed since 1900.

- **Technology-related distancing**

The *Moral Distancing Hypothesis* postulates that technology increases the propensity for unethical conduct by creating a **moral distance** between an act and the moral responsibility for it.

Print technologies divided people into separate communication systems and distanced them from face-to-face response, sound and touch. Television involved audile-tactile senses and made distance less inhibiting, but it exacerbated *cognitive distancing*: story and image are biased against space/place and time/memory. This distancing has not diminished with computers; interactivity has however increased. In terms of Hunter: technology only re-articulates *communication distance*, because it also must be regarded as the space between understanding and not. The collapsing of spatial barriers diminishes economic but not social and cognitive distance.

On the other hand, the *Psychological Distancing Model* in [Well86] relates the immediacy of communication to the number of information channels: sensory modalities decrease progressively as one moves from face-to-face to telephone, videophone, and e-mail. On-line settings tend to filter out social and relational cues. Also, the lack of instant feedback, because of e-mail communication, is asynchronous and can be isolating: it and low bandwidth limit visual and aural cues. For example, moral and cognitive effects of distancing in on-line education are not known at present.

**Virtual distance** is the perceived distance between individuals when their primary way of communication is not face-to-face. The main markers of virtual distance are physical, operational and affinity distances.

- **Relational proximity**

Economic Geography considers, as opposed to geographical proximity, different types of proximity (organizational, institutional, cognitive, etc.). In particular, **relational proximity** (or trust-based interaction between actors) is an inclusive concept of the benefits derived from spatially localized sets of economic activities. In particular, it generates relational capital through the dynamic exchange of locally produced knowledge.

The five dimensions of relational proximity are proximity: of contact (directness), through time (continuity, stability), in diversity (multiplicity, scope), in mutual respect and involvement (parity), of purpose (commonality).

Individuals are close to each other in a relational sense when they share the same interaction structure, make transactions or realize exchanges. They are *cognitively close* if they share the same conventions and have common values and representations (including knowledge and technological capabilities).

Bouba-Olga and Grossetti, 2007, divide also socio-economic proximity into relational proximity (role of social networks) and *mediation proximity* (role of resources such as newspapers, directories, Internet, agencies, etc.)

- **Commuting distance**

The **commuting distance** is the distance (or travel time) separating work and residence when they are located in separated places (say, municipalities).

- **Migration distance (in Economics)**

The **migration distance**, in Economic Geography, is the distance between the geographical centers of the municipalities of origin and destination.

- **Gravity models**

The general **gravity model** for social interaction is given by the *gravity equation*

$$F_{ij} = a \frac{M_i M_j}{D_{ij}^b},$$

where  $F_{ij}$  is the “flow” (or “gravitational attraction”, *interaction*, *mass-distance function*) from location  $i$  to location  $j$  (alternatively, between those locations),  $D_{ij}$  is the “distance” between  $i$  and  $j$ ,  $M_i$  and  $M_j$  are relevant economic “masses” of  $i$  and  $j$ , and  $a, b$  are parameters. Cf. Newton’s **law of universal gravitation** in Chapter 24, where  $b = 2$ . The first instances were formulated by Reilly (1929), Stewart (1948), Isard (1956) and Tinbergen (1962).

If  $F_{ij}$  is a monetary flow (say, export values), then  $M$  is GDP (gross domestic product), and  $D_{ij}$  is the distance (usually the **great circle distance** between the centers of countries  $i$  and  $j$ ). For trade, the true distances are different and selected by economic considerations. But the distance is a proxy for transportation cost, the time elapsed during shipment, cultural distance, and the costs of synchronization, communication, transaction. The **distance effect on trade** is measured by the parameter  $b$ ; it is 0.94 in Head, 2003, and 0.6 in Leamer-Levinsohn, 1994.

If  $F_{ij}$  is a people (travel or migration) or message flow, then  $M$  is the population size, and  $D_{ij}$  is the travel or communication cost (distance, time, money).

If  $F_{ij}$  is the force of attraction from location  $i$  to location  $j$  (say, for a consumer, or for a criminal), then, usually  $b = 2$ . Reilly’s *law of retail gravitation* is that, given a choice between two cities of sizes  $M_i, M_j$  and at distances  $D_i, D_j$ , a consumer tends to travel further to reach the larger city with the equilibrium point defined by

$$\frac{M_i}{D_i^2} = \frac{M_j}{D_j^2}.$$

- **Distance decay (in Spatial Interaction)**

In general, **distance decay** or **distance effect** (cf. Chapter 29) is the attenuation of a pattern or process with distance.

In Spatial Interaction, **distance decay** is the mathematical representation of the inverse ratio between the quantity of obtained substance and the distance from its source.

This decay measures the effect of distance on accessibility and number of interactions between locations. For example, it can reflect a reduction in demand due to the increasing travel cost. A more abstract example is provided by *bid-rent distance decay*: the cost of overcoming distance has a consequence in a class-based spatial arrangement around a city. In fact, with increasing distance (and so decreasing rent) commercial, industrial, residential and agricultural areas follow.

In location planning for a service facility (fire station, retail store, transportation terminal, etc.), the main concerns are *coverage standard* (the maximum distance, or travel time, a user is willing to overcome to utilize it) and distance decay (demand for service decays with distance).

Distance decay is related to **gravity models** and another “social physics” notion, **friction of distance**, which posits that distance usually requires some amount of effort, money, and/or energy to overcome.

- **Nearness principle**

The **nearness principle** (or Zipf’s *least effort principle*, in Psychology) is the following basic geographical heuristic: given a choice, a person will select the route requiring the least expenditure of effort. Similarly, an information-seeking person will tend to use the most convenient search method, in the least exacting mode available (path of least resistance).

The geographical nearness principle is used in transportation planning and (Rossmo, 2000) locating of serial criminals: they tend to commit their crimes fairly close to where they live.

The *first law of geography* (Tobler, 1970) is: “Everything is related to everything else, but near things are more related than distant things”.

- **Consumer access distance**

**Consumer access distance** is a distance measure between the consumer’s residence and the nearest provider where he can get specific goods or services (say, a store, market or a health service).

Measures of geographic access and spatial behavior include distance measures (**map’s distance**, **road travel distance**, perceived travel time, etc.), **distance decay** (decreased access with increasing distance) effects, transportation availability and *activity space* (the area in km<sup>2</sup> of  $\approx \frac{2}{3}$  of the consumer’s routine activities).

For example, US consumers had access in 2007, within driving distance of their current pharmacy, to 30, 7 and 14 competing pharmacies in urban, suburban and rural areas, respectively. (By Medicare standards, this distance, corresponding to the residence of the vast majority of beneficiaries, is 2, 5 and 15 miles in urban, suburban and rural areas.) Also,  $\approx 81\%$  of the population of Texas is within 25 miles of a medical oncologist and radiation therapy facility.

Similar studies for retailers revealed that the negative effect of distance on store choice behavior was (for all categories of retailers) much larger when this behavior was measured as “frequency” than when it was measured as “budget share”.

- **Distance selling**

**Distance selling**, as opposed to face-to-face selling in shops, covers goods or services sold without face-to-face contact between supplier and consumer but through *distance communication means*: press adverts with order forms, catalog sales, telephone, tele-shopping, e-commerce (via Internet), m-commerce (via mobile phone). Examples of the relevant legislation are Consumer Protection (Distance Selling) Directive 97/7/EC and Regulations 2000 in EU.

The main provisions are: clear prior information before the purchase, its confirmation in a durable medium, delivery within 30 days, “cooling-off” period of 7 working days during which the consumer can cancel contract without any reason and penalty. Exemptions are: *Distance Marketing* (financial services sold at distance), business-to-business contracts and some purchases (of land, at an auction, from vending machines).

- **Surname distance model**

A **surname distance model** was used in [COR05] in order to estimate the preference transmission from parents to children by comparing, for 47 provinces of mainland Spain, the  $47 \times 47$  distance matrices for **surname distance** with those of **consumption distance** and **cultural distance**. The distances were  $l_1$ -distances  $\sum_i |x_i - y_i|$  between the frequency vectors  $(x_i)$ ,  $(y_i)$  of provinces  $x$ ,  $y$ , where  $z_i$  is, for the province  $z$ , either the frequency of the  $i$ -th surname (**surname distance**), or the budget share of the  $i$ -th product (**consumption distance**), or the population rate for the  $i$ -th cultural issue, say, rate of weddings, newspaper readership, etc. (**cultural distance**), respectively.

Other (matrices of) distances considered there are:

- *geographical distance* (in kilometers, between the capitals of two provinces);
- *income distance*  $|m(x) - m(y)|$ , where  $m(z)$  is mean income in the province  $z$ ;
- *climatic distance*  $\sum_{1 \leq i \leq 12} |x_i - y_i|$ , where  $z_i$  is the average temperature in the province  $z$  during the  $i$ -th month;
- *migration distance*  $\sum_{1 \leq i \leq 47} |x_i - y_i|$ , where  $z_i$  is the percentage of people (living in the province  $z$ ) born in the province  $i$ .

Strong *vertical preference transmission*, i.e., correlation between surname and consumption distances, was detected only for food items.

- **Distances in Criminology**

The **geographic profiling** (or *geoforensic analysis*) aims to identify the spatial behavior (target selection and, especially, likely *point of origin*, i.e., the residence or workplace) of a serial criminal offender as it relates to the spatial distribution of linked crime sites.

The **offender’s buffer zone** (or *coal-sack effect*) is an area surrounding the *offender’s heaven* (point of origin) from which little or no criminal activity will be observed; usually, such a zone occurs for premeditated personal offenses. The primary streets and network arterials that lead into the buffer zone tend to intersect near the estimated offender’s heaven. An 1 km buffer zone was found for UK serial

rapists. Most personal offenses occur within about 2 km from the offender's heaven, while property thefts occur further away.

Given  $n$  crime sites  $(x_i, y_i)$ ,  $1 \leq i \leq n$  (where  $x_i$  and  $y_i$  are the latitude and longitude of  $i$ -th site), the *Newton-Swoope Model* predicts the offender's heaven to be within the circle around the point  $(\frac{\sum_i x_i}{n}, \frac{\sum_i y_i}{n})$  with the search radius being

$$\sqrt{\frac{\max |x_{i_1} - x_{i_2}| \cdot \max |y_{i_1} - y_{i_2}|}{\pi(n-1)^2}},$$

where the maxima are over  $(i_1, i_2)$ ,  $1 \leq i_1 < i_2 \leq n$ . The *Ganter-Gregory Circle Model* predicts the offender's heaven to be within a circle around the first offense crime site with diameter the maximum distance between crime sites.

The *centrographic models* estimate the offender's haven as a *center*, i.e., a point from which a given function of travel distances to all crime sites is minimized; the distances are the Euclidean distance, the Manhattan distance, the **wheel distance** (i.e., the actual travel path), perceived travel time, etc. Many of these models are the reverse of Location Theory models aiming to maximize the placement of distribution facilities in order to minimize travel costs. These models (*Voronoi polygons*, etc.) are based on the **nearness principle** (*least effort principle*).

The **journey-to-crime decay function** is a graphical **distance curve** used to represent how the number of offenses committed by an offender decreases as the distance from his/her residence increases. Such functions are variations of the center of gravity functions; cf. **gravity models**.

For detection of criminal, terrorist and other hidden networks, there are also used many data-mining techniques which extract latent associations (distances and **near-metrics** between people) from proximity graphs of their co-occurrence in relevant documents, events etc.

- **Drop distance**

In judicial hanging, the **drop distance** is the distance the executed is allowed to fall. In order to reduce the prisoner's physical suffering (to about a third of a second), this distance is pre-determined, depending on his/her weight, by special *drop tables*. For example, (US state) Delaware protocol prescribes, in pounds/feet, about 252, 183 and 152 cm for at most 55, 77 and at least 100 kg.

In Biosystems Engineering, a ventilation jet *drop distance* is defined as the horizontal distance from an air inlet to the point where the jet reaches the occupational zone. In Aviation, an airlift *drop distance* (or *drop height*) is the vertical distance between the aircraft and the drop zone over which the airdrop is executed.

In Ballistics (cf. **ballistics distances** in Chapter 24), *drop distance* is the height the bullet loses between the moment it leaves the rifle and the moment it reaches the target.

## 28.3 Distances in Perception, Cognition and Language

- Oliva et al. perception distance



Let  $\{s_1, \dots, s_n\}$  be the set of stimuli, and let  $q_{ij}$  be the conditional probability that a subject will perceive a stimulus  $s_j$ , when the stimulus  $s_i$  was shown; so,  $q_{ij} \geq 0$ , and  $\sum_{j=1}^n q_{ij} = 1$ . Let  $q_i$  be the probability of presenting the stimulus  $s_i$ .

The **Oliva et al. perception distance** ([OSLM04]) between stimuli  $s_i$  and  $s_j$  is defined by

$$\frac{1}{q_i + q_j} \sum_{k=1}^n \left| \frac{q_{ik}}{q_i} - \frac{q_{jk}}{q_j} \right|.$$

- **Visual space**

**Visual space** refers to a stable perception (internal representation) of the environment provided by vision, while **haptic space** (or *tactile space*) and **auditory space** refer to such representation provided by the senses of pressure perception and audition. The geometry of these spaces and the eventual mappings between them are unknown. The main observed kinds of distortion of vision and haptic spaces versus physical space follow; the first 3 were observed for auditory space also.

1. *Horopter lines*: perceived frontparallel (to the observer) lines are physically parallel only at a certain distance depending on subject and task.
2. *Parallel-alleys*: perceived parallel (to the medial plane of the observer) lines are, actually, some hyperbolic curves.
3. *Distance-alleys*: lines with corresponding points perceived as equidistant, are, actually, some hyperbolic curves. Usually, the parallel-alleys are lying within the distance-alleys and, for visual space, their difference is small at distances larger than 1.5 m.
4. *Oblique effects*: performance of certain tasks is worse when the orientation of stimuli is oblique rather than horizontal or vertical.
5. *Equidistant circles*: the **egocentric distance** is direction-dependent; the points perceived as equidistant from the subject lie on egg-like curves instead of circles.

The above effects and **size-distance phenomena** should be incorporated in a good model of visual space. In a visual space the distance  $d$  and direction are defined from self as the origin (the **egocentric distance**). There is evidence that visual space is almost affine and, if it admits a metric  $d$ , then  $d$  is a **projective metric**, i.e.,  $d(x, y) + d(y, z) = d(x, z)$  for any 3 perceptually collinear points  $x, y, z$ . The main proposals for visual space are to see it as a Riemannian space of constant negative curvature (cf. **Riemannian color space** in Chapter 21), a general Riemannian/Finsler space, or an affinely connected (so not metric, in general) space ([CKK03]).

An *affine connection* is a linear map sending two vector fields into a third one. The expansion of perceived depth on near distances and its contraction at far distances indicate that the mapping between visual and physical space is not affine.

Amedi et al. (2002) observed convergence of visual and tactile shape processing in the human lateral occipital complex. The *vOICE technology* (OIC for "Oh I see!") explores cross-modal binding for inducing visual sensations through sound (mental imagery and artificial synesthesia).

- **Size-distance phenomena**

Examples of **size-distance phenomena** of visual perception follow.

**Emmert's size-distance law** states that a retinal image is proportional in perceived size (apparent height) to the perceived distance of the surface it is projected upon. This law is based on the fact that the perceived size of an object doubles every time its perceived distance from the observer is cut in half and vice versa. Emmert's law accounts for *constancy scaling*, i.e., the fact that the size of an object is perceived to remain constant despite changes in the retinal image (as objects become more distant they begin, because of visual perspective, to appear smaller). The **size-distance invariance hypothesis** posits that the ratio of perceived size and perceived distance is the tangent of the physical visual angle. In particular, objects which appear closer should also appear smaller.

But with the *moon illusion* it comes to a **size-distance paradox**. The Moon (and, similarly, the Sun) illusion is that, despite constancy of its visual angle (roughly, 0.52 degree), the moon at the horizon may appear to be about twice the diameter of the zenith moon. This illusion is still not understood completely; it is supposed to be cognitive: the size of the zenith moon is underestimated since it is perceived as approaching. The most common optical illusions distort size or length; for example, the Mueller-Lyer, Sander, and Ponzo illusions.

The **size-distance centration** is the overestimation of the size of objects located near the focus of attention and underestimation of it at the periphery.

- **Probability-distance hypothesis**

In Psychophysics, the **probability-distance hypothesis** is a hypothesis that the probability with which one stimulus is discriminated from another is a (continuously increasing) function of some subjective quasi-metric between these stimuli (see [Dzha01]). Under this hypothesis, such a subjective metric is a **Finsler metric** if and only if it coincides in the small with the **intrinsic metric** (i.e., the infimum of the lengths of all paths connecting two stimuli).

- **Distance ceptor**

A **distance ceptor** is a nerve mechanism of one of the organs of special sense whereby the subject is brought into relation with his distant environment.

- **Egocentric distance**

In Psychophysiology, the **egocentric distance** is the perceived absolute distance from the self (observer or listener) to an object or a stimulus (such as a sound source); cf. **subjective distance**. Usually, the visual egocentric distance underestimates the actual physical distance to far objects, and overestimates it for near objects. Such distortion is direction-dependent: it decreases in a lateral direction.

In Visual Perception, the *action space* of a subject is 1 – 30 m; the smaller and larger spaces are called the *personal space* and *vista space*, respectively.

The **exocentric distance** is the perceived relative distance between objects.

- **Indirect measures of egocentric distance**

In order to avoid biases of direct, by a verbal report, measuring of perceived egocentric distance  $D'$ , two following **indirect measures**, using relation between  $D'$  and some other percept, are known.

The **size-distance invariance hypothesis** (Gilinsky, 1951) claims, in general, that  $C \frac{D'}{S'} = \frac{D}{S}$  holds, where  $S'$  is perceived size of visual stimulus,  $C$  is an observer constant, and  $S, D$  are physical size and distance. A simplified formula is  $\frac{D'}{S'} = (\tan \frac{\alpha}{2})^{-1}$ , where  $\alpha$  is the angular size of stimulus.

If an observer's head translates smoothly through a distance  $K$  as the observer views a stationary target point at pivot distance  $D_p$ , then the point will appear to move smoothly through a displacement  $W'$  when it is perceived to be at a distance  $D'$ . The **apparent distance/pivot distance hypothesis** (Gogel, 1982) claims that  $\frac{D'}{D_p} + \frac{W'}{K} = 1$  holds.

- **Distance cues**

The **distance cues** are cues used to estimate the **egocentric distance**.

For a listener at a fixed location, the main auditory distance cues include: *intensity* (in open space it decreases by 5 dB for each doubling of the distance; cf. far field **acoustic distance** in Chapter 21), *direct-to-reverberant energy ratio* (in the presence of sound reflecting surfaces), *spectrum*, and *binaural differences*.

For an observer, the main visual distance cues include:

- *relative size, relative brightness, light and shade*;
- *height in the visual field* (in the case of flat surfaces lying below the level of the eye, the more distant parts appear higher);
- *interposition* (when one object partially occludes another from view);
- *binocular disparities, convergence* (depending on the angle of the optical axes of the eyes), *accommodation* (the state of focus of the eyes);
- *aerial perspective* (distant objects become bluer and paler), *distance hazing* (distant objects become decreased in contrast, more fuzzy);
- *motion perspective* (stationary objects appear to a moving observer to glide past).

Examples of the techniques which use the above distance cues to create an optical illusion for the viewer, are:

- *distance fog*: a 3D computer graphics technique so that objects further from the camera are progressively more blurred (obscured by haze). It is used, for example, to disguise too short the **draw distance**, i.e., the maximal distance in a 3D scene that is still drawn by the rendering engine;
- *forced perspective*: a film-making technique to make objects appear either far away, or nearer depending on their positions relative to the camera and to each other.

- **Subjective distance**

The **subjective distance** (or *cognitive distance*) is a mental representation of actual distance molded by an individual's social, cultural and general life experiences; cf. **egocentric distance**. Cognitive distance errors occur either because information about two points is not coded/stored in the same branch of memory, or because of errors in retrieval of this information. For example, the length of a route with many turns and landmarks is usually overestimated. In general, the filled or divided space (distance or area) appears greater than the empty or undivided one.

Human mental maps, used to find out distance and direction, rely mainly, instead of geometric realities, on real landscape understanding, via webs of landmarks. Ellard, 2009, suggests that this loss of natural navigation skills, coupled with unique ability to imagine themselves in another location, may have given modern humans the freedom to create a reality of their own.

- **Geographic distance biases**

Sources of distance knowledge are either symbolic (maps, road signs, verbal directions) or directly perceived ones during locomotion: environmental features (visually-perceived turns, landmarks, intersections, etc.), travel time, and travel effort.

They relate mainly to the perception and cognition of the **environmental distances**, i.e., those that cannot be perceived in entirety from a single point of view but still can be apprehended through direct travel experience.

Examples of **geographic distance biases** (subjective distance judgments, location estimates) are:

- observers are quicker to respond to locations preceded by locations that were either close in distance or were in the same region;
- distances are overestimated when they are near to a reference point; for example, intercity distances from coastal cities are exaggerated;
- subjective distances are often asymmetrical as the perspective varies with the reference object: a small village is considered to be close to a big city while the big city is likely to be seen as far away from it;
- traveled routes segmented by features are subjectively longer than unsegmented routes; moreover, longer segments are relatively underestimated;
- increasing the number of pathway features encountered and recalled by subjects leads to increased distance estimates;
- structural features (such as turns and opaque barriers) breaking a pathway into separate vistas strongly increase subjective distance (suggesting that distance knowledge may result from a process of summing vista distances) (turns are often memorized as straight lines or right angles);
- *Chicago-Rome illusion*: belief that some European cities are located far to the south of their actual location; in fact, Chicago and Rome are at the same latitude ( $42^\circ$ ), as are Philadelphia and Madrid ( $40^\circ$ ), etc.;
- *Miami-Lima illusion*: belief that cities on the east coast of US are located to the east of cities on the west coast of South America; in fact, Miami is  $3^\circ$  west of Lima.

Possible sources of such illusions could be perceptually based mental representations that have been distorted through normalization and/or conceptual non-spatial plausible-reasoning.

Thorndyke and Hayes-Roth, 1982, compared distance judgements of people with navigation- and map-derived spatial knowledge. The subjects were asked route and Euclidean distances between the centers of rooms on the 1st floor of a Rand Corporation building. Navigation-derived route distance estimates were more accurate than Euclidean judgements, and this difference diminished with increased exploration. The reverse was true for map subjects, and no improvement was observed in the map learning. Turner and Turner, 1997, made similar experiment in the plane virtual building. Exploration-derived Euclidean judgements were good but route distances were much underestimated; repeated exposure not helped. Authors suggest that exploration of virtual environments is similar to navigation in real world but with restricted field of view, as in tunnels, caves or wearing a helmet, watching TV.

Krishna, Zhou and Zhang, 2008, compared spatial judgements of *self-focused* (say, “Western”) and *relationship-focused* (say, “Eastern”) people. The former ones were more likely to misjudge distance when multiple features should be considered; they were more likely to pay attention to only focal aspects of stimuli and ignore the context and background information.

- **Spatial cognition**

**Spatial cognition** concerns the knowledge about spatial properties of objects and events: location, size, distance, direction, separation/connection, shape, pattern, and movement. For instance, it consider navigation (locomotion and wayfinding) and orientation during it: recognition of landmarks and *path integration* (an internal measuring/computing process of integrating information about movement). Spatial cognition addresses also our (spatial) understanding of the World Wide Web and computer-simulated virtual reality.

Men surpass women on test of spatial relations and mental rotation, while women have better memory for objects and their location. Such selection should come from a division of labor in Pleistocene groups: hunting of mobile prey for men and gathering of immobile plant foods for women. One of *cultural universals* (traits common to all human cultures) is that men on average travel greater distances over lifetime.

**Spatialization** (Lefebvre, 1991) refer to the spatial forms that social activities and material things, phenomena or processes take on. It include cognitive maps, cartography, everyday practice and imagination of possible spatial worlds.

- **Psychgeography**

**Psychogeography** (Debord, 1955) is the study of the precise laws and specific effects of the geographical environment, consciously organized or not, on the emotions and behavior of individuals. Example of related notions is a *desire path* (or *social trail*), i.e., a path developed by erosion caused by animal or human footfall, usually the shortest or easiest route between an origin and destination.

Also, the term **psychogeography** is used for the psychoanalytic study of spatial representation within unconscious construction of the social and physical world.

- **Spatial reasoning**

**Spatial reasoning** is the domain of spatial knowledge representation: spatial relations between spatial entities and reasoning based on these entities and relations.

As a modality of human thought, spatial reasoning is a process of forming ideas through the spatial relationships between objects (as in Geometry), while verbal reasoning is the process of forming ideas by assembling symbols into meaningful sequences (as in Language, Algebra, Programming). *Spatial intelligence* is the ability to comprehend 2- and 3-dimensional images and shapes.

**Spatial-temporal reasoning** (or *spatial ability*) is the capacity to visualize spatial patterns, to manipulate mentally them over a time-ordered sequence of spatial transformations and to draw conclusions about them from limited information.

More specifically, *spatial visualization ability* is the ability to manipulate mentally 2- and 3-dimensional figures. *Spatial skills* is the ability to locate objects in a 3D-world using sight or touch. *Spatial acuity* is the ability to discriminate two closely-separated points or shapes (say, two polygons of the same size but with different numbers of sides).

*Visual thinking* (or *visual/spatial learning*, *picture thinking*) is the common (about 60% of the general population) phenomenon of thinking through visual processing. Spatial-temporal reasoning is prominent among visual thinkers, as well as among *kinesthetic learners* (who learn through body mapping and physical patterning) and *logical thinkers* (mathematical/systems thinking) who think in patterns and relationships and may work diagrammatically without this necessary being pictorially.

In Computer Science, spatial-temporal reasoning aims at describing, using abstract relation algebras, the common-sense background knowledge on which human perspective of physical reality is based. It provides rather inexpensive reasoning about entities located in space and time.

Fleet, Hallet and Jepson, 1985, found spatio-temporal inseparability in early visual processing by retinal cells. Maruya and Sato, 2002, reported new illusion (time difference of two motion stimuli is converted in the illusory spatial offset) indicating interchangeability of space and time in early visual processing. The differences appear at the level of higher processing because of different representations: space is represented in retinotopic maps within the visual system, while time is processed in cerebellum, basal ganglia and cortical structures.

- **Spatial language**

**Spatial language** consists of natural-language spatial relations used to indicate where things are, and so to identify or refer to them. It usually expresses unprecise and context-dependent information about space.

Among spatial relations there are *topological* (such as on, to, in, inside, at), *path-related* (such as across, through, along, around), *distance-related* and more complex ones (such as right/left, between, opposite, back of, south of, surround).

A **distance relation** is a spatial relation which specifies how far the object is away from the reference object: near, far, close etc.

The **distance concept of proximity** (Pribbenow, 1992) is the area around the RO (reference object) in which it can be used for localization of the LO (local object), so that there are visual access from RO and non-interruption of the spatial region between objects, while LO is less directly related to a different object. Such proximity can differ with physical distance as, for example, in “The Morning Star is to the left of the church”. The area around RO, in which a particular relation is accepted as a valid description of the distance between objects, is called the *acceptance area*.

Pribbenow, 1991, proposed five distance distinctions: *inclusion* (acceptance area restricted to projection of RO), *contact/adjacency* (immediate neighborhood of RO), *proximity, geodistance* (surroundings of RO) and *remoteness* (the complement of the proximal region around RO).

Jackendorff-Landau, 1992, showed that in English there are mainly 3 degrees of distance distinctions: interior of RO (*in, inside*), exterior but in contact (*on, against*), proximate (*near*), plus corresponding negatives (such as *outside, off of, far from*).

Semantics of spatial language is considered in Spatial Cognition, Linguistics, Cognitive Psychology, Anatomy, Robotics, Artificial Intelligence and Computer Vision. Cognitively based common-sense spatial ontology and metric details of spatial language are modeled for eventual interaction between Geographic Information Systems and users. An example of far-going applications is the Grove’s *Clean Space*, a *neurolinguistic programming* psychotherapy based on the spatial metaphors produced by (or extracted from) the client on his present and desired “space” (state).

- **Language distance from English**

There are many such measures based either on a typology (comparing formal similarities between languages), or language trees, or performance (mutual intelligibility and learnability of languages). Some examples of **language distance from English** follow.

Rutheford, 1983, defined *distance from English* as the number of differences from English in the following three-way typological classification: subject/verb/object order, topic-prominence/subject-prominence and pragmatic word-order/grammatical word-order. It gives distances 1, 2, 3 for Spanish, Arabic/Mandarin, Japanese/Korean.

Borland, 1983, compared several languages of immigrants by their acquisition of four areas of English syntax: copula, predicate complementation, negation and articles. The resulting ranking was English, Spanish, Russian, Arabic, Vietnamese.

Elder-Davies, 1998, used ranking based on the following 3 main types of languages: isolating, analytic or root (as Chinese, Vietnamese), inflecting, synthetic or fusional (as Arabic, Latin, Greek), agglutinating (as Turkish, Japanese). It gave ranks 1, 2, 4, 5 for Romance, Slavic, Vietnamese/Khmer, Japanese/Korean, respectively, and the intermediate rank 3 for Chinese, Arabic, Indonesian, Malay.

The **language distance index** (Chiswick-Miller, 1998) is the inverse of the *language score* of the average speaking proficiency (after 24 weeks of instruction) of English speakers learning this language (or, say, fluency in English of immigrants having it as native language). This score was measured by a standardized test at regular intervals by increments of 0.25; it ranges from 1.0 (hardest to learn) to 3.0 (easiest to

learn). The score was, for example, 1.00, 1.25, 1.50, 1.75, 2.00, 2.25, 2.50, 2.75, 3.00 for Japanese, Cantonese, Mandarin, Hindi, Hebrew, Russian, French, Dutch, Afrikaans.

In addition to the above distances, based on syntax, and **linguistic distance**, based on pronunciation, see the lexical semantic distances in Section 2 of Chapter 22.

Cf. **clarity similarity** in Chapter 14, **distances between rhythms** in Chapter 21, **Lasker distance** in Chapter 23 and **surname distance model** in Chapter 28.

Translations of the English noun *distance*, for example, into French, Italian, German, Swedish, Spanish, Interlingua, Esperanto are: distance, distanza, distanz, distans, distancia, distantia, distanco.

- **Editex distance**

The main phonetic encoding algorithms are (based on English language pronunciation) *Soundex*, *Phonix* and *Phonex*, converting words into one-letter three-digits codes. The letter is the first one in the word and the three digits are derived using an assignment of numbers to other word letters. Soundex and Phonex assign:

0 to *a, e, h, i, o, u, w, y*;    1 to *b, p, f, v*;    2 to *c, g, j, k, q, s, x, z*;    3 to *d, t*;  
4 to *l*;    5 to *m, n*;    6 to *r*.

Phonix assigns the same numbers, except for 7 (instead of 1) to *f* and *v*, and 8 (instead of 2) to *s, x, z*.

The **Editex distance** (Zobel-Dart, 1996) between two words *x* and *y* is a cost-based **editing metric** (i.e., the minimal cost of transforming *x* into *y* by substitution, deletion and insertion of letters). For substitutions, the costs are 0 if two letters are the same, 1 if they are in the same letter group, and 2 otherwise.

The *syllabic alignment distance* (Gong-Chan, 2006) between two words *x* and *y* is another cost-based **editing metric**. It is based on Phonix, the identification of syllable starting characters and seven edit operations.

- **Phone distances**

A *phone* is a sound segment that has distinct acoustic properties, and is the basic sound unit. Cf. *phoneme*, i.e., a family of phones that speakers usually hear as a single sound; the number of phonemes range, among about 6,000 languages spoken now, from 11 in Rotokas to 112 in !Xóõ (languages spoken by about 4,000 people in Papua New Guinea and Botswana, respectively).

The two main classes of **phone distance** (distances between two phones *x* and *y*) are:

1. *Spectrogram-based distances* which are physical-acoustic distortion measures between the sound spectrograms of *x* and *y*;
2. *Feature-based phone distances* which are usually the **Manhattan distance**  $\sum_i |x_i - y_i|$  between vectors ( $x_i$ ) and ( $y_i$ ) representing phones *x* and *y* with respect to a given inventory of phonetic features (for example, nasality, stricture, palatalization, rounding, sillability).

The **Laver consonant distance** refers to the improbability of confusing 22 consonantal phonemes of English, developed by Laver, 1994, from subjective auditory



impressions. The smallest distance, 15%, is between phonemes  $[p]$  and  $[k]$ , the largest one, 95%, is, for example, between  $[p]$  and  $[z]$ . Laver also proposed a quasi-distance based on the likelihood that one consonant will be misheard as another by an automatic speech-recognition system.

Liljencrans-Lindlom, 1972, developed a *vowel space* of 14 vowels. Each vowel, after a procedure maximizing contrast among them, is represented by a pair  $(x, y)$  of resonant frequencies of the vocal tract (first and second formants) in linear mel units with  $350 \leq x \leq 850$  and  $800 \leq y \leq 1700$ . Roughly, higher  $x$  values correspond to lower vowels and higher  $y$  values to less rounded or farther front vowels. For example,  $[u]$ ,  $[a]$ ,  $[i]$  are represented by  $(350, 800)$ ,  $(850, 1150)$ ,  $(350, 1700)$ , respectively.

- **Phonetic word distance**

The **phonetic word distance** (or *pronunciation distance*) between two words  $x$  and  $y$  is the **Levenstein metric** with costs, i.e., the minimal cost of transforming  $x$  into  $y$  by substitution, deletion and insertion of phones. A word is seen as a string of phones.

Given a **phone distance**  $r(u, v)$  on the International Phonetic Alphabet with the additional phone 0 (the silence), the cost of substitution of phone  $u$  by  $v$  is  $r(u, v)$ , while  $r(u, 0)$  is the cost of insertion or deletion of  $u$ .

Cf. in Section 3 of Chapter 23 distances on the set of 20 amino acids.

- **Linguistic distance**

The **linguistic distance** (or **dialectology distance**) between language varieties  $X$  and  $Y$  is the mean, for fixed sample  $S$  of notions, **phonetic word distance** between *cognate* (i.e., having the same meaning) words  $s_X$  and  $s_Y$ , representing the same notion  $s \in S$  in  $X$  and  $Y$ , respectively. Usually, the **Levenshtein metric** defined in Chapter 11 is used (the minimum number of inserting, deleting or substituting sounds needed to recover the word pronunciation).

As an example of similar work, the **Stover distance** between phrases with the same key word is (Stover, 2005) the sum  $\sum_{-n \leq i \leq +n} a_i x_i$ , where  $0 < a_i < 1$ , and  $x_i$  is the proportion of non-matched words between the phrases within a moving window. Phrases are first aligned, by the common key word, to compare the uses of it in context; also, the rarest words are replaced with a common pseudo-token.

- **Language distance effect**

In Foreign Language Learning, Corder, 1981, conjectured the existence of the following **language distance effect**: where the mother tongue (L1) is structurally similar to the target language, the learner will pass more rapidly along the developmental continuum (or some parts of it) than where it differs; moreover, all previous learned languages have a facilitating effect.

Ringbom, 1987, added: the influence of the L1 is stronger at early stages of learning, at lower levels of proficiency and in more communicative tasks.

But such correlation could not be direct. For example, the written form of Chinese does not vary among the regions of China, but the spoken languages differ sharply. Alternatively, spoken German and Yiddish are close but have different alphabets.

- **Long-distance dependence (in Language)**

In Language, **long-distance dependence** (or *syntactic binding*) is a construction, including wh-questions (as “Who do you think he like”), topicalizations (as “Mary, he like”), *easy*-adjectives (as “Mary is easy to talk to”), relative clauses (as “I saw the woman who I think he likes”) - which permits an element in one position (*filler*) to fill the grammatical role associated with another not adjacent position (*gap*). The *filler-gap distance*, in terms of the number of intervening clauses or words between them in a sentence, can be arbitrarily large.

In Generative Linguistics, *anaphora* is a reciprocal (such as *one another* and *each other*) or reflexive (such as *myself*, *herself*, *themselves*, *oneself*, etc.) pronoun in English, or an analogous referential pattern in other language. In order to be interpreted, anaphora must get its content from an antecedent in the sentence, which is, usually, syntactically local as in “Mary excused *herself*”. A **long-distance anaphora** is an anaphora with antecedent outside of its local domain, as in “The players told us stories about *each other*”. Its resolution (finding what the anaphora refer to) is an unsolved linguistic problem of machine translation.

Cf. **long range dependence** in Chapter 29.

## 28.4 Distances in Philosophy, Religion and Art

- **Kristeva non-metric space**

Kristeva’s (1980) basic psychoanalytic distinction is between pre-Oedipal and Oedipal aspects of personality development. Narcissistic identification and maternal dependency, anarchic component drives, polymorphic erotogenicism, and primary processes characterize the pre-Oedipal. Paternal competition and identification, specific drives, phallic erotogenicism, and secondary processes characterize Oedipal aspects. Kristeva describes the pre-Oedipal feminine phase by an enveloping, amorphous, **non-metric space** (Plato’s *chora*) that both nourishes and threatens; it also defines and limits self-identity. She characterizes the Oedipal male phase by a metric space (Aristotle’s *topos*); the self and the self-to-space are more precise and well defined in *topos*. Kristeva posits also that the semiotic process is rooted in feminine libidinal, pre-Oedipal energy which needs channeling for social cohesion.

Deleuze and Guattari (1980) divided their *multiplicities* (networks, manifolds, spaces) into *striated* (metric, hierarchical, centered and numerical) and *smooth* (“non-metric, rhizomic and those that occupy space without counting it and can be explored only by legwork”).

The above French post-structuralists use the metaphor *non-metric* in line with a systematic use of topological terms by the psychoanalyst Lacan. In particular, he sought space the *J* (of *Jouissance*, i.e., sexual relations) as a bounded metric space.

Back to Mathematics, the **non-metricity tensor** is the *covariant derivative* of a **metric tensor**. It can be non-zero for **pseudo-Riemannian metrics** and vanishes for **Riemannian metrics**. Also, sometimes when a notion, theorem or algorithm is extended from metric space to general distance space, the later is called **non-metric space**.

- **Simone Weil distance**

We call the **Simone Weil distance** a kind of moral radius of the Universe which the French philosopher, Christian mystic, social activist and self-hating Jew, Simone Weil (1909–1943) introduced in “The Distance”, one of the philosophico-theological essays comprising her *Waiting for God* (posthumous English edition by Putnam, New York, 1951).

She connects God’s love to the distance; so, his absence can be interpreted as a presence: “every separation is a link” (Plato’s *metaxu*). In her peculiar Christian theodicy, “evil is the form which God’s mercy takes in this world”, and the crucifixion of Christ (the greatest love/distance) was necessary “in order that we should realize the distance between ourselves and God ... for we do not realize distance except in the downward direction”. The Simone Weil *God-cross distance* (or *Creator-creature distance*) recalls the old question: can we equate distance from God with proximity to Evil? Her main drive, the purity, consisted of maximizing **moral distance** to Evil, embodied for her by “the social, Rome and Israel”.

Cf. Pascal’s *God-nothing* distance in *Pensées*, note 72: “For after all what is man in nature? A nothing in relation to infinity, all in relation to nothing, a central point between nothing and all and infinitely far from understanding either”. Cf. earlier Montaigne’s *nothing-smallest-largest* distances in *Essais, III:11 On the lame*: “Yet the distance is greater from nothing to the minutest thing in the world than it is from the minutest thing to the biggest.” Cf. also Tipler’s (2007) *Big Bang - Omega Point* time/distance with Initial and Final singularities seen as God-Father and God-Son, respectively. Tipler’s *Omega point* (technological singularity) is a variation of prior use of the term (Teilhard de Chardin, 1950) as the supreme point of complexity and consciousness: the Logos, or Christ.

Calvin’s *Eucharistic theology* (doctrine on the meaning of bread and vine that Christ offered to his disciples during the last supper before his arrest) also relies on spatial distance as a metaphor that best conveys the separation of the world from Christ and of the earthly, human from the heavenly, divine.

Weil’s approach reminds also of the Lurian kabbalistic notions: *tzimtzum* (God’s concealment, withdrawal of a part, creation by self-delimitation) and *shattering of the vessels* (evil as impure vitality of husks, produced whenever the force of separation loses its distancing function, and giving man the opportunity to choose between good and evil). The purpose is to bridge the distance between God (or Good) and the diversity of existence, without falling into the facility of dualism (as manicheanism and gnosticism). It is done by postulating intermediate levels of being (and purity) during emanation (unfolding) within the divine and allowing humans to participate in the redemption of the Creation.

So, a possible individual response to the Creator is purification and *ascent*, i.e., a spiritual movement through the levels of emanation in which the coverings of impurity, that create distance from God, are removed progressively. Meanwhile, a song “From a Distance”, written by Julie Gold, is about how God is watching us and how, despite the distance (physical and emotional) distorting perceptions, there is still a little peace and love in this world.

- **Distance to Heaven**

Below are given examples of distances and lengths which old traditions related (sometimes as a metaphor) to such notions as God and Heaven.

In the early Hebrew mystical text *Shi'ur Qomah*, i.e., *The measure of the (divine) body*, the height of the Holy Blessed One is  $236 \times 10^7$  *parasangs*, i.e.,  $14 \times 10^{10}$  (divine) *spans*. In the Biblical verse “Who has measured the waters in the hollow of his hand and marked off the heaven with a span” (Isaiah 40:12), the size of the Universe is one such span.

The **cosmic light horizon** (or age/size of the Universe) is  $\approx 13.7$  billion light-years. *Sefer HaTemunah* (by Nehunia ben Hakane, 1-st century) and *Otzar HaChaim* (by Yitzchok deMin Acco, 13-th century) deduced that the World was created *in thought* 42,000 divine years, i.e.,  $42,000 \times 365,250 \approx 15.3$  billion human years, ago. This exegesis counts, using a 42-letter name at the start of Genesis, that now we are in the 6-th cycle of the 7 cosmic *sh'mitah* cycles, each one being 7000 divine years long. *Tohu* and *bohu* followed and less than 6000 years ago the creation of world *in deed* is posited.

In the Talmud (Pesahim, 94), the Holy Spirit points out to “impious Nebuchadnezzar” (planning “to ascend above the heights of the clouds like the Most High”): “The distance from earth to heaven is 500 year’s journey alone, the thickness of the heaven again 500 years...”. This heaven is the the *firmament* plate, and the journey is by walking. Seven other heavens, each 500 years thick, follow “and the feet of the holy Creatures are equal to the whole...”. Their ankles, wings, necks, heads and horns are each consecutively equal to the whole. Finally, “upon them is the Throne of Glory which is equal to the whole”. The resulting journey of 4,096,000 years amounts, at the rate of 80 miles per day, at about  $\approx 2,600$  AU  $\approx \frac{1}{100}$  of the distance to the nearest other star.

On the other hand, *Baraita de Massechet Gehinom* affirms in Section VII.2 that Hell consists of 7 cubic regions of side 300 year’s journey each; so, 6,300 years altogether. According to Cristian Bible (Chapter 21 of the Book of Revelation), New Heavenly Jerusalem (a city that is or will be the dwelling place of the Saints) is a cube of side 12,000 furlongs ( $\approx 2,225$  km), or a similar pyramid or spheroid.

Islamic tradition (Dawood, Book 40, Nr. 470) also attributes a journey of 71 – 500 years (by horse, camel or foot) between each *asmaa* (the ceiling containing one of the 7 luminaries: Moon, Mercury, Venus, Sun, Mars, Jupiter, Saturn).

Vedic texts (Pancavimsa-Brahmana, circa 2000 BC) states that the distance to Heaven is 1000 Earth diameters and Sun (the middle one among 7 luminaries) is halfway at 500 diameters. A similar ratio 500 – 600 was expected till the first scientific measurement of 1 AU (Earth-Sun distance) by Cassini in 1672. The actual ratio is  $\approx 11,687$ .

The sacred Hindu number 108 ( $=6^2 + 6^2 + 6^2 = \prod_{1 \leq i \leq 3} i^i$ ), also connected to Golden Ratio as the interior angle  $108^\circ$  of a regular pentagon, is traced to following Vedic values: 108 Sun’s diameters for the Earth-Sun distance and 108 Moon’s diameters for the Earth-Moon distance. The actual values are  $\approx 107.6$  and (steadily increasing)  $\approx 110.6$ ; they could be computed without any instruments during an eclipse, since the angular size of Moon and Sun, viewed from Earth, is almost identical. Cf. the *Metonic cycle* (period of 19 *tropical years*, i.e., 6939.60 days, that is equal to 235

*synodic lunar months*,  $\approx 29.53$  days each, plus about two hours) and the *Saros cycle* (period of 223 synodic months  $\approx 6585.33$  days) that can be used to predict eclipses of the Sun and Moon.

Also, the ratio between Sun and Earth diameters is  $\approx 108.6$ , but it is unlikely that Vedic sages knew it. In Ayurveda, the devotee's distance to his "inner sun" (God within) consists of 108 steps; it corresponds to 108 beads of *japamala* (rosary): the devotee, while saying beads, does a symbolic journey from his body to Heaven.

- **Swedenborg heaven distances**

The Swedish scientist and visionary Emanuel Swedenborg (1688–1772), in Section 22 (Nos. 191–199, *Space in Heaven*) of his main work *Heaven and Hell* (1952, first edition in Latin, London, 1758), posits: "distances and so, space, depend completely on interior state of angels". A move in heaven is just a change of such a state, the length of a way corresponds to the will of a walker, approaching reflects similarity of states. In the spiritual realm and afterlife, for him, "instead of distances and space, exist only states and their changes".

- **Space (in Philosophy)**

The present Newton-Einstein notion of **space** were preceded by the Aristotelian Cosmos (space is a finite system of relations between material objects) and earlier, in the same 4-th century BC, by Democritus Void (space is the infinite container of objects).

For Newton, space was absolute: it existed permanently and independently of whether there is any matter in it. For Leibniz (in the same 17-th century), space was a collection of relations between objects, given by their distance and direction from one another, i.e., an idealized abstraction from the relations between individual entities or their possible locations, which must therefore be discrete.

For Kant (18-th century), space and time are not objective features of the world, with substance or relation. Instead, they are part of an unavoidable systematic framework used by humans to organize their experiences.

Disagreement continues between philosophers over whether space is an entity, a relationship between entities, or part of a conceptual framework.

- **Quotes on "near-far" distances**

"Better is a nearby neighbor, than a far off brother." (the Bible)

"It is when suffering seems near to them that men have pity; as for disasters that are ten thousand years off in the past or the future, men cannot anticipate them, and either feel no pity for them, or at all events feel it in no comparable measure." (Aristotle)

"The path of duty lies in what is near, and man seeks for it in what is remote." (Mencius)

"Sight not what is near through aiming at what is far." (Euripides)

"Good government occurs when those who are near are made happy, and those who are far off are attracted." (Confucius)

“Our main business is not to see what lies dimly at a distance, but to do what lies clearly at hand.” (Thomas Carlyle)

“The closer the look one takes at a world, the greater distance from which it looks back.” (Karl Kraus)

“By what road”, I asked a little boy, sitting at a cross-road, “do we go to the town?” – “This one”, he replied, “is short but long and that one is long but short”. I proceeded along the “short but long road”. When I approached the town, I discovered that it was hedged in by gardens and orchards. Turning back I said to him, “My son, did you not tell me that this road was short?” – “And”, he replied, “Did I not also tell you: “But long”? I kissed him upon his head and said to him, “Happy are you, O Israel, all of you are wise, both young and old”. (Erubin 53b, Talmud)

“The Prophet Muhammad was heard saying: “The smallest reward for the people of paradise is an abode where there are 80,000 servants and 72 wives, over which stands a dome decorated with pearls, aquamarine, and ruby, as wide as the distance from Al-Jabiyyah [a Damascus suburb] to Sana’a [Yemen]”. (Hadith 2687, Islamic Tradition)

“There is no object so large ... that at great distance from the eye it does not appear smaller than a smaller object near.” (Leonardo da Vinci)

“Nothing makes Earth seem so spacious as to have friends at a distance; they make the latitudes and longitudes.” (Henri David Thoreau)

“In true love the smallest distance is too great, and the greatest distance can be bridged.” (Hans Nouwens)

“Do we need distance to get close?” (Sarah Jessica Parker)

“Once the realization is accepted that even between the closest human beings infinite distances continue, a wonderful living side by side can grow, if they succeed in loving the distance between them which makes it possible for each to see the other whole against the sky.” (Rainer Maria Rilke)

“The human voice can never reach the distance that is covered by the still small voice of conscience.” (Mohandas Gandhi)

“Truth is always the shortest distance between two points.” (Sun Myung Moon)

“The shortest distance between two points is under construction.” (Leo Aikman)

“Time is the longest distance between two places.” (Tennessee Williams)

“Everywhere is within walking distance if you have the time.” (Steven Wright)

“Fill the unforgiving minute with sixty seconds worth of distance run.” (Rudyard Kipling)

“Distance not only gives nostalgia, but perspective, and maybe objectivity.” (Robert Morgan)

“Age, like distance lends a double charm.” (Oliver Wendell Holmes)

“There is an immeasurable distance between late and too late.” (Og Mandino)

“Everything is related to everything else, but near things are more related than distant things.” (Tobler’s first law of Geography).

Cf. **nearness principle** in Chapter 28 and, in Chapters 22 and 24, **action at a distance**.

- **Antinomy of distance**

The **antinomy of distance**, as introduced in [Bull12] for aesthetic experiences by beholder and artist, is that both should find the right amount of **emotional distance**, defined in Chapter 28 (neither too involved, nor too detached), in order to create or appreciate art. The fine line between objectivity and subjectivity can be crossed easily, and the amount of distance can fluctuate in time.

The **aesthetic distance** is a degree of emotional involvement of the individual, who undergoes experiences and objective reality of the art, in a work of art. It means the frame of reference that an artist creates, by the use of technical devices in and around the work of art, to differentiate it psychologically from reality; cf. **distanciation**. Some examples are: the perspective of a member of the audience in relation to the performance, the psychological and the emotional distance between the text and the reader, the *actor-character distance* in the Stanislavsky system of acting.

Antinomy between inspiration and technique (embracement and estrangement) in performance theory is called *Ion hook* since Ion of Ephesus (a reciter of rhapsodic poetry, in a Platon's dialogue) employed a double-consciousness, being ecstatic and rational. The acting model of Stanislavsky and Brecht are, respectively, incarnating the role truthfully and standing artfully distanced from it. Cf. **role distance**.

[Morg76] defines pastoral ecstasy as the experience of *role-distancing*, or the authentic self's supra-role suspension, i.e., the capacity of an individual to stand outside or above himself for purposes of critical reflexion. Morgan concludes: "The authentic self is an *ontological possibility*, the social self is an *operational inevitability*, and awareness of both selves and the creative coordination of both is the gift of ecstasy" Interplay of proximity and distance to the Other is central also in Levinas ethics.

A variation of the antinomy of distance appears in critical thinking: the need to put some emotional and intellectual distance between oneself and ideas, in order to better evaluate their validity. Another variation is detailed in *Paradox of Dominance: Distance and Connection* (posting on <http://www.leatherpage.com>) by Sprott.

The **historical distance**, in terms of [Tail04], is the position the historian adopts *vis-à-vis* his objects – whether far-removed, up-close, or somewhere in between; it is the fantasy through which the living mind of the historian, encountering the inert and unrecoverable, positions itself to make the material look alive. The antinomy of distance appears again because historians engage the past not just intellectually but morally and emotionally. Historical knowledge is always mediate/inferential, never empirical/perceptual. The formal properties of historical accounts are influenced by the affective, ideological and cognitive commitments of their authors.

A related problem is how much distance people must put between themselves and their pasts in order to remain psychologically viable; Freud showed that often there is no such distance with childhoods.

- **Distanciation**

In scenic art and literature, **distanciation** (Althusser, 1968, on Brecht's *alienation effect*) consists of methods to disturb purposely (in order to challenge basic codes and conventions of spectator/reader) the *narrative contract* with him, i.e., implicit clauses defining logic behavior in a story. The purpose is to differentiate art psychologically from reality, i.e., to create some **aesthetic distance**.

One of distanciation devices is *breaking of the 4-th wall*, when the actor/author addresses the spectators/readers directly through an imaginary screen separating them. The "4-th wall" is the conventional boundary between the fiction and the audience. It is a part of the *suspension of disbelief* between them: the audience tacitly agrees to provisionally suspend their judgment in exchange for the promise of entertainment.

Cf. **distancing** and **distantiation**.

- **Role distance**

In Sociology, Goffman, 1961, using a dramaturgical metaphor, defined **role distance** (or *role distancing*) as actions which effectively convey some disdainful detachment of the (real life) performer from a role he is performing. For example, the actor may only play the role in a tongue and cheek fashion. An example of social role distancing is when a teacher explains to students that his disciplinary actions are due only to his role as a teacher. So, the occupant of a role try to de-emphasize the importance of that role and communicate that his actions should be attributed rather to the role.

Goffman observed that children are capable to merge doing and being, i.e., *embracement of the performer's role*, only from 3-4 years. Starting from about 5, their role distance (distinguishing being from doing) appear and expands, especially, at age 8, 11 and adult years.

Beside role embracement and role distance, one can play role cynically in order to manage the outcomes of the situation (impression management). The most likely cause of role distancing is *role conflict*, i.e., the pressure exerted from another role to act inconsistently from the expectations of the first role.

- **Far Near Distance**

**Far Near Distance** is the name of the program of the House of World Cultures in Berlin which presents a panorama of contemporary positions of all artists of Iranian origin. Some examples of similar use of distance terms in modern popular culture follow.

"Some near distance" is the title of an art exhibition of Mark Lewis (Bilbao, 2003), "A Near Distance" is a paper collage by Perle Fine (New York, 1961), "Quiet Distance" is a fine art print by Ed Mell, "Zero/Distance" is the title of an art exhibition of Jim Shrosbree (Des Moines, Iowa, 2007).

"Distance" is a Japanese film directed by Hirokazu Koreeda (2001) and an album of Utada Hikaru (her famous ballad is called "Final Distance"). It is also the stage name of a British musician Greg Sanders and the name of the late-1980 rock/funk band led by Bernard Edwards. "The Distance" is a film directed by Benjamin Busch (2000) and an album by American rock band "Silver Bullet" led by Bob



Seeger. “Near Distance” is a musical composition by Chen Yi (New York, 1988) and lyric by the Manchester quartet “Purescence”. “Distance to Fault” (DTF) is a metal/indie rock band based in Hampshire UK.

The terms *near distance* and *far distance* are also used in Ophthalmology and for settings in some sensor devices.

- **Spatialism**

**Spatialism** (or *Spazialismo*) is an art movement founded by Lucio Fontana in Milan in 1947, intended to synthesize space, colour, sound, movement and time into a new “art for the Space Age”. Instead of the illusory virtual space of traditional easel painting, he proposed to unite art and science to project colour and form into real space by the use of up-to-date techniques as, say, TV and neon lighting.

His *Spatial Concept* series consisted of holes or slashes, by a razor blade, on the surface of monochrome paintings.

- **Scale in Art**

In an architectural composition, the **scale** is the two-term relationship of the parts to the whole, which is harmonized with a third term - observer. For example, besides the proportions of a door and their relation to those of a wall, an observer measures them against his own dimensions.

The **scale** of an outdoor sculpture, when it is one element in a larger complex such as the facade of a building, must be considered in relation to the scale of its surroundings. In *flower arrangement* (floral decoration), the **scale** indicates relationships: the sizes of plant materials must be suitably related to the size of the container and to each other.

In drawing, the **scale** refers to the proportion or ratio that defines the size relationships. It is used to create the illusion of correct size relationships between objects and figures. The *relative scale* is a method used to create and determine the spatial position of a figure or object in 3D picture plane: objects that are more distant to the viewer are drawn smaller in size. In this way, the relative size of an object/figure creates the illusion of space on a flat 2D picture.

The *hierarchical scale* in Art is the manipulation of size and space in a picture to emphasize importance of a specific object. Manipulating the scales was the theme of *Measure for Measure*, an art/science exhibition at Los Angeles Art Association, 2010. Examples of the interplay of the small and the large in the literature are Swift’s *Gulliver’s Travels* and Carroll’s *Through the Looking Glass*. In the cinema, the spectator can easily be deceived about the size of objects, since scale constantly changes from shot to shot.

In Advertising and Packaging, the size changes the meaning or value of an object. The idea that “bigger is better” is validated by the sales of sport utility vehicles, super-sized soft drinks and bulk food at Wal-Mart. In reverse, the principle “small is beautiful” is often used to champion small, appropriate objects and technologies that are believed to empower people more. For example, small-sized models sell the benefits of diet programs and fitness regimes designed to scale back people-proportions. Examples of Japanese miniaturization culture are bonzai and many small/thin portable devices.

