The notion of spatial search is used in at least three different senses: (1) search in real (vista, environmental, or geographic) space; (2) search in virtual space; and (3) search in non-spatial domains using a spatial metaphor for navigation. Important distinctions of real spaces in comparison to other spaces are: their inherent restriction to three, two, or one dimension; the presence of at most one physical entity on any location; and a strict ordering of entities on any of the dimensions (with periodic orderings on circular dimensions). These properties can be exploited for effective and efficient search procedures. Unless otherwise noted, I will focus on search in real space.

In comparison to abstract spaces, size-restricted real spaces contain a finite number of physical entities; but although at any given location we only can have a single physical entity, this entity may belong to a multitude of conceptual entities; these may be in a hierarchical or heterarchical relationship to one another. These properties of entities in real space and their conceptualizations are responsible for interesting features related to search.

In abstract spaces, we may have an arbitrary number of dimensions such that each entity can be a neighbor of each other entity; this would allow us to directly reach any entity from any other entity; the problem with this very general framework is that it does not scale well with the number of objects involved: each new object requires a link to each existing object; this constitutes an exponential growth with respect to the number of entities, and consequently results in expensive computational procedures.

If we restrict the dimensionality of space to those of real spaces, we also restrict the number of spatially neighboring physical entities; but we do not seriously restrict the places we can visit: we first visit a neighbor; from there we can visit a neighbors’ neighbor, etc. If all entities are connected in a single network, we can reach any place. The growth in complexity is only linear in the number of entities involved. Reaching nearby places is cheaper than reaching distant places; this is exactly what we want in a benign world in which Tobler’s First Law of Geography (“Everything is related to everything else, but nearby things are more related than distant things”) applies (Tobler 1970). The property described here applies on any level of spatial resolution.

Spatial neighborhood and spatial movement induce conceptual neighborhood of spatial relations (Freksa 1991). Together, they result in a very interesting and useful property that allow for the conceptualization of spatial entities on various levels of spatial and conceptual resolution. For example, we can conceptualize an entity at a given spatial location as a house, as part of a settlement, or as a room (in a house); this is a side-effect of spatial coherence that is expressed in Tobler’s First Law.
The spatial coherence between fine-grained and coarse-grained spatial entities and their corresponding conceptualizations enable very useful approaches to spatial search; in particular, we can move to a coarser level of resolution (zoom out) when we search for a certain entity; this will reduce the size of the search space while at the same time this will widen the scope to closely related items that may not fully agree with the fine specification the search has started with. At a later stage of search, we can refine resolution (zoom in) again in order to select the most suitable candidate from the answer set. In human cognition, such coarsening and refinement operations appear to constitute important mechanisms for efficient and effective search.

Here are some issues to discuss in connection with spatial structure and spatial integrity:

**Conceptual dimensions of spatial structure:**
- horizontal (near – far) vs. vertical (fine – coarse)
- search metaphors: fine to coarse and back vs. coarse to fine and back
- abstraction – concretion operations
- approximation – precesiation operations

**Representational / cognitive economy**
- why do we coarsen knowledge obtained in fine structures when we require precise answers?
- why do we refine knowledge when coarse answers are sufficient?

**The role of qualitative spatial relations in search**

**Exploitation of redundancies**

**Spatial context and context-based affordances**

**Virtual vs. real search spaces**

**The role of spatial reference systems for search**
- location vs. content search

**Knowledge in the world vs. knowledge in the head**
- quantitative / qualitative interaction (e.g., wayfinding in the real world)
- spatial and conceptual neighborhood (Tobler’s 1st law of Geography)

**Trade-offs**
- space – time – accuracy
- one or all search

**Affordance- vs. constraint-based search**
- forward – backward search
- incomplete and / or inaccessible knowledge

**References**