Patterns for Human oriented Information Presentation

Shape ◇ Associativity ◇ Structure

Introduction

Humans interchange information using textual and graphical forms of representation. For an efficient information interchange human specific abilities in information perception, retrieval and recognition have to be considered.

Key aspects in perception, retrieval and recognition of information are:

- Shape

  Human information perception is based on spatial cues. Geometric shapes and patterns are the basic form of information which humans visually perceive. The eye nerves are a lengthening of the brain. Geometric shapes and patterns trigger information perception and processing on a direct way.

- Associativity

  Human information perception is associative. New information has to be included into an existing associative net of known information. Important are the relationships between information items.

- Structure

  The process of perceiving information consists of building up relations of information items to exiting ones in our associative memory.

  Integrating information in the associative net of known information relies on internal structures, which are modified, completed and even new built.

  The quest for structure in the way to deal with the mass of information pouring into us and therefore enlarging and completing our knowledge.

The Rationale of the Patterns of this collection refer directly or indirectly to these key aspects. The Patterns can be applied in a wide range of situations where information has to be represented and interchanged: from writing papers to preparing talks or performing a creative process of capturing ideas.

The following sections represent the structure of this document and the relationships between the Patterns in different ways:

- Graphical representation: A directed graph shows the Patterns as entities and additionally the relationships between them.
- Classical form: A *Table of Contents* represents the structure of a document as a list.

These two forms are examples, how to represent structure and relationships. The Patterns of this collection refer to these examples.

Overview

Figure 1 provides an overview of this collection of Patterns as a graphical map, which illustrates the patterns and the relations between them. The problem solution pairs are given condensed.

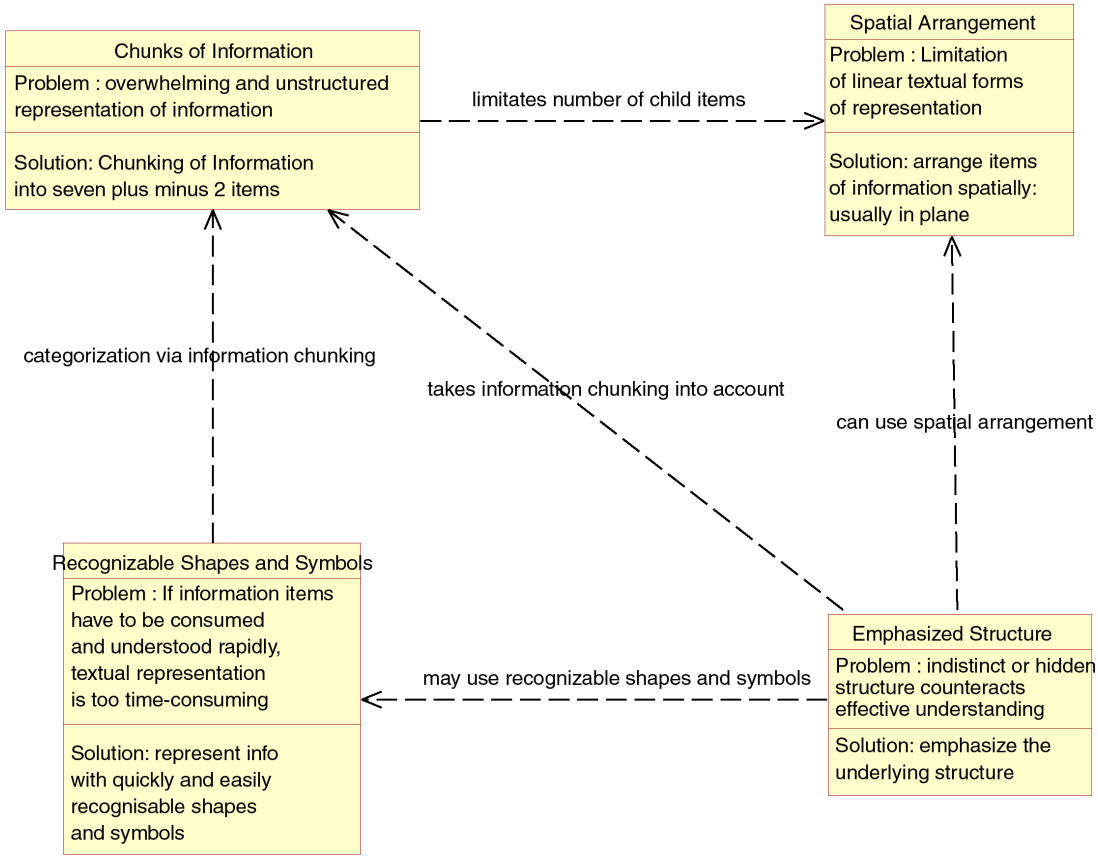

Fig. 1: Overview Map

Table of Contents

1 Pattern: *Chunks of Information*

1.1 Context

We want to represent information for a direct or indirect information interchange:

- Direct Information interchange: discussions, talks, presentations, ...
- Indirect Information interchange: books, papers, docs, ...

1.2 Problem

The capacity of information, which can be perceived at a time, is restricted.

Large chunks of information and lack of structure overwhelm readers and especially audiences.

1.3 Forces

- Presenting large quantities of information items at once is time saving and efficient.

  However, this way of transferring information is suitable for machines. Human information processing is consists of stepwise receiving and understanding.

- If one presents every part by itself, cohesion and association get lost and it costs a lot of time.

- Usefulness of grouping information items depends on balancing between the two extremes: Single separated items – with possible lost of cohesion – as one extreme and indiscriminate equalized chains of items as the other extreme.

1.4 Solution

All information should be presented in information units, which contain no more than seven – plus or minus two – separate items.

If the limit of seven is going to be exceeded, sub-chunks should be grouped. In case of software design, entities containing sub-chunks are e.g. modules or categories.

In general, if the complexity of information increases the limit of items, which can be perceived at once, decreases. Thus representation of complex information should be done using chunks of five to seven items.

Hints for applying the solution:

- No more than seven bullet points on a slide
- No more than seven bullet points on a bulleted list - classify the information into smaller logically related groups and introduce a subheading
- No more than seven bubbles on a single data flow diagram - consider reducing this further if the functions are complex
- No more than seven classes in an object model module - consider creation of more super-classes or a more granular partitioning

If there is a non-linear relationship between information items, like a hierarchical order or nearness of a single item to multiple other items, linear forms are not suitable. The Pattern *Spatial Arrangement* provides a solution for this problem.

1.5 Rationale

Miller, a psychologist, studied in the 1950s the short time memory. He investigated for example how many numbers a person can remember reliably a few minutes after having been told these numbers.

Miller presented his results in an article titled "The Magic Number Seven, Plus or Minus Two" (Miller, 1956). He found out that human consumption and remembering of information is restricted to seven plus or minus two separate items of information. The phenomenon is called the "chunking limit".

Chunking seems to be the way our internal "associative memory" organizes information storage and retrieval. This method of organizing is related to our spatial perception.

1.6 Known Uses and Examples

This Pattern collection has 8 units: an introduction, four patterns, an detailed example, acknowledgments and references. Each Pattern has seven sections.

1.7 Consequences

- Chunking items of information improves comprehension and the ability to access and retrieve information.
- In case of extensive and complex information a one level process of chunking helps to reduce complexity and the problem of overload. Nevertheless, a single level of chunking may not be enough: in an iterative process cohesive chunks have to be grouped as larger units.

2 Pattern: *Spatial Arrangement*

2.1 Context

We want to represent complex information or multi interwoven information items.

2.2 Problem

Representing information items in an one-dimensional form can not visualize semantic nearness of information items.

In Table of Contents, Lists, Indices, etc. items of information are organized linear, i.e. one-dimensional. Cross relations, relational proximity between a group of items can not be represented one-dimensional.

2.3 Forces

- Due to technical constraints or by the aim of space-efficiency information items are presented in a **linear** order (e.g. lists). On the other hand, the natural way of retrieving information is **non-linear** and based o spatial cues.
- In a linear order of items – e.g. lists – each item has two near neighbors; the grade of nearness grows linear. Such linearity is easy to represent and understand.

  Complex relationships between items and manifold grades of nearness of items can not be represented adequate in a linear form: a linear form means a insufficient reduction of complexity and lost of graduation. Nevertheless, such a reduction caused by a linear form is often chosen due to convenience or technical constraints.

2.4 Solution

In case of non-linear relationships between information items, like a hierarchical order or nearness of a single item to multiple other items, a two-dimensional representation is preferable.

Information items are arranged on a plane. The location helps to find associations and to remember the items. Using ***Recognizable Shapes and Symbols*** assist effective perception. Lines or arcs between items can visualize relationships. Additional labels allow to explain the relationships.

The "chunking limit" should be considered: each entity representing an item should not be related to more than seven (plus or minus two) other entities.

2.5 Rationale

The utility of knowledge depends on its ease of recall. Organizing information items into geometric patterns makes them easier to remember. The key idea is efficiency.

Human information perception is associative and based on spatial cues and geometric patterns. Thus linear and only text-based forms of information representation are not optimal suited for human information consumption.

Storing and retrieving items of information is more efficient, if those items are associated to a spatial location and optional to an additional geometric shape.

Two-dimensional representation allows to express contextual nearness and multiple relations by means of spatial nearness.

Variants result from different kinds of relationships between items, different multiplicity of neighbors or importance of the items:

- Spider Form: All relationships are equal
- Chain Form: Representation consists of sequences in a definite order
- Hierarchical Form: Map is organized according to the importance of items

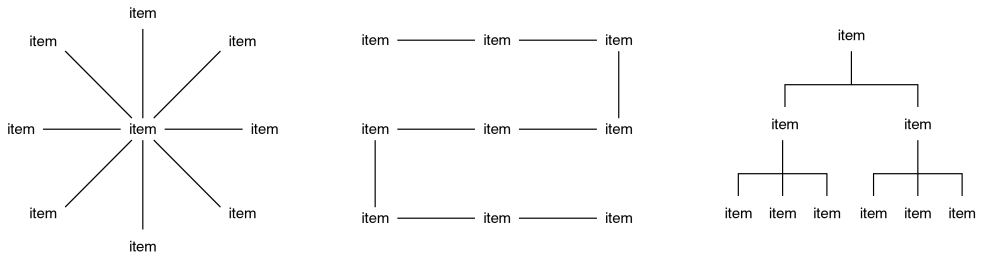

Fig. 2: Basic Variants of Arrangement: Spider, Chain and Hierarchy Form

2.6 Known Uses and Examples

Spatial arranged and interrelated information items, which are represented as **Recognizable Symbols** optionally completed with text, are widely applied: semantic networks in artificial intelligence, bond graphs in mechanical and electrical engineering, CPM and PERT charts in operations research, Petri nets in communications, category graphs in mathematics, graphical notations in software engineering.

Furthermore there are technique for visually representing the structure of information: Conceptmaps and Mindmaps. Section 4.7 shows a mindmap as a detailed example, how to arrange information items spatially.

Known Uses from the Patterns area are:

- Class Diagrams

  Almost all class diagrams in Patterns, like those presented in (Gamma *et al.*, 1995) and (Buschmann *et al.*, 1996), contain about five – plus or minus two – classes.

  It seems, that proven generic solution in object oriented software design can be expressed in terms of the co-operation of about five plus or minus two classes/objects.

  Of course, a solution of a single Pattern can be applied together with related solutions or one solution includes others.

  Nevertheless, obviously the "chunking limit" influences the way we perceive and retrieve experience information and – as the consequence – how such experience can be represented and communicated.

- Overview Maps

  Several Pattern languages and catalogues provide a graph or map as an overview and to visualize the relationships between Patterns. An example is the "Design Pattern Relationships" graph in (Gamma *et al.*, 1995).

  Figure 1 (p. 2) represents the Patterns of this Pattern collection graphically and visualizes relationships between them.

2.7 Consequences

- Visualization of information as two-dimensional maps allows information items to be associated to symbols and a spatial location.
- Paper or graphical editors allow two-dimensional locating of information items. Higher dimensional representation is difficult. To solve this problem, researchers developed e.g. Virtual Reality applications which allow three-dimensional locating of items assigned to geometric objects. In case of a two-dimensional representation, links between items can express and visualize nearness and specific relations. Links furthermore can be labeled to name and describe the relationship.
- Electronic forms of documents allow links from elements of a graphic to text positions as well as links from single words or sentences to others (Hyperlinks).

3 Pattern: *Recognizable Shapes and Symbols*

3.1 Context

We want a rapid and easy recall of information items and basic knowledge entries.

3.2 Problem

Reading textual representation of information is time-consuming. If information items have to be recognized rapidly, the textual representation is too time-consuming and therefore inadequate.

3.3 Forces

- Textual representation allows detailed descriptions without more or less no limitations. The cost of textual representation is the time-consuming process of reading.
- Experienced readers confident with the topic, recognize words as shapes/patterns. We read words character by character only if they are new to us.
- Although most non-volatile information is represented textual, human perception is based on recognizing shapes and patterns.

3.4 Solution

Represent information items and basic knowledge entries with recognizable shapes and symbols.

Instead of a textual description, abstract or descriptive symbols represent fundamental knowledge units or concepts.

3.5 Rationale

Visual perception is the most important way of getting information. Geometric shapes and patterns trigger information perception and processing on a direct way. In prehistoric times humans started to represent non-volatile information by drawing simplified pictures of prey like deer on the walls of caves or on rocks.

Simplified pictures and fundamental shapes are recognized and remembered easily. Such symbols and shapes are widely independent of languages and cultures.

Textual representation is based on characters. Characters have their origin in symbols derived from visualizations of animals or objects of the environment.

3.6 Known Uses and Examples

Recognizable Shapes and Symbols is widely applied in everyday's live as well as in technical domains, like:

- Traffic Signs

  Important information items in traffic – like "Stop", warnings, etc. – have to be recognized very quickly. Therefore basic geometric forms are used for traffic signs. Basic geometric form stands for a specific category. E.g. rectangular signs contains information and triangular ones with the base at the bottom are warnings.

- Notations for Design and Documentation

  Scientific and Technical domains have developed extensive systems of symbols. An example from the area of software engineering are the various graphical notations for modeling static and dynamic aspects of software.

- Icons

  Many programs offer users a quick access of specific functionality by means of a Toolbar: a row, column or table of small icons. By clicking an icon a particular task is executed, which otherwise has to be found via menu entries. Figure 3 shows an example of a toolbar. Symbols like that of a printer are self descriptive and easy to recognize. The recognition can be increased by an arrangement, which is always the same. For example, an symbolized empty sheet of paper representing "New File" is mostly arranged as the first icon of a toolbar.

Fig. 3: Example: A Toolbar

3.7 Consequences

- *Recognizable Shapes and Symbols* provide easy and quick access to information items.
- Symbolic representation of information is very compact and efficient.
- If symbols are not self descriptive and intuitive to identify, they have to be defined, introduced and learned previously.

4 Pattern: *Emphasized Structure*

4.1 Context

We want to provide readers and listeners an effective and easy access extensive information.

4.2 Problem

If the structure of written or verbally presented information is indistinct or hidden, contents are not understand easily and effective.

A difficult access to information can result in a negative attitude to the information.

4.3 Forces

- Normally information has an internal structure.

  Keeping information about the underlying structure from the addressee of a presentation, may spare time or space but makes understanding for the readers or listeners more difficult.

- The process of consuming presented information dependents on the contents as well as on the form it is presented.

  In case of an overdone and obtrusive structure addresses may lost interest and curiosity. An indistinct, nebulous or hidden structure impedes the process of stepwise information retrieval and processing (= understanding).

4.4 Solution

Emphasize the underlying structure. Readers and listeners can get an overview over the internal organization of the presented information and therefore easier understand it.

The structure of a document can be emphasized by means of:

- Layout techniques:
  - Different font sizes and types
  - Indent of paragraphs
  - Different colors

- Usage of *Recognizable Shapes and Symbols*

  Additional symbols can help to emphasize the structure of a document.

4.5 Rationale

The process of perceiving information consists of building up relations of information items to exiting ones in our associative memory.

Being aware of the underlying structure, readers or listeners can easier associate information items among each other and to already known information units.

If readers or listeners cannot detect the internal organizational structure of information they have to deal with, they might become frustrated or angry. A result can be a refusing attitude to the presented information, even if the information itself might be of a high quality.

4.6 Known Uses and Example

- Verbal Presentations

  Good practice for longer slide presentations is to show the agenda after each section recurrently and to clarify the progress of the presentation on the agenda.

- Written Presentations

  – Linear Form

    Table of Contents are a common form to represent the structure of a document.

    This paper provides a Table of Contents as a linear form to represent the structure of the document.

  – Maps

    The introduction of this paper contains an overview map, which shows the relationships between the unit of the document. The overview map follows the Pattern *Spatial Arrangement*.

  – Trees

    Electronic documents can present the structure parallel to the text. For example, PDF readers can show the structure of a document as a tree in a separate frame beside the text (c.f. fig. 4). The elements of the tree can be clicked to navigate to the chosen section.

Fig. 4: Example: A document with a contents tree beside the main text

– Usage of *Recognizable Shapes and Symbols*

  In some documents icons are placed at the page margins in order to indicate certain types of information. Figure 5 shows for instance an extract from a user manual with icons at the page margin.

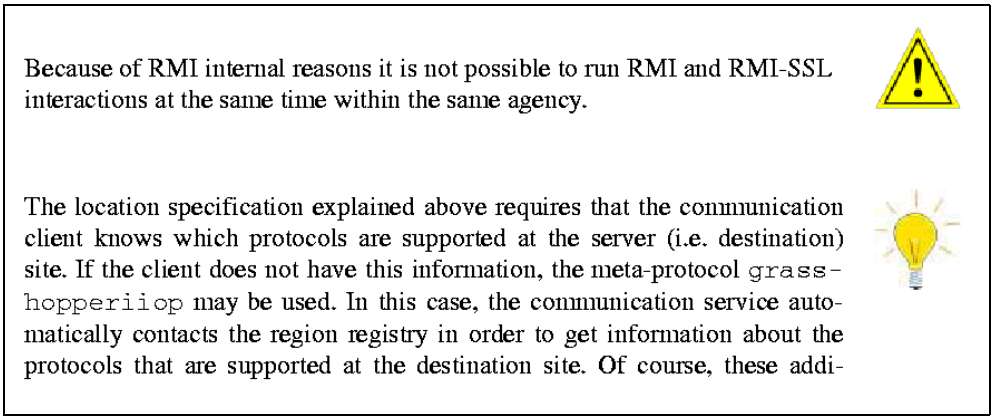

Fig. 5: Excerpt of a user manual ("Grasshopper" from IKV++)

4.7 Consequences

Emphasizing the structure provides readers or listeners an effective and easy access to written or verbally presented information.

Nevertheless, the extensiveness of the emphasizing has to be appropriate for the information. An overdone emphasizing of the structure is more likely to confuse than to aid.

Detailed Example

In the 1960s Prof. Joseph D. Novak developed *Concept Maps*. The base idea of Concept Maps is that "Meaningful learning involves the assimilation of new concepts and propositions into existing cognitive structures" (Novak, 1977).

Concept Maps consist of hierarchically arranged nodes or cells – containing a single concept, item or question – and labeled links. "Linking" words and arrow symbols specify (directed) relationships between nodes/concepts.

Buzan developed a similar technique (cf. Buzan, 1993): *Mind Maps*. The center of a Mind Map consists of a word fixing the main idea or concept. Around the central word a couple – recommended are 5 to 9 – of related words / ideas are grouped. Each "child word" can have relationships drawn as lines or arrows to another group of words.

Mind Maps allows to rapidly produce and capture an almost infinite number of ideas. By placing ideas (information items) next to the ideas they are related to, the information is organized at the same time. This makes Mind Maps a very powerful tool for creative writing or report writing, where it is very important to get down all your ideas first.

Mind Maps were used to work out the Patterns of this collection. As an example, figure 6 shows the Mind Map belonging to the Pattern *Spatial Arrangement*.

The Patterns of this collection are applied:

- Pattern *Chunks of Information*

  Each item has no more than seven child items.

- Pattern *Spatial Arrangement*

  The items are arranged spatially. Around the center – the Pattern name – the "first level" pattern elements Context, Problem, Solution and Consequences form a inner circle. Each of these items / elements has child items, which comprises more detailed information.

- Pattern *Recognizable Shapes and Symbols*

  There are some *Recognizable Shapes and Symbols* in the mind map. For instance, a "double flash of lightning" visualizes contrasts and an exclamation mark empasizes the *Solution* element.

- Pattern *Recognizable Shapes and Symbols*

  Main Pattern elements are underlined twice, other Pattern elements have a single underline in the shown Mind Map.

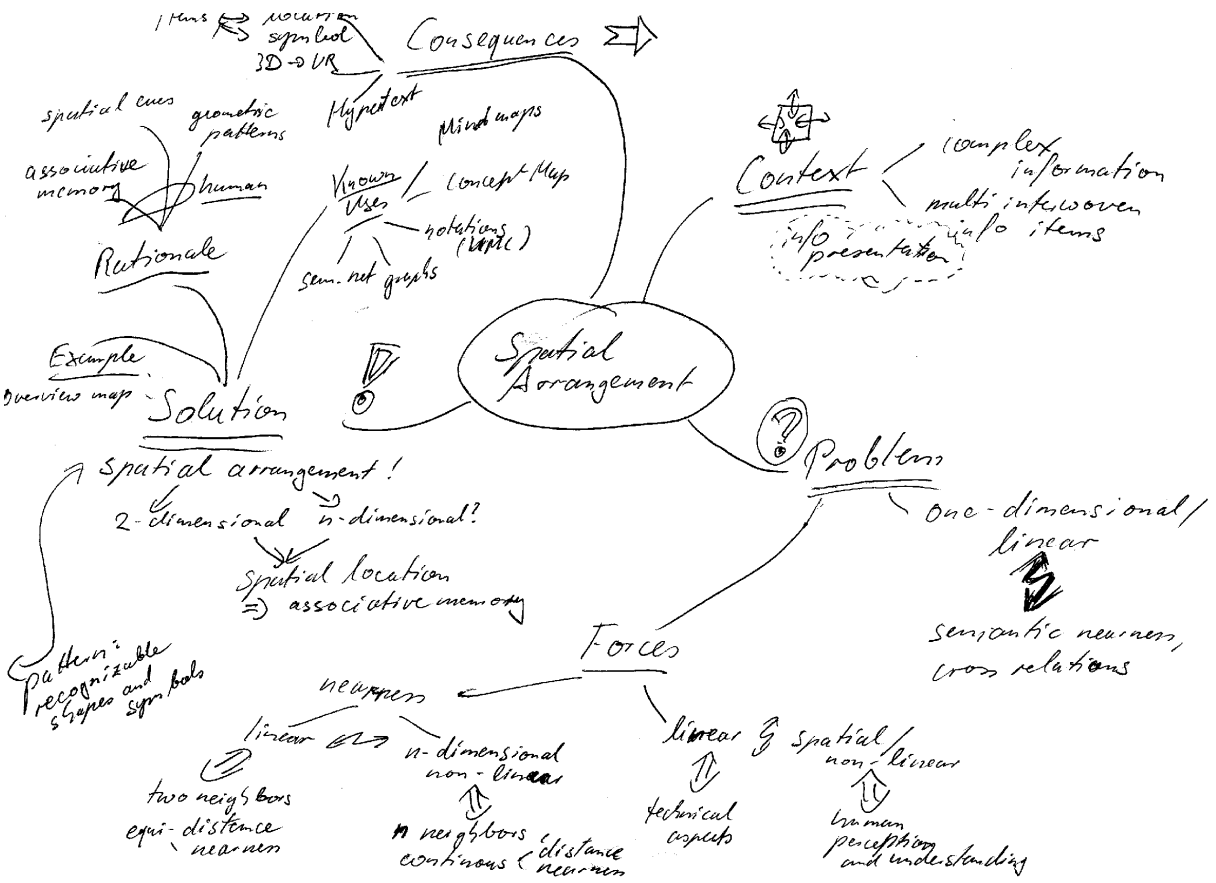

Fig. 6: Mindmap belonging to this Pattern

Acknowledgements

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