Knowledge Exchange

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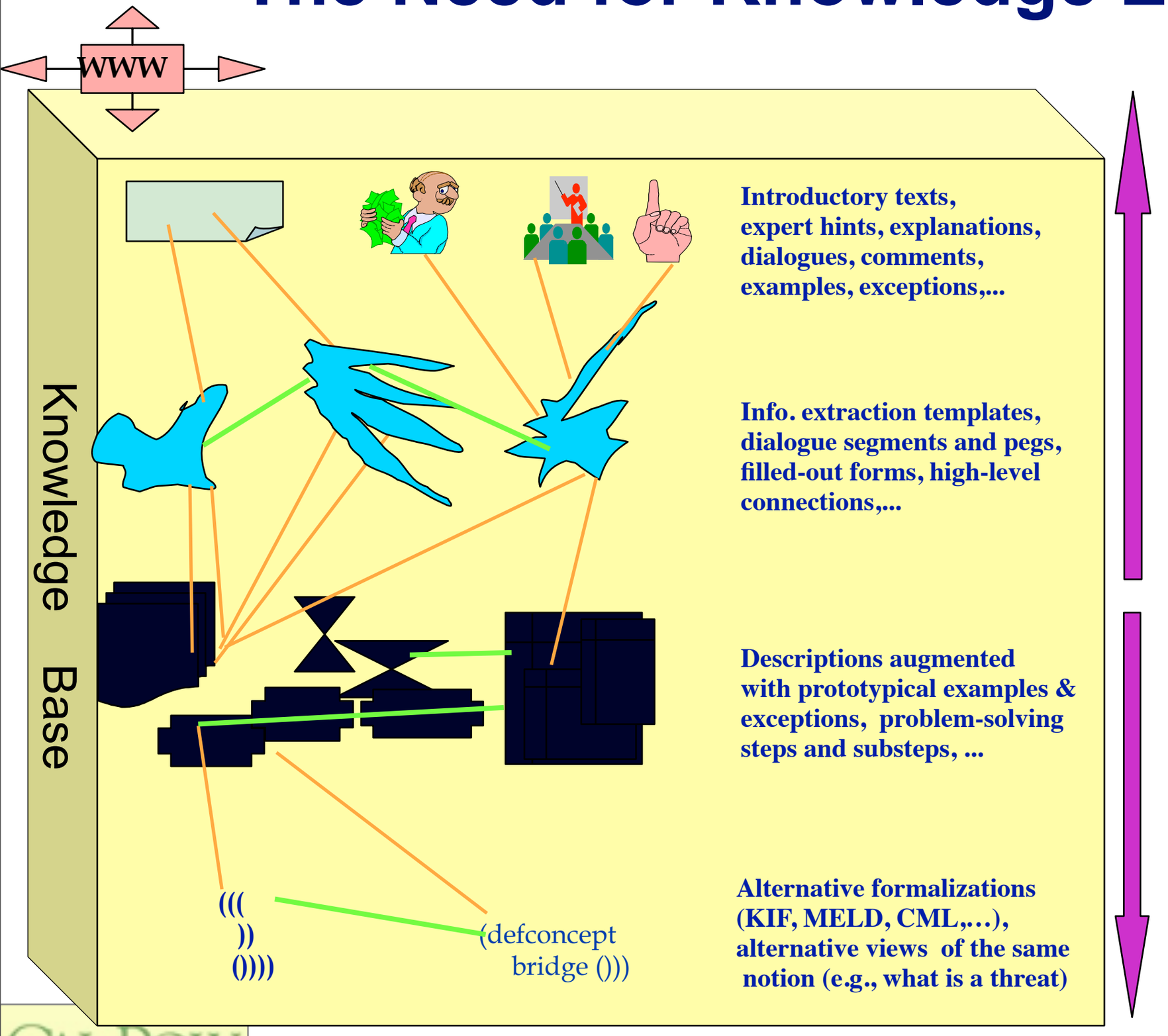
Overview Knowledge Exchange

- Introduction
- Knowledge Capture
  - Explicit Capture
  - Extraction From Text
  - Case-based Reasoning
  - Enhancement of Existing Documents
- Transfer of Knowledge
  - Communication
    - Basic Concepts
    - Language and Communication
  - Natural Language
  - Formal Languages
  - Communication Models
- Distribution of Knowledge
  - Knowledge Repositories
    - Distribution Models
    -

Introduction

The Need for Knowledge Exchange



Richer representations
More ambiguous
More versatile

More formal
More concrete
More introspectible

[Gil 2000]

Knowledge Mobility

- multiple views and versions of the same information
  - need to provide tools that establish connections among alternative versions/views of the same information
- hyper-connectivity
  - need to provide tools that suggest further connections to related sources when users compose documents
  - need to annotate hyperlinks
- basis to support information morphing
  - how one or more knowledge sources are used for
    - alternative purposes
    - track alternative knowledge transformations
    - various renderings and implementations of a knowledge source

[Gil 2000]

Knowledge Capture

- before knowledge can be shared, it must be captured
  - in and encoding and representation that is suitable for the sender and recipient of the knowledge
  - the representation format must be suitable for transmission via a communication channel between sender and recipient
  - for human-to-human knowledge exchange, natural language in written or spoken form is often suitable and convenient

Knowledge Capture Methods

- Explicit Capture
- Extraction from Documents
  - text
  - other formats
- Case-based Reasoning
- Enhancement of Existing Documents

Explicit Capture

- conventional techniques for knowledge acquisition
  - interviews with experts, knowledge engineers
- advantages
  - carefully constructed
  - suitable knowledge representation methods
  - usually common-sense evaluation
  - sometimes formal evaluation
    - consistency checks, other formal aspects

Extraction From Text

- syntactic level
  - keywords, descriptive features
    - construction of an index, meta data
- semantic level
  - document structure
    - requires information about structure (tags, DDT, RDF)
  - sentence structure
    - natural language processing (NLP)
- pragmatic level
  - context (thesaurus, ontology, NLP)

Case-based Reasoning

- solutions to a problem in a specific context are collected
- represented in a structured format
  - problem, context, solution
  - usable by a computer-based system
  - cases are often represented through frames or similar mechanisms
- new cases are matched against existing ones
  - patterns in the frames provide the basis for matching
  - the suitability of the solution is judged by the user

Enhancement of Existing Documents

- in addition to the methods mentioned above, collections of documents can be enhanced
  - addition of meta-knowledge
  - integration into an existing framework/ontology
    - manually through categorization
    - automatically through keyword extraction
    - indirectly through statistical correlations with other documents

Transfer of Knowledge

- Communication
  - Basic Concepts
  - Language and Communication
    - Natural Language
    - Formal Languages
  - Communication Models

Basic Concepts

- communication
  - exchange of information
  - requires a shared system of signs
  - greatly enhanced by language
  - speaker
    - produces signs as utterances
    - general: not only spoken language
- listener (hearer)
  - perceives and interprets signs

Purpose of Communication

- sharing of information among agents or systems
  - query other agents for information
  - responses to queries
  - requests or commands
    - actions to be performed for another agent
  - offer
    - proposition for collaboration
  - acknowledgement
    - confirmation of requests, offers
  - sharing
    - of experiences, feelings

Communication Problems

- intention
  - what is the expected outcome (speaker's perspective)
- timing
  - when is a communication act appropriate
- selection
  - which act is the right one
- language
  - what sign system should be used
- interpretation
  - will the intended meaning be conveyed to the listener
- ambiguity
  - can the intention be expressed without the possibility of misunderstandings

Language and Communication

- Natural Language
  - used by humans
  - evolves over time
  - moderately to highly ambiguous
- Formal Languages
  - invented
  - rigidly defined
  - little ambiguity

Natural Language

- formal description is very difficult
  - sometimes non-systematic, inconsistent, ambiguous
- mostly used for human communication
  - easy on humans
  - tough on computers
- context is critical
  - situation, beliefs, goals

Formal Languages

- symbols
  - terminal symbols
    - finite set of basic words
    - not: alphabet, characters
  - non-terminal symbols
    - intermediate structures composed of terminal or non-terminal symbols
- strings
  - sequences of symbols
- phrases
  - sub-strings grouping important parts of a string

Formal Languages Cont.

- sentences
  - allowable strings in a language
  - composed from phrases
- grammar
  - rules describing correct sentences
    - often captured as rewrite rules in BNF notation
- lexicon
  - list of allowable vocabulary words

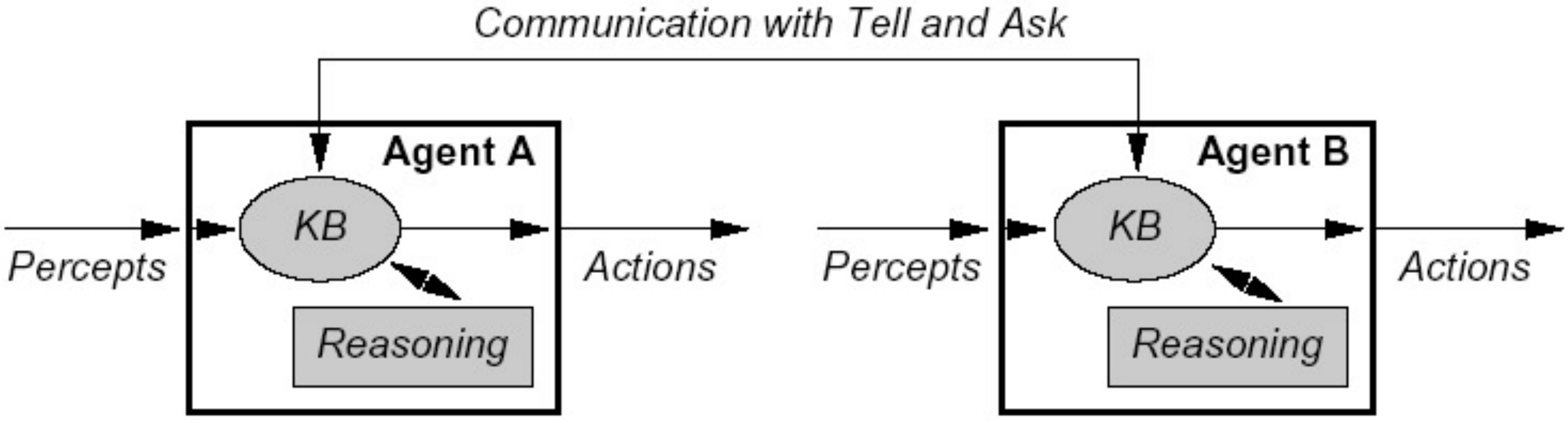
Communication Models

- encoded message model
  - a definite proposition of the speaker is encoded into signs which are transmitted to the listener
  - the listener tries to decode the signs to retrieve the original proposition
  - errors are consequences of transmission problems
- situated language model
  - the intended meaning of a message depends on the signals as well as the situation in which they are exchanged
  - mis-interpretation may lead to additional problems

Communication Types

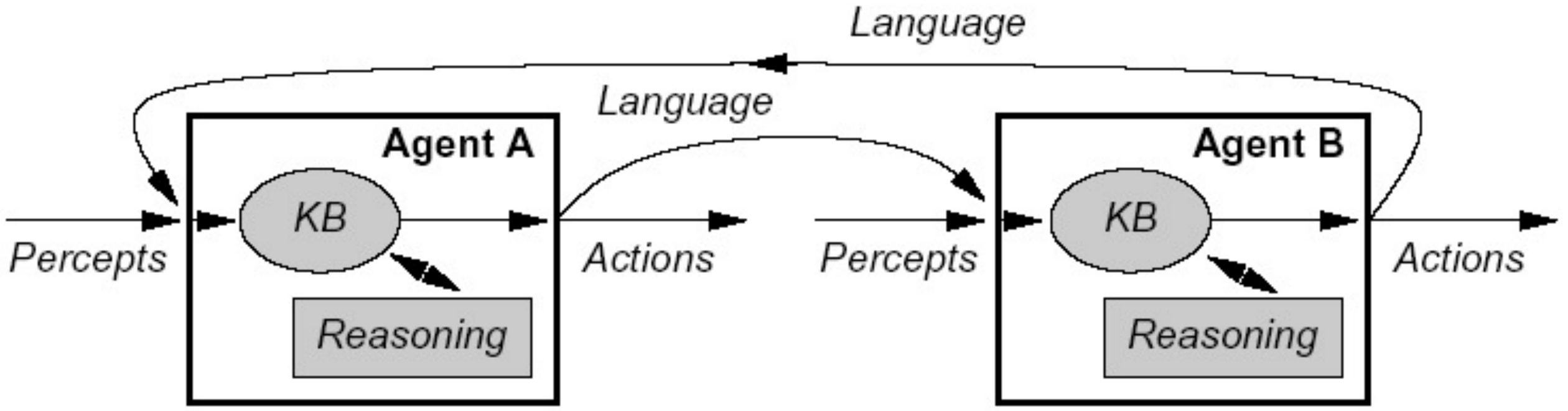
- telepathic communication
  - speaker and listener have a shared internal representation
  - communication through Tell/Ask directives
- language-based communication
  - speaker performs actions that produce signs which other agents can perceive and interpret
  - communication language is different from the internal representation
  - more complex
    - involves several mappings
    - language needs to be generated, encoded, transmitted, decoded, and interpreted

Telepathic Communication



[Russell & Norvig 1995]

Language-Based Communication



[Russell & Norvig 1995]

Communication Steps: Speaker

- intention
  - decision about producing a speech act
- generation
  - conversion of the information to be transferred into the chosen language
- synthesis
  - actions that produce the generated signs

Communication Steps: Listener

- perception
  - reception of the signs produced by the speaker
    - speech recognition, lip reading, character recognition
  - analysis
    - syntactic interpretation (parsing)
    - semantic interpretation
- disambiguation
  - selection of the most probable intended meaning
- incorporation
  - the selected interpretation is added to the existing world model as additional piece of evidence

Communication Example

SPEAKER

Intention:

$Know(H, \neg\ Alive(Wumpus, S_3))$

Generation:

"The wumpus is dead"

Synthesis:

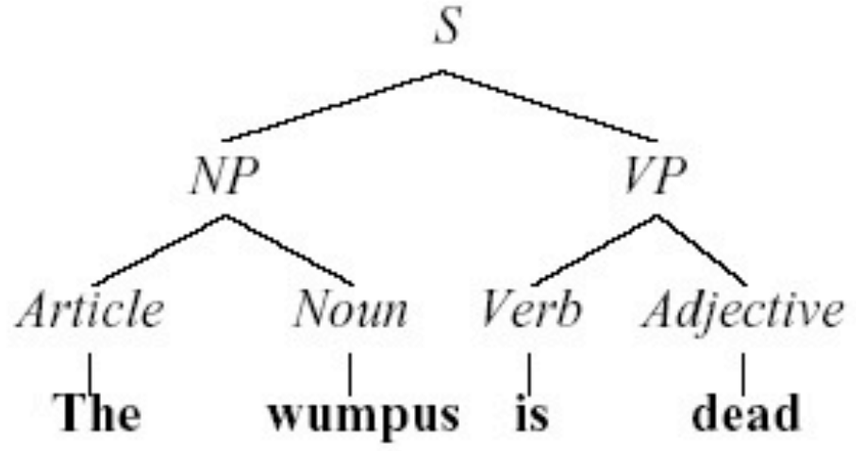
[thaxwahmpahsihzdeyd]

HEARER

Perception:

"The wumpus is dead"

Analysis:
(Parsing):



(Semantic Interpretation): $\neg\ Alive(Wumpus, Now)$
$Tired(Wumpus, Now)$

(Pragmatic Interpretation): $\neg\ Alive(Wumpus, S_3)$
$Tired(Wumpus, S_3)$

Disambiguation:

$\neg\ Alive(Wumpus, S_3)$

Incorporation:

$TELL(\ KB,$
$\neg\ Alive(Wumpus, S_3))$

[Russell & Norvig 1995]

Knowledge Exchange Perspectives

Different Perspectives

- Roles
- Scope
- Purpose

Roles

- knowledge creator
  - source of the knowledge
- knowledge facilitator
  - supports the exchange of knowledge between creator and user
- knowledge user
- sender
  - initiates and conducts the transmission of knowledge
  - may be creator or facilitator
- recipient
  - typically the knowledge user

Scope of Knowledge Exchange

- number of people involved
  - individuals, groups, organizations, humanity
- coherence
  - domain knowledge, educational background, intellectual ability, familiarity with the environment, ...
- spread
  - geographical distribution

Individuals

- informal
- direct communication
- quick feedback
- low persistence tolerable
- clarification easy
- consistency issues easy to resolve

Groups

- informal
- direct communication
- coordination and synchronization required
- moderate persistence desirable
- clarification via discussion

Organization

- more formal repositories, exchange methods; systematic communication, coordination and synchronization necessary; persistence important; more structured approaches to clarification and consistency beneficial

Community

- formal “body of knowledge”
  - well-structured, reasonably controlled vocabulary, established repositories of knowledge, procedures for validation (“peer review”)
- established exchange methods
  - journals, official publications, books, conferences, portals
- professional organizations with controlled memberships
  - established communication, coordination, and synchronization methods

Humanity

- no coherent “body of knowledge”
- communication, coordination, and synchronization of knowledge exchange across boundaries is difficult
- differences in vocabulary, methods, knowledge validation processes make exchange of knowledge difficult
- serious problems with clarification, resolution of inconsistencies are possible

Purpose

- personal enrichment
- better product
- better working conditions
- commercial advantage
- stronger community
- societal benefits

Knowledge Distribution

Distribution of Knowledge

- Knowledge Repositories
  - Digital Libraries
- Distribution Models

Knowledge Repositories

- persistent storage of digital documents
  - internal representation in the original format
    - loss-less transformation may be acceptable
- transparent internal organization
  - multiple presentation methods for various users and usage methods
- multiple access methods
  - according to users' needs and capabilities

Wikipedia

- collaborative effort to capture knowledge
- contributions by volunteers
  - not restricted to “experts”
- liberal policy for entry modifications
  - editorial policies to limit abuse

Scientific American “Edit This”

- public is invited to comment on some articles before they are published
  - see “Science 2.0: Great New Tool, or Great Risk?” as an example
    - http://www.sciam.com/article.cfm?id=science-2-point-0-great-new-tool-or-great-risk&page=1

Google Knols

Educational Repositories

- Open Course Ware Initiative
- Connexions
- Merlot

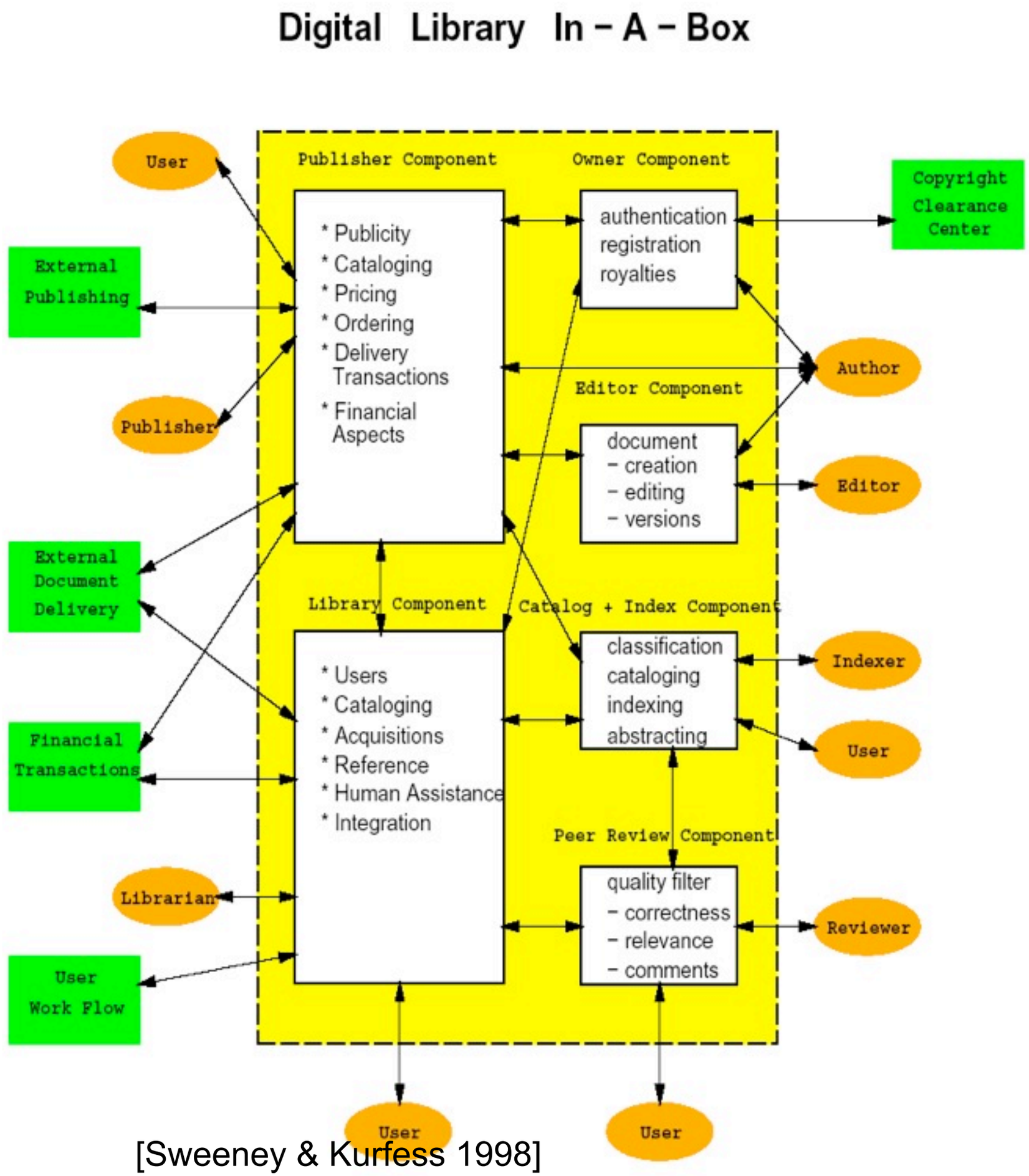
General Repositories

- Instructables.com
- Slideshare.com
- Blogs
- Youtube and similar sites

Digital Libraries

- collections of documents and artifacts stored and accessed via computers
- remotely accessible through networks
- enhanced functionality compared with paper-based libraries
  - access methods
  - organization principles
  - duplication
- implementation and usage unclear

Digital Library In-A-Box



[Sweeney & Kurfess 1998]