Facilitating cross-language retrieval and machine translation by multilingual domain ontologies

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Outline

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Objective

To show how can ontologies be used to improve the multilingual access to domain specific information.

Eurogene

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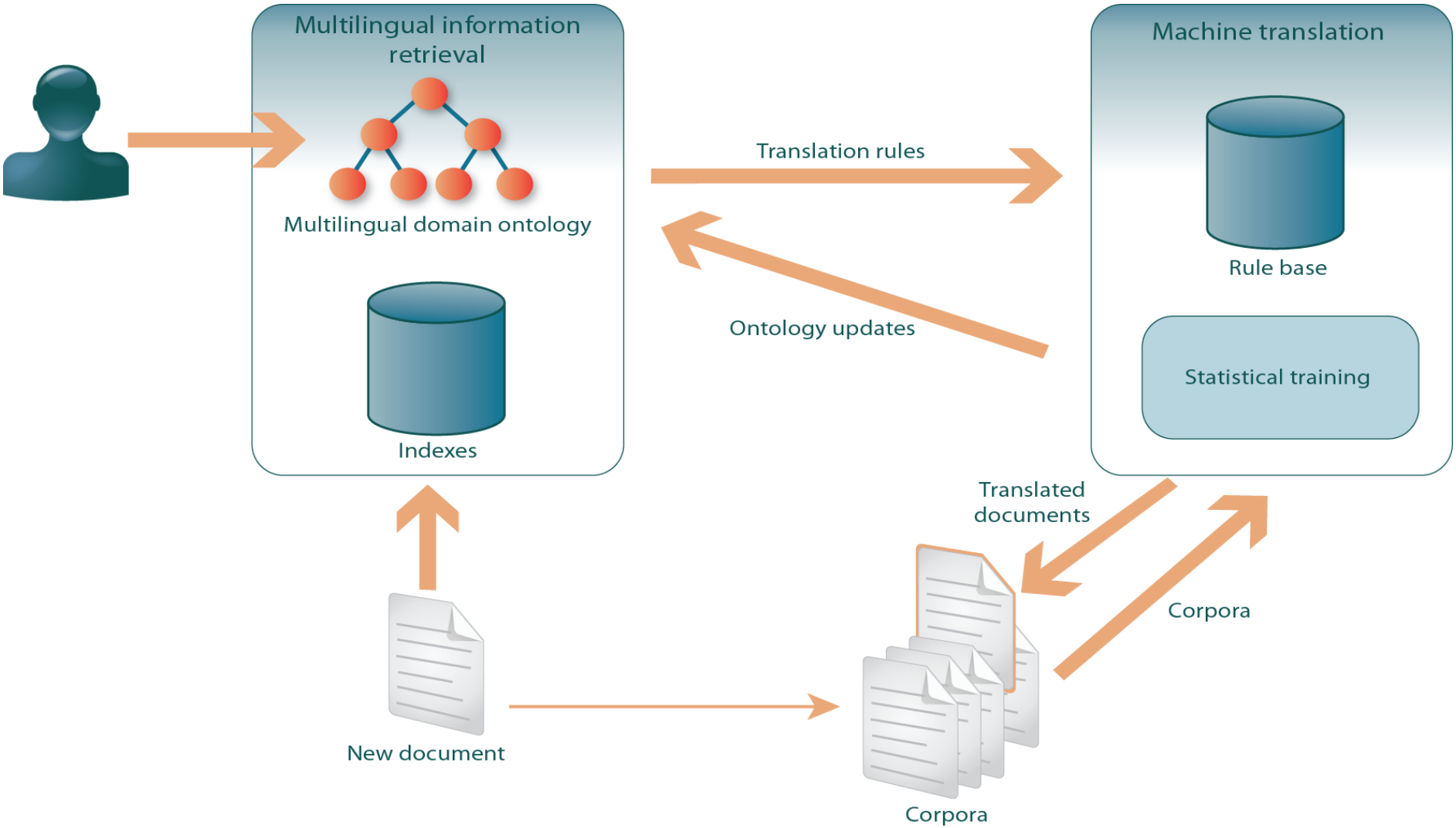
- Architecture for accessing and sharing multilingual resources is one of the project subgoals (KMI & Systran).
  - *Cross-language information retrieval (CLIR)*
  - *Machine translation (MT)*.
  - Both should be synchronized for terminology.

Outline

Architecture



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We are using approach 1(a) because:

- Multilingual ontologies are well-suited for domain CLIR.
- Multilingual ontologies can also be used to adapt MT to the target domain.
- Parallel corpora in specific domains often not initially available.

Synergy of CLIR and MT

Method has two phases:

- *initialization* phase
  - Development of a *seed* monolingual ontology - reuse of an existing ontology or by using ontology learning methods (Cimiano and Völker, 2005, Sclano and Velardi 2007).
  - Extension of the ontology to multiple languages.

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- *bootstrapping* phase
  - Adaption of the MT dictionaries (hybrid MT system required).
  - Adaption of the multilingual ontology.

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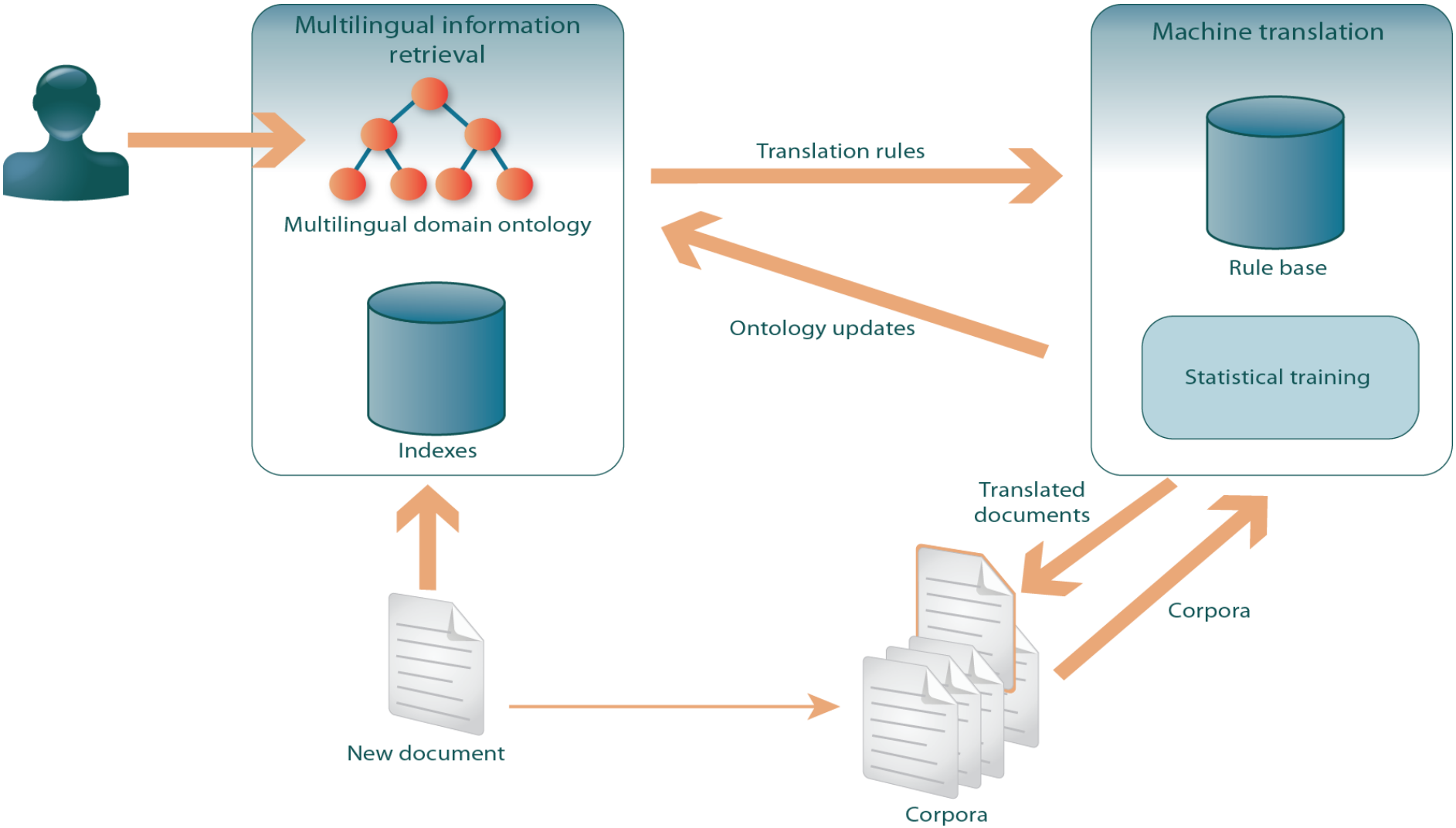


Monolingual ontology

A monolingual ontology is a 4-tuple $O = \langle C, T, E, f \rangle$:

- C is a set of concepts.
- T is a set of terms (representations of concepts).
- E is a set of oriented relations (*is-a* relations), such that $\langle C, E \rangle$ is a directed acyclic graph.
- $f : T \rightarrow C$ is a surjective function from terms to concepts.

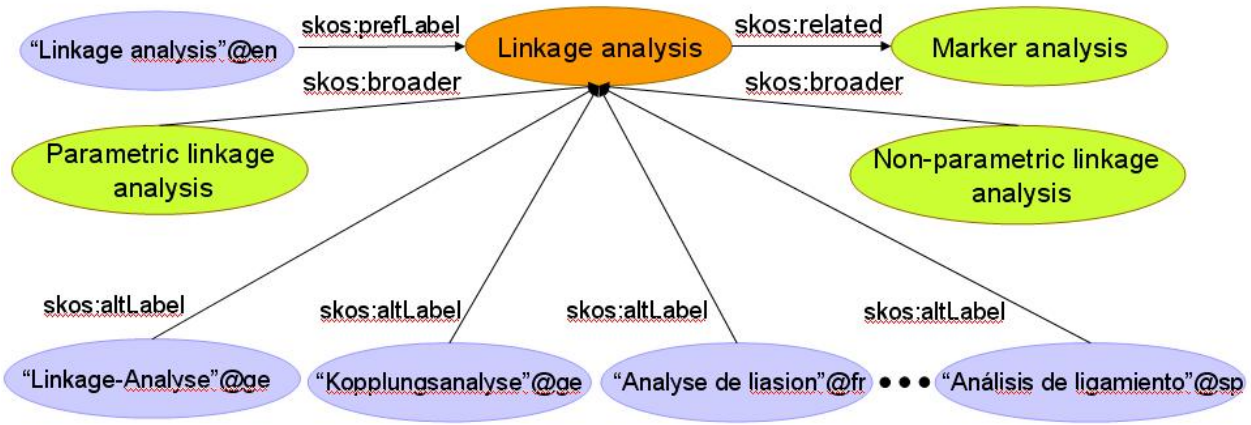
Multilingual ontology

A *multilingual ontology* is a 6-tuple $O' = \langle C, T, E, f, L, lang \rangle$

- A monolingual ontology $O = \langle C, T, E, f \rangle$
- L is the set of languages.
- $lang : T \rightarrow L$ is a mapping from terms to languages.

Multilingual ontology - example

- Lightweight ontology
- SKOS-like representation



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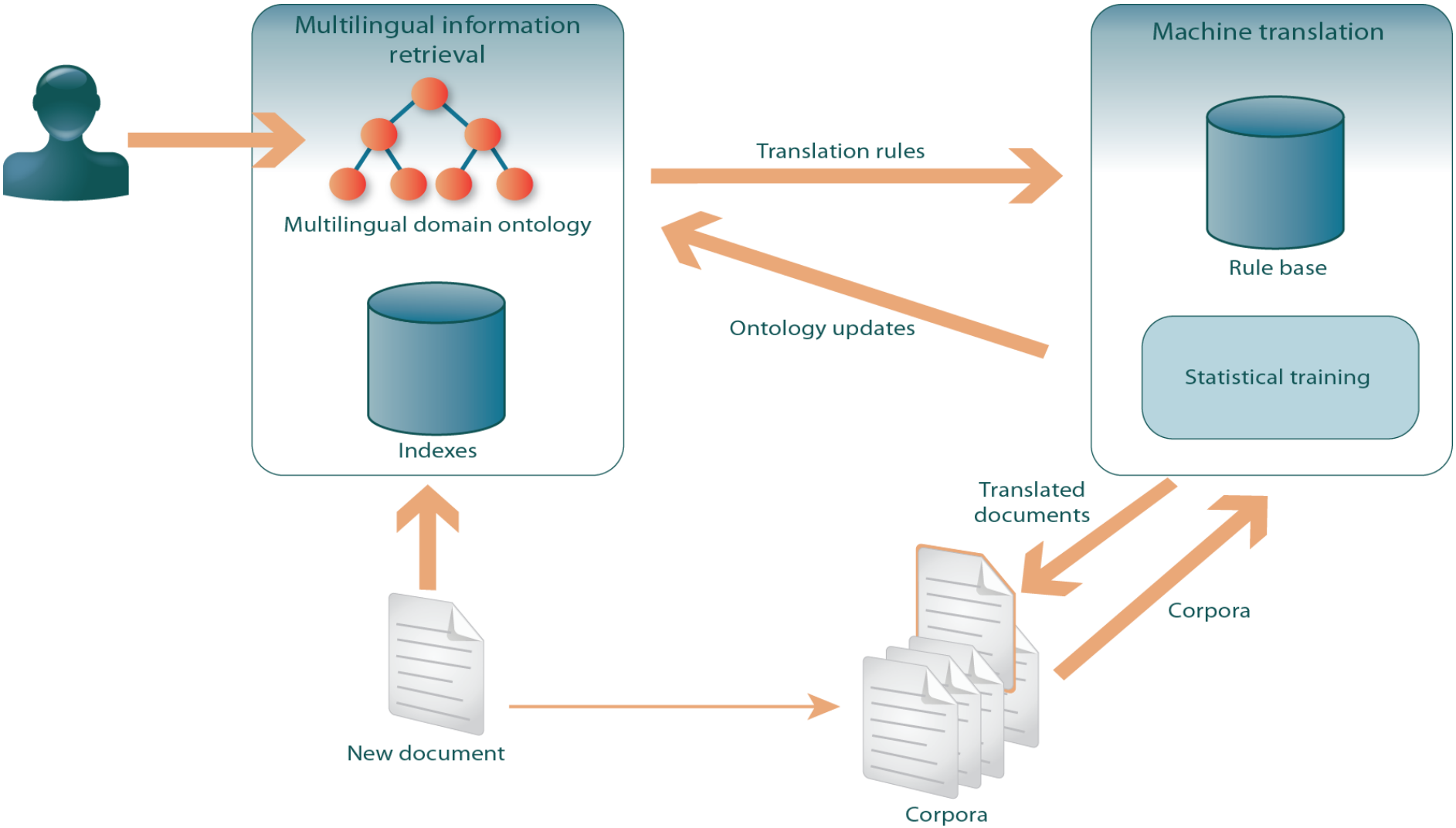

Bootstrapping phase - MT improvement step

The MT system is adapted to a specific domain:

- Using bilingual substitution rules of form: $t_{L_1} \rightarrow t_{L_2}$ extracted from the multilingual ontology.
- Rules satisfy the condition $f(t_{L_1}) = f(t_{L_2})$, where $t_{L_1} \in T_{L_1}, t_{L_2} \in T_{L_2}$ and T_{L_n} is defined as $T_{L_n} = \{t | lang(t) = L_n\}$.
- Flattening the ontological structure and deriving pairs for all supported combinations.

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Example

linkage analysis$_{en}$ $\rightarrow$ Kopplunganalyse$_{de}$
analyse de liasion$_{fr}$ $\rightarrow$ Analisis de ligamiento$_{sp}$

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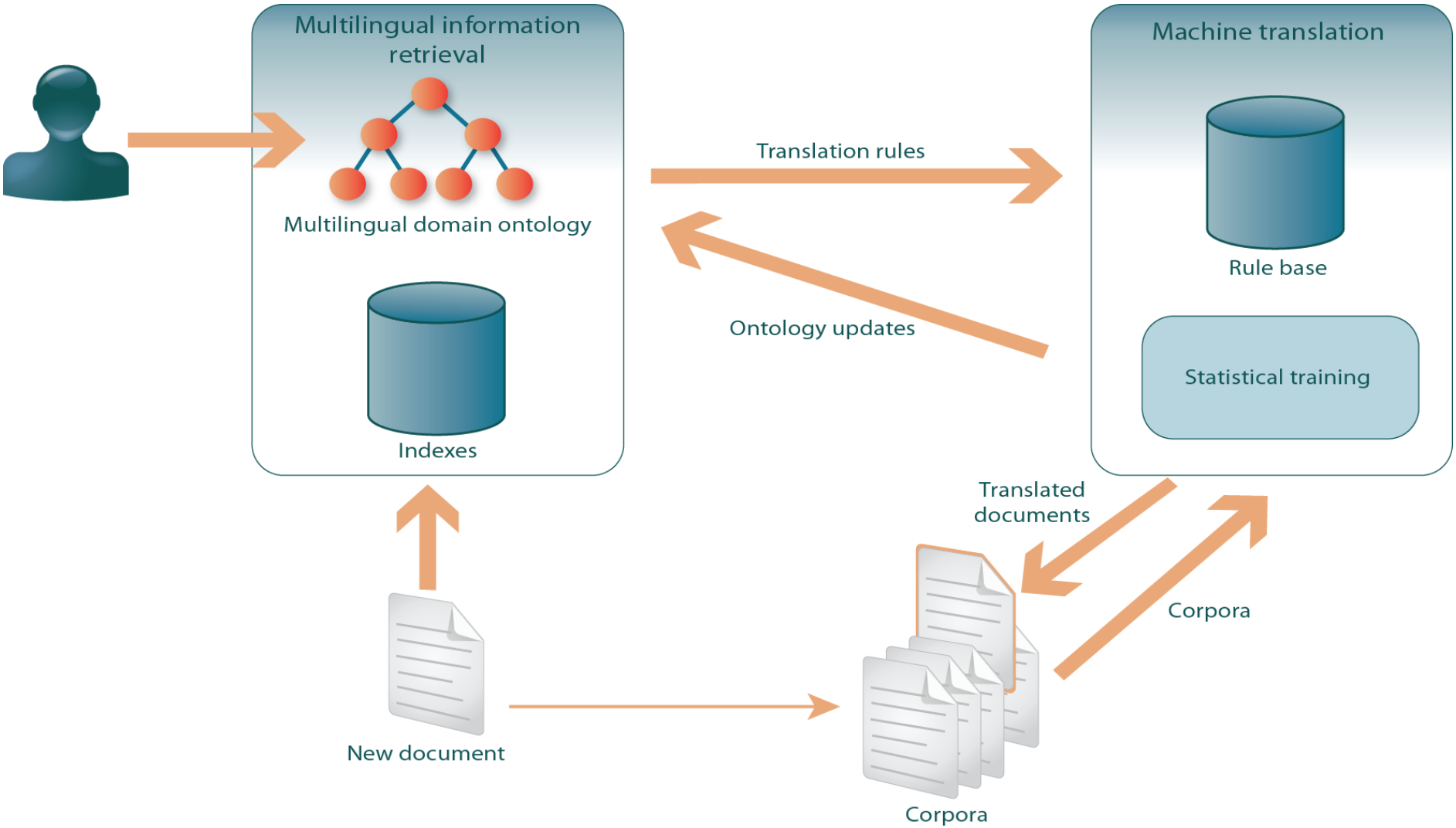

Bootstrapping phase - Ontology refinement

- Content grows over time.
- New parallel texts can be automatically recognized (Resnik, 2003) and used by the machine translation system for training.
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The ontology is adapted by rules of form $(t_{L_1}, t_{L_2}, conf, lang_q)$ produced as an output of the statistical phase.

- *conf* is the confidence measure of translating term t_{L_1} to t_{L_2} estimated from text.
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Example

$\langle \text{indirekte DNA-Analyse}_{de}, \text{linkage analyse}_{en}, 0.85 \rangle$

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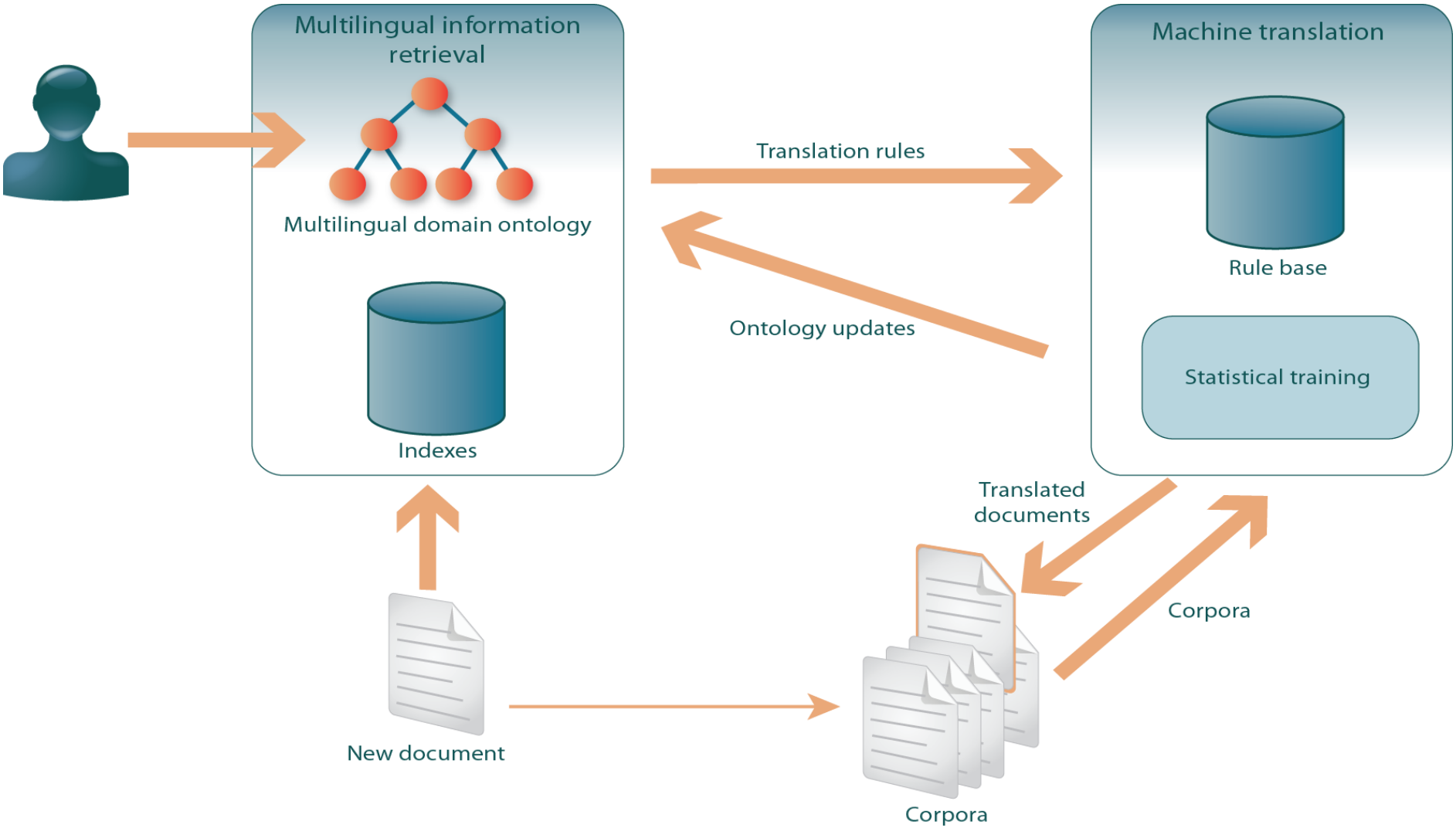

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  - Annotation
  - CLIR
  - Query expansion
  - Navigation across content in multiple languages (semantic similarity)
  - MT
- Statistics:
  - About 20,000 files (papers, presentations, videos, images)
  - About 15,000 ontological terms.
  - Nine languages (English, French, Spanish, German, Greek, Italian, Dutch, Czech, Lithuanian).
- `http://eurogene.open.ac.uk/`

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Properties of the approach

- Performance of both CLIR and MT should never decrease as a result of any bootstrapping iteration.
- Two steps where an error may be introduced:
  - The update of the MT rule base.
  - The update of the multilingual ontology.

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- Performance of both CLIR and MT should never decrease as a result of any bootstrapping iteration.
- Two steps where an error may be introduced:
  - The update of the MT rule base.
  - The update of the multilingual ontology.
- Evaluation - many components involved:
  - Coverage and specificity of the ontology.
  - Amount of domain corpora available.
  - Performance of the statistical training.
  - Validity of human judgements.
  - Other factors ...

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- Can be used as a synchronization component for domain adaption of CLIR and MT systems.
- The solution is easily readable and adjustable by humans.
- Publishing of multilingual ontologies on the Web in a standard format may allow an application to decide which domain ontology to use for query expansion and for adaption of the MT system based on the context of the query.

Discussion

Thank you for attention !