Informatics Applied to Medicine:

Some Challenges Related to Knowledge Extraction from Medical Data Bases

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LABI Laboratório de Bioinformática unioeste

Outline

- Informatics and Health
- Research Institutions in Brazil
- Artificial Intelligence in Medicine
- Knowledge Extraction from Data Bases
- Data Pre-processing
- Data Mapping
- Concluding Remarks

Informatics and Health

- **Informatics:** the study of information processing; computer science;
- The name “Health Informatics” only came into use around 1973;
- But it is as old as the healthcare itself;
- Has grown considerably in recent years, mainly by advances in computer technology.

Health Informatics – HI

- Bioinformatics;
- Biomedical Informatics;
- Computational Biology;
- Bioengineering – BE.

Health Informatics

- Bioinformatics;
- Biomedical
- Computatio
- Bioenginee

The use of computers in solving information problems (manipulation of data and knowledge) in the life sciences.

Health Informatics

- Bioinformatics;
- Biomedical Informatics;
- Computational Biology;
- Bioengineering – BE.

Health Informatics

- Bioinformatics;
- Biomedical Informatics;
- Computatio
- Bioenginee

• Construction of support systems to the biomedical area in general;

• Use of information technology in health care and education.

Health Informatics

- Bioinformatics;
- Biomedical Informatics;
- Computational Biology;
- Bioenginee

Application of computers to solve problems in biology, mainly on molecular biology and biological modeling and simulation.

Health Informatics

- Bioinformatics;
- Biomedical Informatics;
- Computational Biology;
- Bioengineering – BE.

• Development of instruments and new methods in biomedical area.

• The application of engineering principles to the fields of biology and medicine, as in the development of aids or replacements for defective or missing body organs.

Health Informatics

- Information Systems;
- Protocol-based Systems;
- Communication Systems;
- Internet;
- Intelligent Clinical Decision Support.

Research Institutions – HI

- USP/São Carlos
  - Laboratório de Inteligência Computacional – LABIC;
  - Escola de Engenharia – EESC;
  - Instituto de Física – IFSC.
- Unicamp
  - Instituto de Computação – IC;
  - Núcleo de Informática Biomédica – NIB;

Research Institutions – HI

- USP/SP
  - Instituto de Química – IQ;
  - Instituto de Matemática e Estatística – IME.
- UFRGS
  - Laboratório de Bioinformática – LabBioInf.
- UFSC
  - Departamento de Microbiologia e Parasitologia – MIP;
  - Departamento de Informática e Estatística – INE.

Research Institutions – HI

- UTFPR
  - Laboratório de Bioinformática – BIOINFO.
- Unioeste
  - Laboratório de Bioinformática – LABI.

Research Institutions – BE

- UNICAMP
  - Departamento de Engenharia Biomédica – DEB;
  - Centro de Engenharia Biomédica – CEB.
- UFMG
  - Laboratório de Bioengenharia – LABBIO.
- UFRJ/COPPE
  - Programa de Engenharia Biomédica – PEB

Research Institutions – BE

- UFSC
  - Instituto de Engenharia Biomédica – IEB.
- USP/São Paulo
  - Laboratório de Engenharia Biomédica – LEB.

Artificial Intelligence in Medicine

- In the beginning – expectation:
  - Electronic brain;
  - “Doctors in a box”;
  - Artificial Intelligence in Medicine: revolutionize medicine and push forward the frontiers of technology;
  - Computer scientists and healthcare professionals: MIT, Pittsburgh, Stanford e Rutgers.

Artificial Intelligence in Medicine

- Today – more realistic vision:
  - No “stand alone” systems;
  - Integration with electronic patient record systems;
  - Reduction of the barriers to the effective application of these systems;
  - Approximation with the healthcare professionals and fitting into the process of care.

Artificial Intelligence in Medicine

- Today – more realistic vision:
  - Support healthcare process as a whole (assisting with tasks that rely on manipulation of data and knowledge):
    - Daily tasks;
    - Decision support;
    - Knowledge extraction (scientific research).

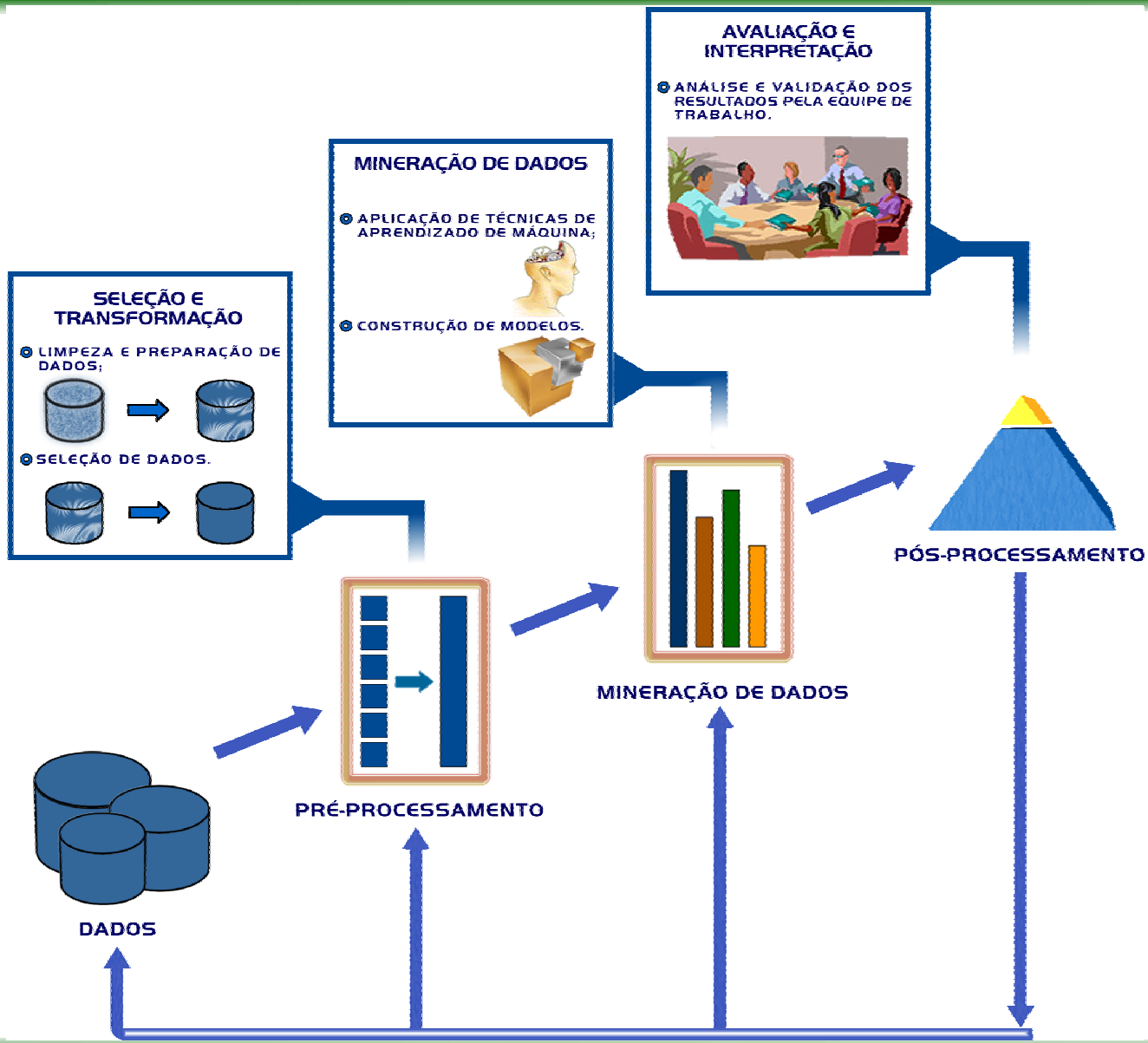
Artificial Intelligence in Medicine

- Some applications:
  - Alerts and reminders;
  - Diagnostic assistance;
  - Therapy critiquing and planning;
  - Information retrieval;
  - Image recognition and interpretation.

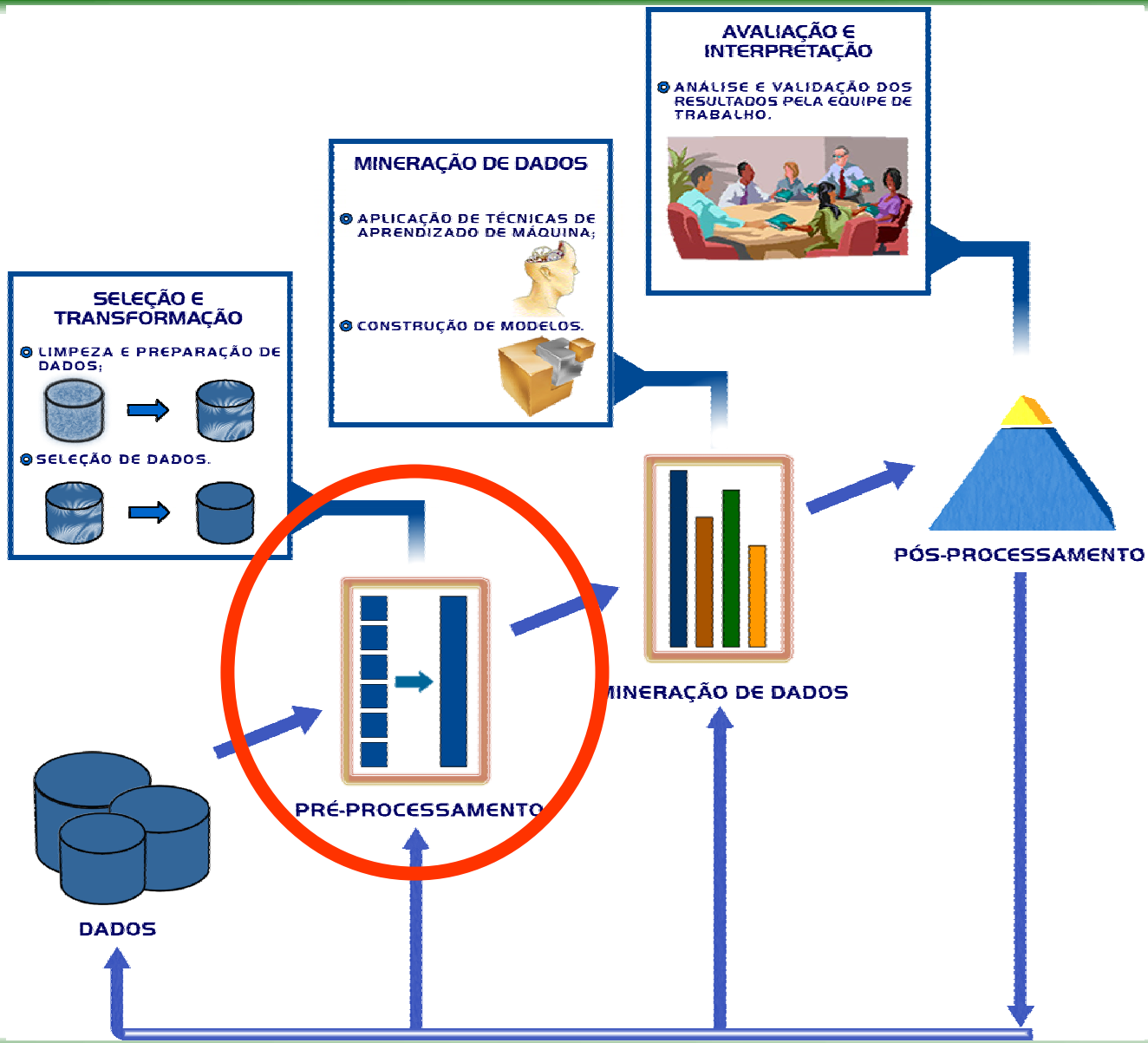
Artificial Intelligence in Medicine

- Barriers to the larger application of these systems:
  - Failure to fit naturally into the routine process of care;
  - Focus on problems that were not perceived as an issue;
  - Poor interface;
  - Imposition of changes in the way healthcare professionals work;
  - Most institutions and practices do not yet have all their working data available electronically.

Knowledge Extraction From Data Bases



Knowledge Extraction From Data Bases



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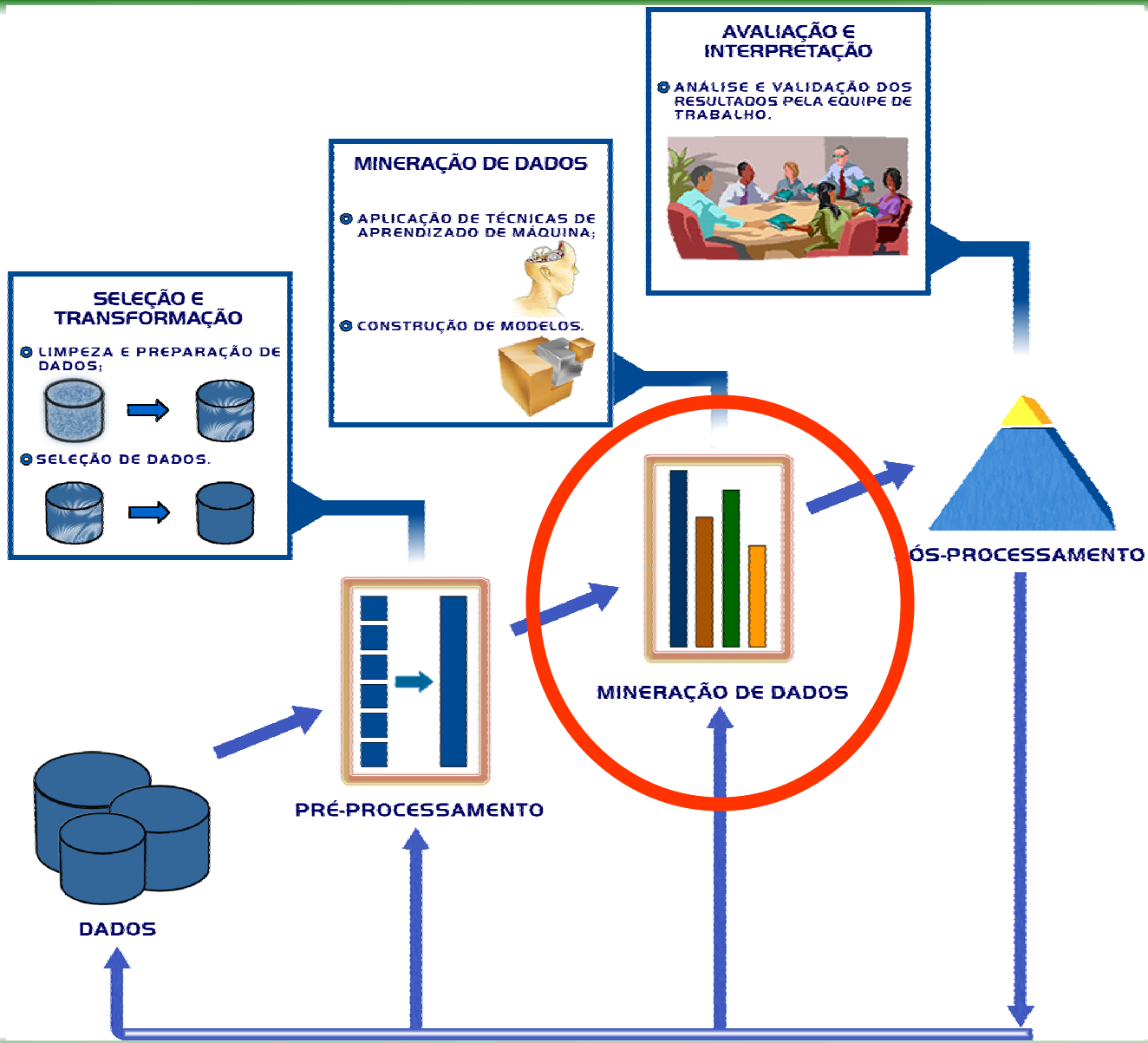

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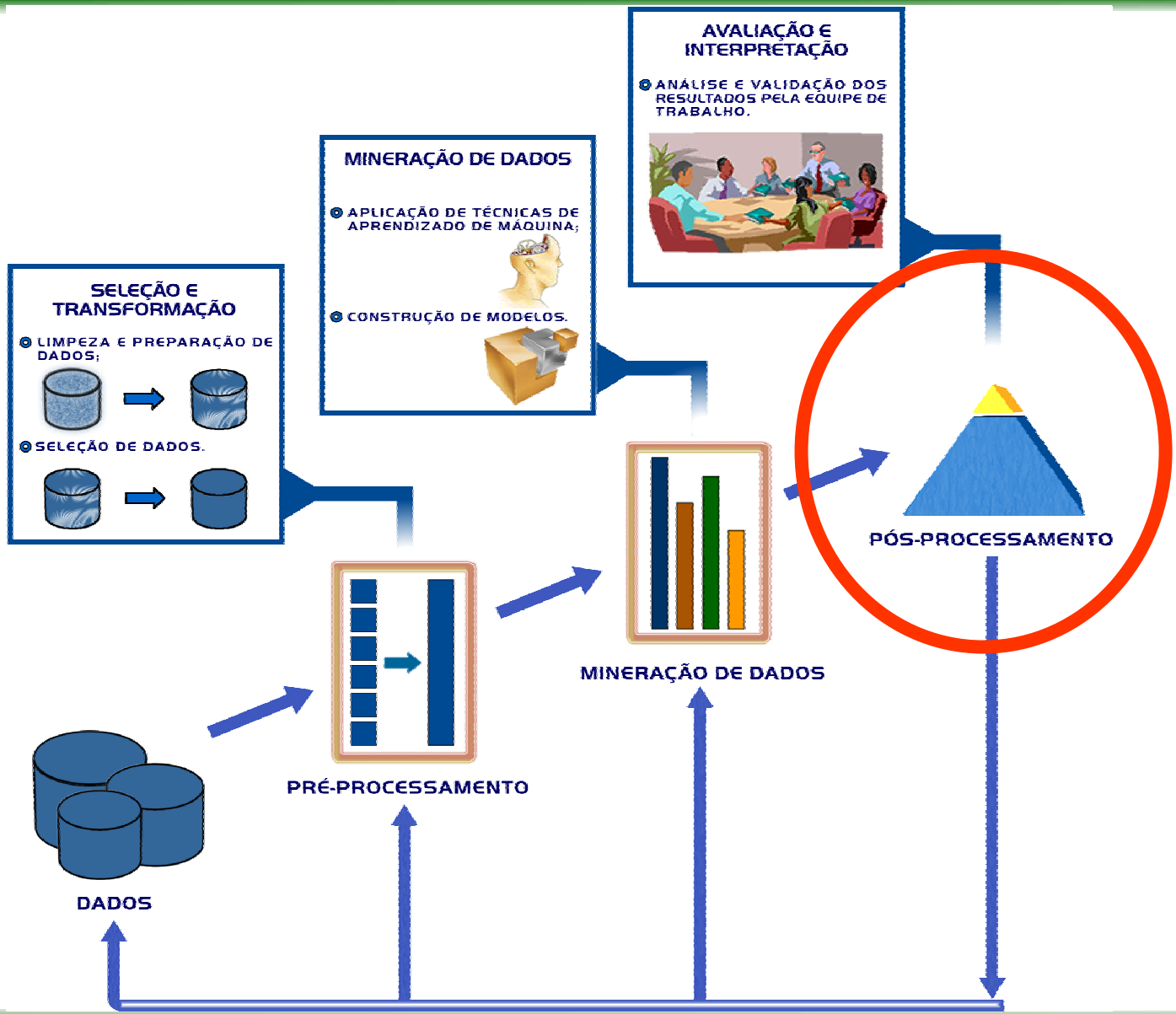

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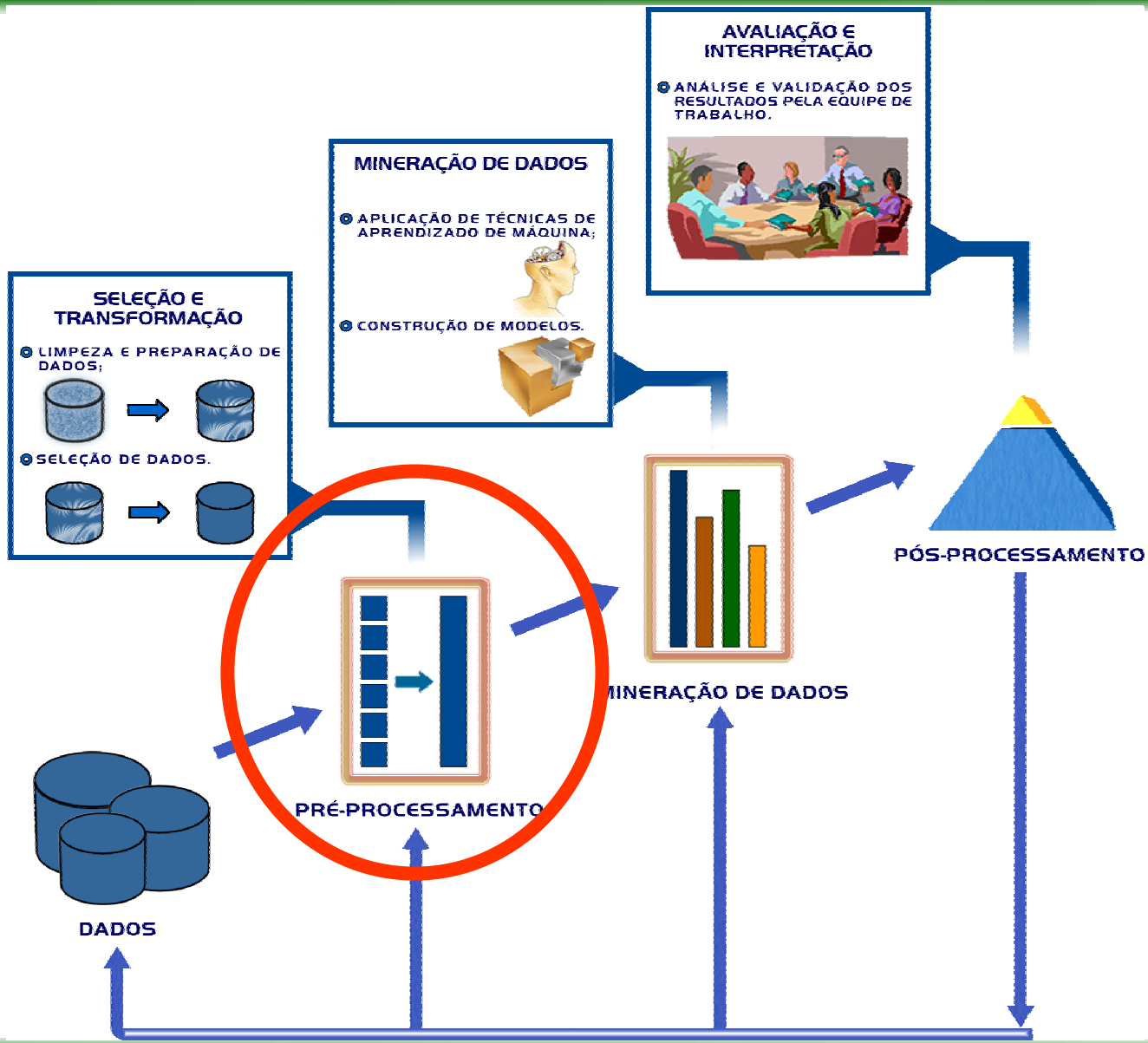

Pre-processing of Data

- Usually, it is the most time consuming phase;
- Several tasks are performed:
  - Selection of examples and features;
  - Cleansing of data;
  - Transformation of data.

Pre-processing of Data

- In the medical area, it is frequent the representation of data using unstructured medical findings and forms described in “natural language”;
- There is a need of mapping these data (interpretation and transforming) to more appropriated formats;
- Expensive and subjective process.

Mapping of Data (Medical Findings)

1. Identification of patterns to construct a Dictionary;
2. Mapping of information contained in the findings to the structured data base.

Mapping of Data
(Medical Finding – Construction of the Dictionary)

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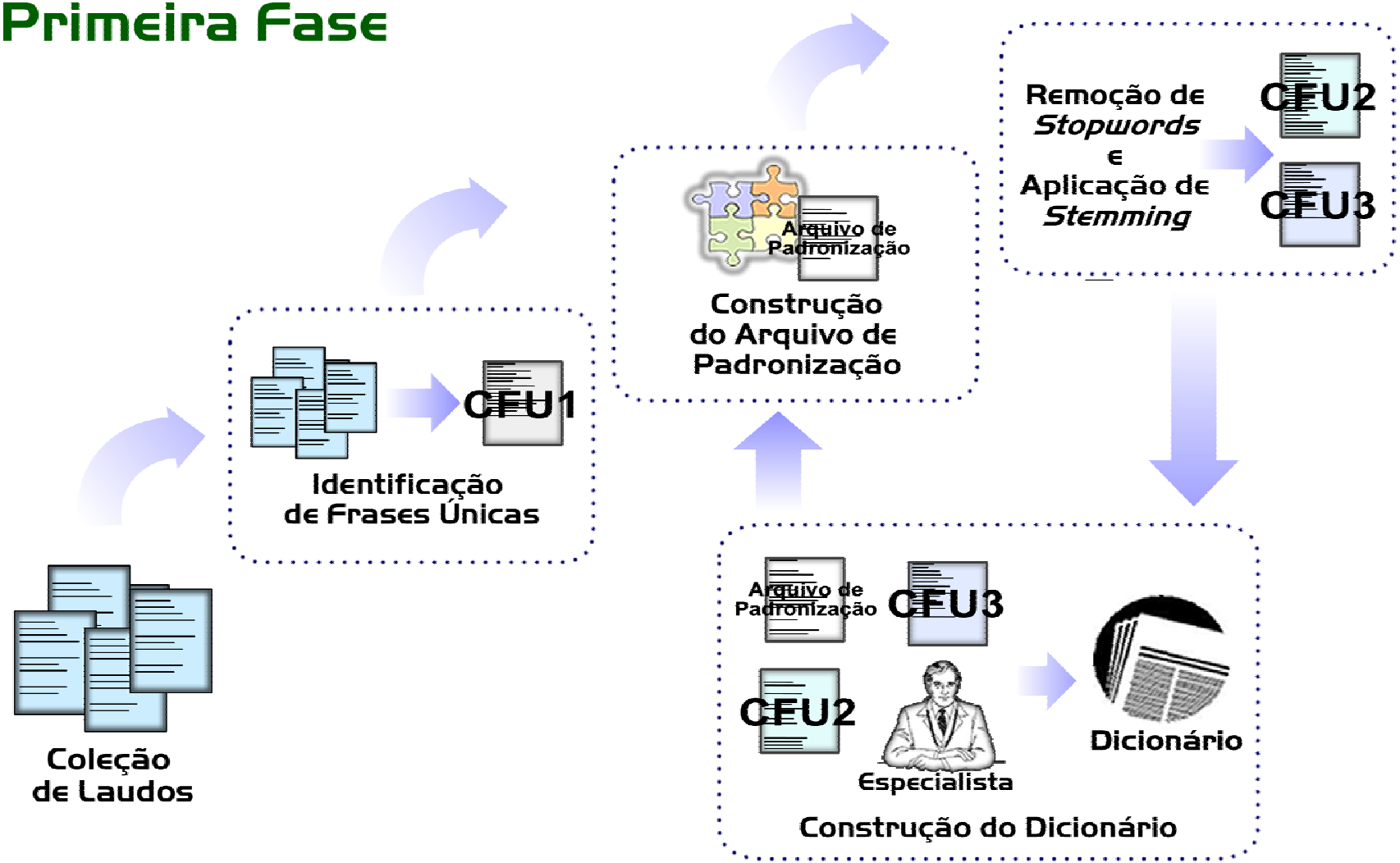
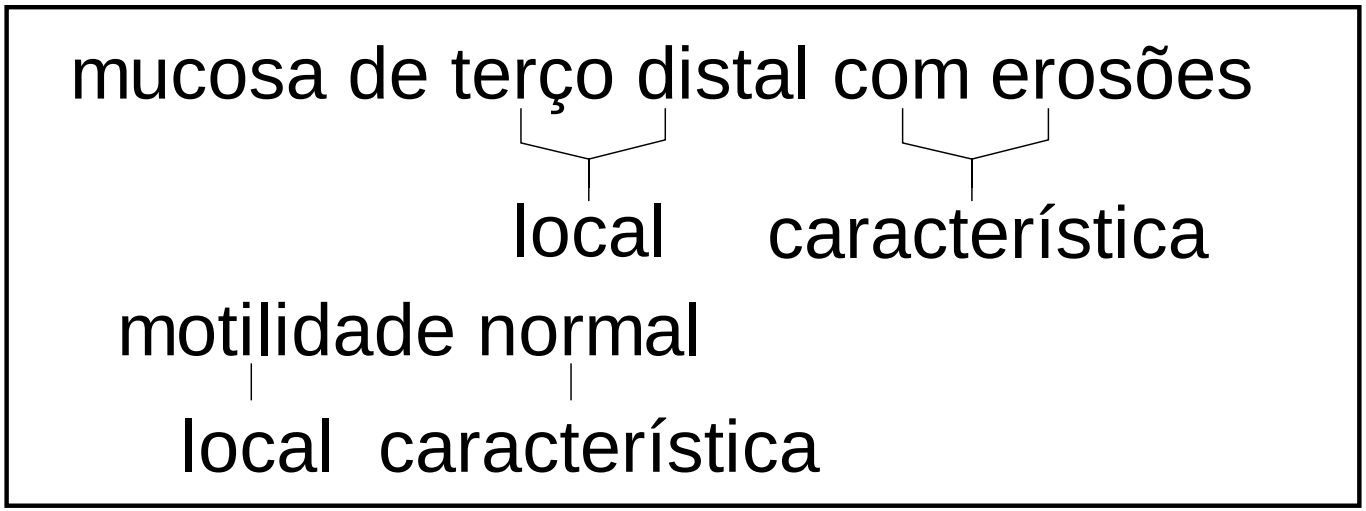
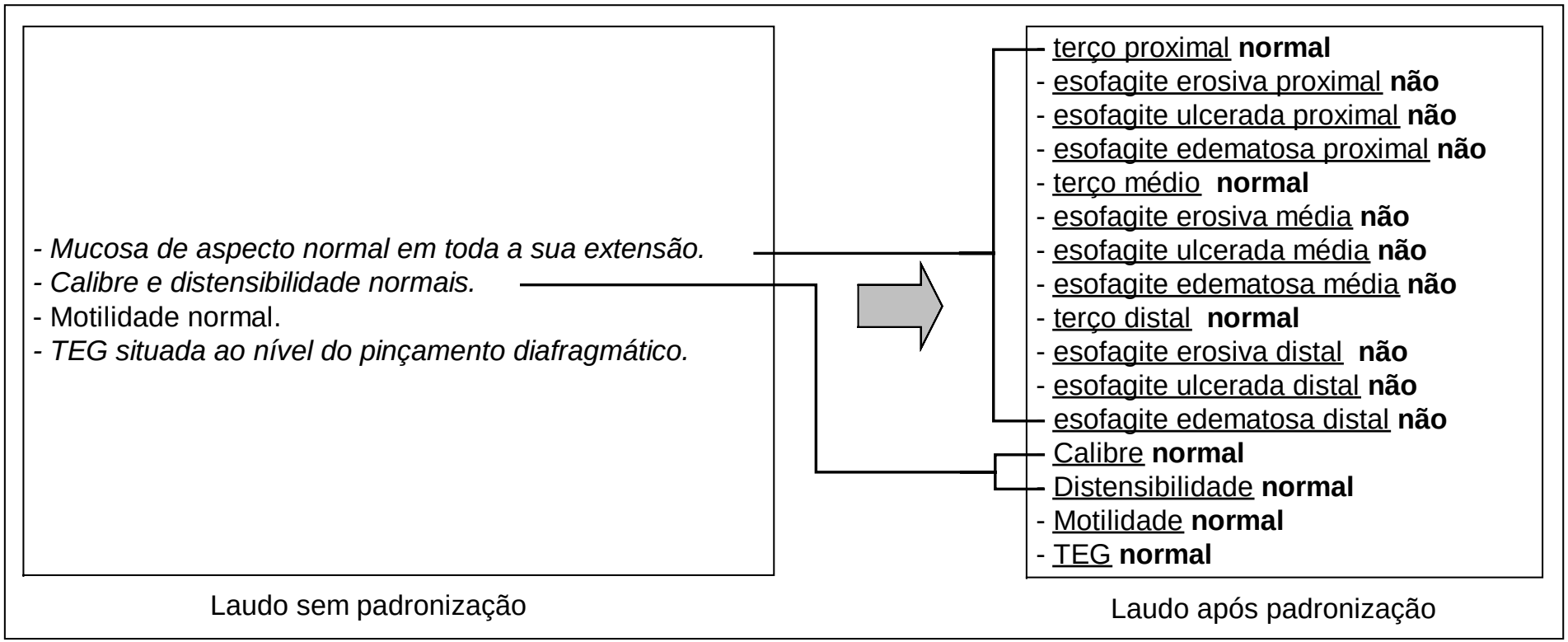
Primeira Fase



Mapping of Data
(Medical Finding – Construction of the Dictionary)



Mapping of Data
(Medical Finding – Construction of the Dictionary)



Mapping of Data
(Medical Finding – Mapping to the Data Base)

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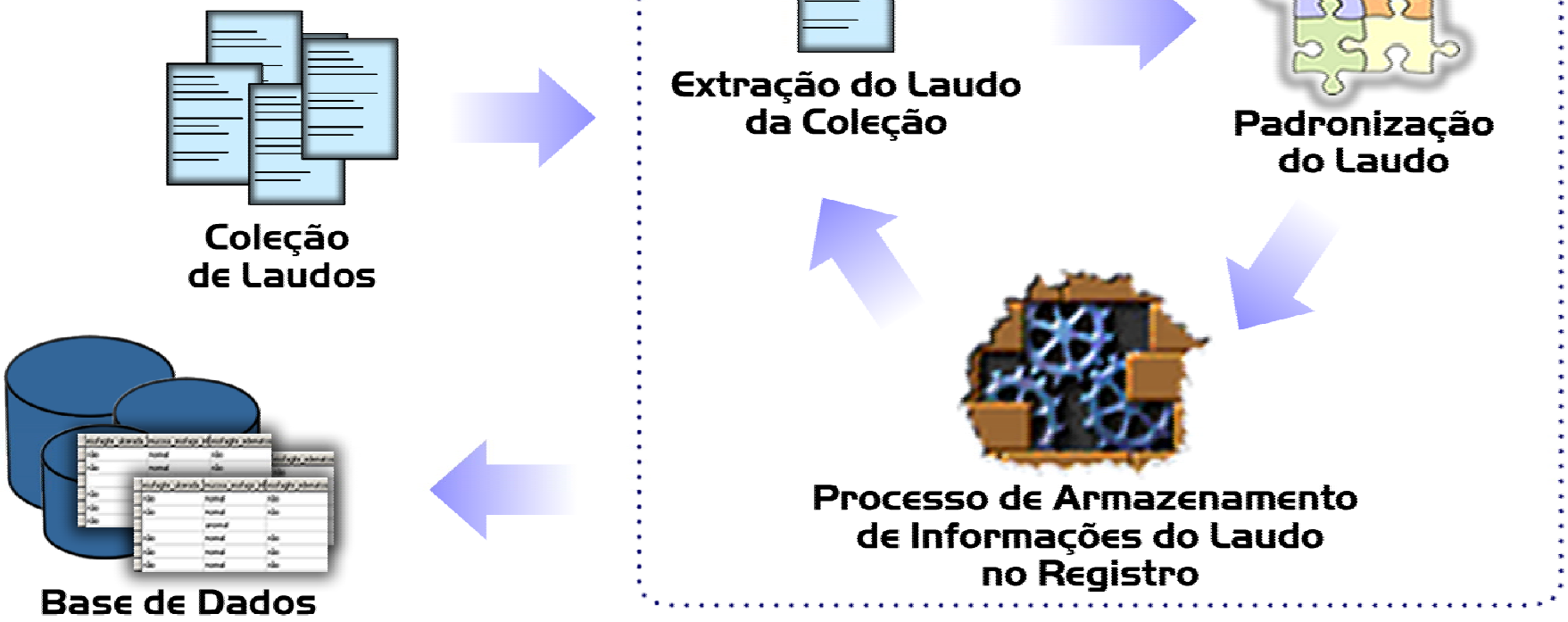
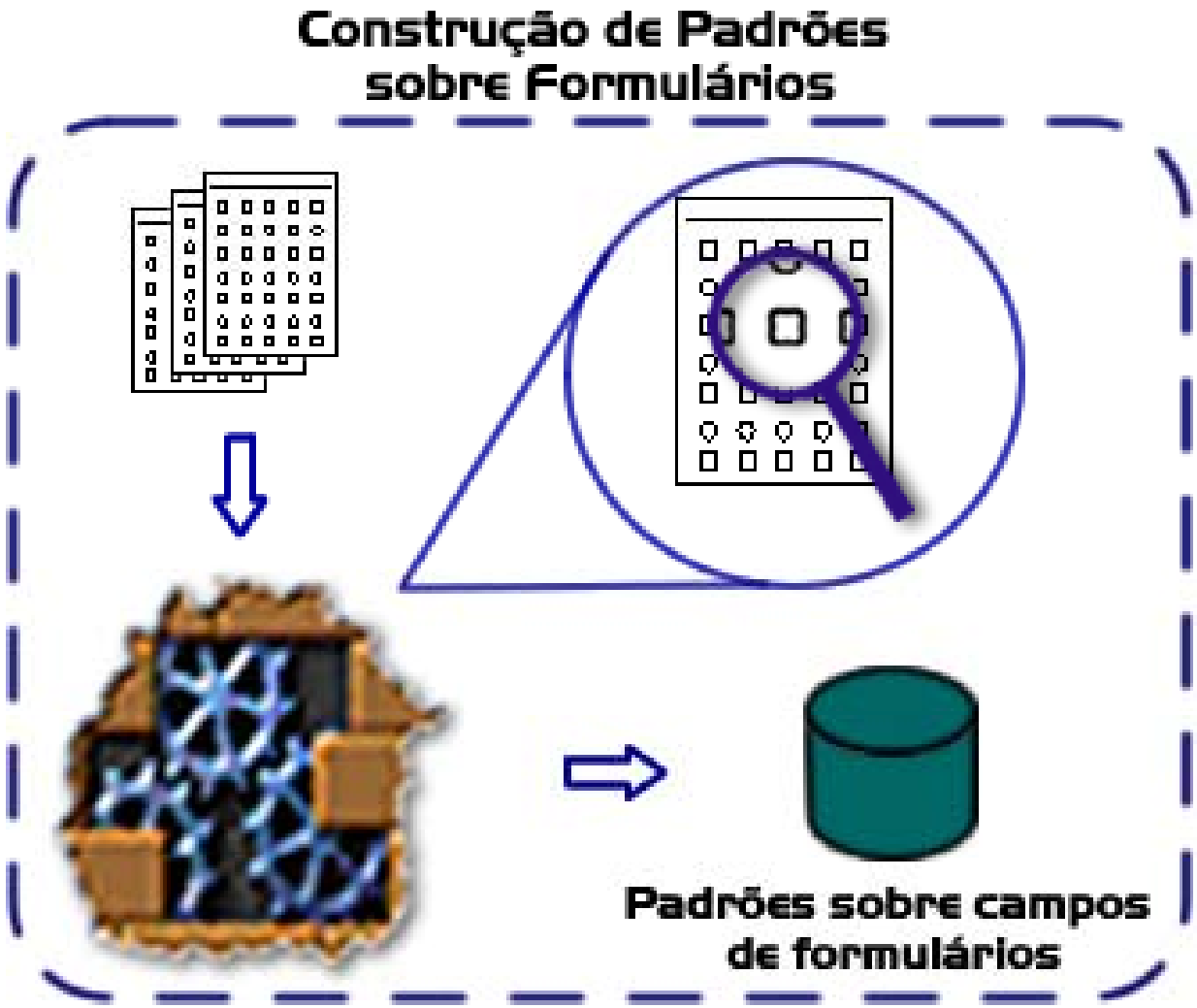
Segunda Fase



Mapping of Data (Medical Forms)

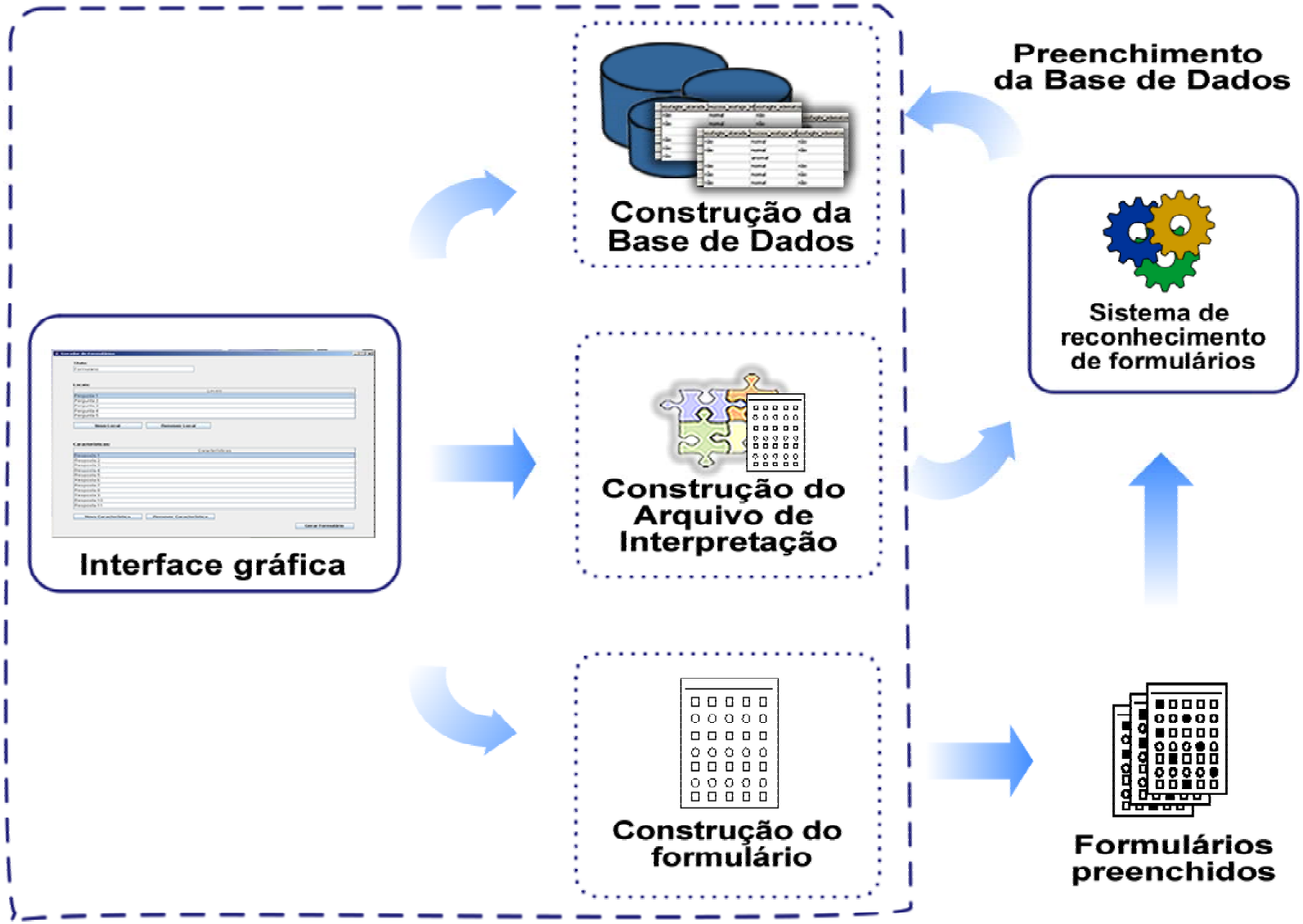
- Mapping of data:
  - Constructions of patterns about the forms;
  - Mapping of the information at the fulfilled forms to the data base.
- Generation of medical forms and construction of data bases.

Mapping of Data (Medical Forms)

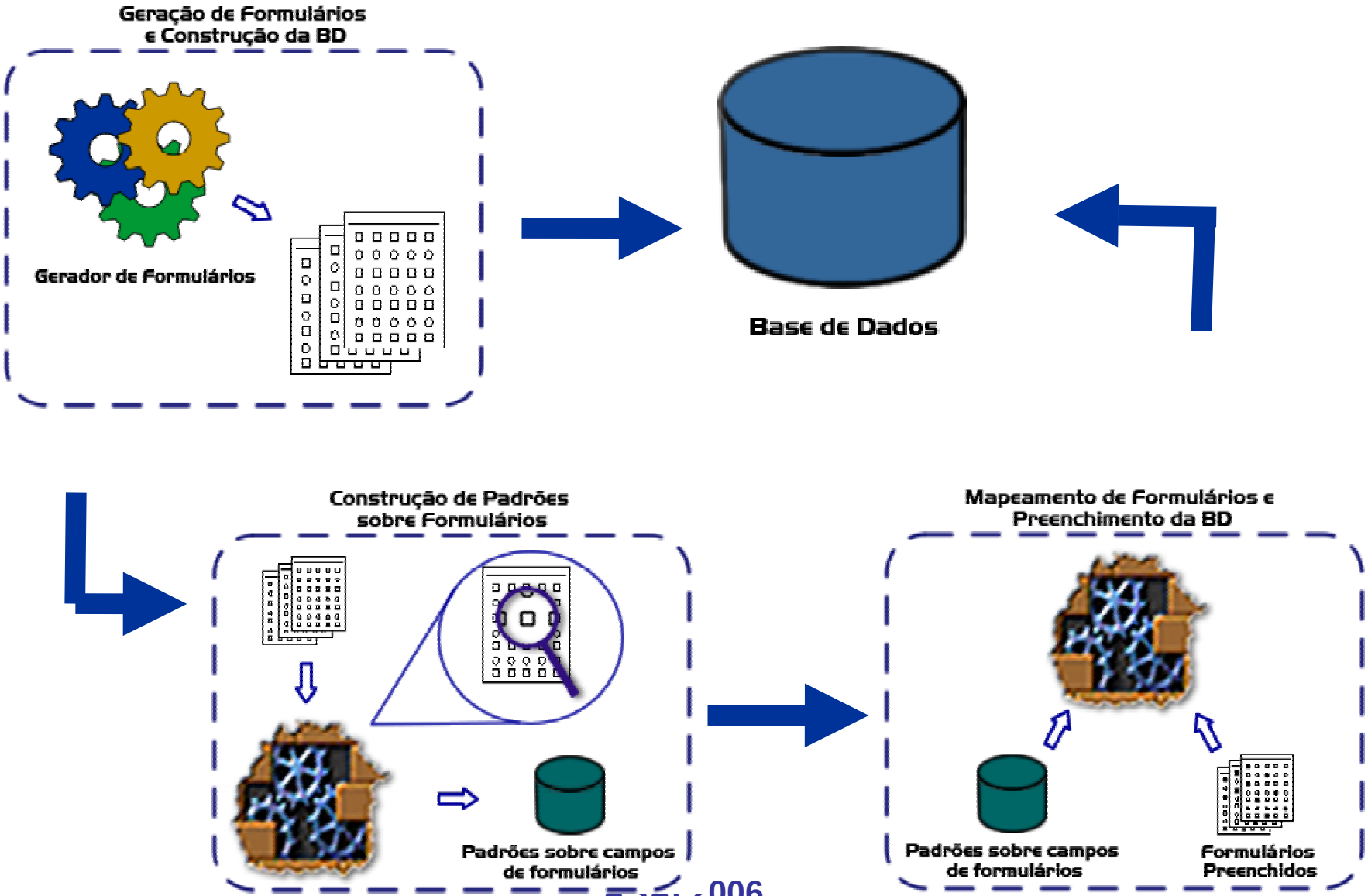


Mapping of Data (Medical Forms)

Mapping of Data (Forms Generation)



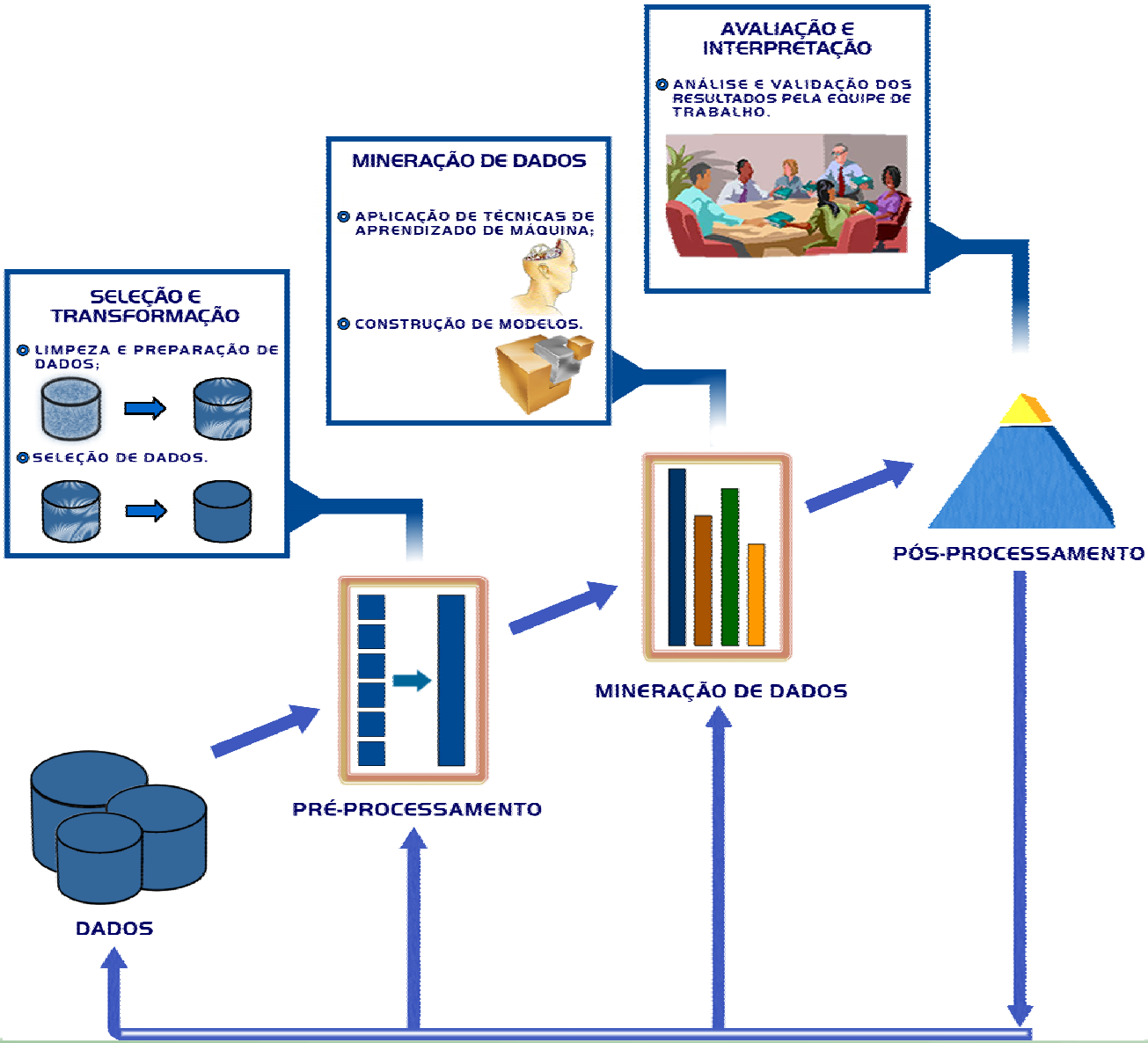
Mapping of Data (Medical Forms)



Mapping of Data

- Medical findings:
  - High Digestive Endoscopies;
  - Semen Processing;
  - Colonoscopies.
- Medical forms:
  - Crohn Disease.

Knowledge Extraction From Data Bases



- Clinical Genome;
- Digestive System Diseases (Crohn e Peptic Diseases);
- Semen Processing;
- Ovarian Hyper-stimulation;
- Concretee Biodeterioration.

Concluding Remarks

- Many AI systems are in use:
  - Acute care settings;
  - Clinical laboratories;
  - Educational institutions;
  - Incorporated into electronic medical record systems.
- Need for a cooperated effort between computer science and healthcare areas;

Concluding Remarks

- Identify issues of interest for both areas;
- Perception of the benefits of using such systems; otherwise, independent of its true value, it will be probably rejected;
- Natural fit into the the process of care;
- Evaluation of systems and extracted knowledge.

"All men naturally desire knowledge."

~ Aristotle ~

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