



## Study Plan

**School:** Institute for Advanced Studies and Research

**Degree:** Doctorate

**Course:** Computer Sciences (cód. 264)

### 1st Year - 1st Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
INF9258D	Introduction to Scientific Research	Informatics	12	Semester	312

### Group of Options

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
INF9259D	Distributed information systems / System interoperability and integration	Informatics	6	Semester	156
INF9260D	Semi Structured Databases and Networked Ontologies	Informatics	6	Semester	156
INF9261D	Information Extraction and Question Answering systems for Textual Bases	Informatics	6	Semester	156
INF9262D	Intelligent Control and Decision	Informatics	6	Semester	156
INF9263D	Automatic Classification and Kernel Methods	Informatics	6	Semester	156
INF9264D	Knowledge Representation and Reasoning in Natural Language Processing Systems	Informatics	6	Semester	156
INF9265D	Parallel Execution for Declarative Programming	Informatics	6	Semester	156
INF9266D	Advanced Techniques on Constraint Programming	Informatics	6	Semester	156

### 1st Year - 2nd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
INF9267D	Qualifying Test	Informatics	6	Semester	156
Thesis					

### 2nd Year - 3rd Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
INF9268D	PhD Seminar I	Informatics	6	Semester	156
Thesis					

### 2nd Year - 4th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
INF9269D	PhD Seminar II	Informatics	6	Semester	156
Thesis					

### 3rd Year - 5th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
INF9270D	PhD Seminar III	Informatics	6	Semester	156
Thesis					

### 3rd Year - 6th Semester

Component code	Name	Scientific Area Field	ECTS	Duration	Hours
INF9271D	PhD Seminar IV	Informatics	6	Semester	156
Thesis					



## Conditions for obtaining the Degree:

\*\*\* TRANSLATE ME: Para aprovação na componente curricular deste programa de doutoramento é necessário a aprovação (através de avaliação ou creditação) das seguintes unidades curriculares:

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1º Semestre {\}newline

- 1 UC Obrigatórias num total de 12ECTS {\}newline

- 3 UC's Optativas num total de 18 ECTS do conjunto de optativas disponíveis no plano de estudos deste curso {\}newline

2º Semestre {\}newline

-1 UC Obrigatória num total de 6ECTS {\}newline

2º Ano {\}newline

3º Semestre: {\}newline

-1 UC Obrigatória num total de 6ECTS {\}newline

4º Semestre {\}newline

-1 UC Obrigatória num total de 6ECTS {\}newline

3º Ano {\}newline

5º Semestre: {\}newline

-1 UC Obrigatória num total de 6ECTS {\}newline

6º Semestre: {\}newline

-1 UC Obrigatória num total de 6ECTS {\}newline

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Para obtenção do grau, é necessário a aprovação na tese num total de 120 ECTS. \*\*\*

## Program Contents

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### **Introduction to Scientific Research (INF9258D)**

Scientific method: theory, observations, formal validation, experimental validation.

Scientific Communication: information lookup, indexes, writing articles, quoting work.

Professional ethics.

Peer Review: principles, variants.

Workshop on free subjects: as author, as member of the PC.

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### **Distributed information systems / System interoperability and integration (INF9259D)**

Concepts and paradigms of distribution/integration;

Levels of integration: semantic, architectural, technological;

Distributed/integrated architectures ;

Distributed/integrated technology;

Reference models: virtual data bases, function based, message based, portal based, wfl based;

Fragmentation: interfaces, databases, processes;

On the fly access; access via replicas, replica updates;

Distributed transactions protocols;

Gateways and middleware;

Security;

Standardization;

Heterogeneous systems;

Legacy systems;

Common, reusable services;

Hiperdistributed systems;

Case studies;

Methods of assessing solutions;

Frameworks and tools



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### **Semi Structured Databases and Networked Ontologies (INF9260D)**

Week Topic

- 1 Introduction, XML
- 2 Data Model and Introduction to XML Schema
- 3 Advanced XML Schema
- 4 XML Namespace, Document Engineering
- 5 Ontologies in computer science and informatics
- 6 XPATH, Introduction to XSLT
- 7 Designing Semistructured Databases: A Conceptual Approach
- 8 Ontologies, dictionaries, thesauri, and coding schemes
- 9 XML in Relational DB
- 10 Ontology annotation and mapping
- 11 Database for Scientific Applications
- 12 Interactive Query and Search in Semistructured Databases
- 13 Temporal modelling and management of normative documents in XML format

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### **Information Extraction and Question Answering systems for Textual Bases (INF9261D)**

1. Basic concepts: document collections, information extraction, text mining, question-answer systems.
2. Question-answer systems evaluation. Standard measures - precision, recall, f-measure - and conferences: QA @ CLEF, TREC QA.
3. NLP symbolic approaches: lexicon, syntax, semantics, pragmatics, ontologies.
4. Statistical approaches: extraction of information through automatic learning techniques.
5. Hybrid approaches.
6. Case Studies: automatic ontology population, semantic tagging - "semantic role labeling", automatic summarization, question-answer systems.

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### **Intelligent Control and Decision (INF9262D)**

- 1 Introduction
- 2 Signals and Systems Theory
  - 2.1 Discrete and continuous time signals. AD and DA conversion.
  - 2.2 Discrete and continuous time systems. Linear systems.
  - 2.3 Time domain and frequency domain representations.
  - 2.4 Fourier transform, Laplace transform and Z transform.
  - 2.5 Stability. Filter design
- 3 Systems Modelling and Simulation
  - 3.1 Physical modelling.
  - 3.2 Estimation and system identification
  - 3.3 Numerical methods for continuous time systems simulation.
  - 3.4 Discretization.
- 4 Decision and Control Systems
  - 4.1 Linear and nonlinear control systems.
  - 4.2 Adaptive control, fuzzy control, rule based control.
  - 4.3 Linear and nonlinear filtering.
- 5 Pattern recognition
  - 5.1 Failure detection and diagnosis.
- 6 Practical use of artificial intelligent techniques and machine learning.



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### **Automatic Classification and Kernel Methods (INF9263D)**

- The Machine Learning approach to the classification problem
- Review of the methods to evaluate and compare classification algorithms
  - Cross-validation and other estimators, error measurement and hypothesis testing
- Review of classification algorithms paradigms
  - decision trees, covering algorithms (rules), Bayesian learning, instance-based learning, linear models
- Kernel methods
  - input space and feature space, the kernel technique, kernel families
- Kernel functions for the vector space and structured data
  - polynomial and RBF kernels
  - convolution kernels: strings, trees and graphs
- Support vector machines
  - maximum margin hyperplane, support vectors, soft margin optimization
- Applications
  - text classification, image and writing recognition, bioinformatics

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### **Knowledge Representation and Reasoning in Natural Language Processing Systems (INF9264D)**

Conceptual maps and semantic networks.

Descriptive propositional logic.

Formalization of Knowledge Bases.

Ontologies.

Descriptive logic and databases.

Time and causality.

Semantic Web and OWL.

Lexical analysis.

Parsing and Logic grammars (DCGs, XGs), tags, and HPSGs CFG.

Semantic Analysis: DRT, Compositionality and other semantics.

Pragmatic Analysis: Theory of acts of speech, anaphora resolution, dialogue. Natural Language Processing Applications.

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### **Parallel Execution for Declarative Programming (INF9265D)**

- Computational models for Logic Programming
- Parallel Logic Programming: OR-parallelism, independent and dependent AND-parallelism, table parallelism
- Constraint Programming: distributed constraint satisfaction, parallel constraint solving
- Applications



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### **Advanced Techniques on Constraint Programming (INF9266D)**

Introduction  
Constraint Satisfaction Problems  
over Integers, Real and Booleans  
Constrained Optimization Problems  
Local Consistency notions  
Node, Arc, Hyper-Arc  
Directional Arc-consistency  
Path Consistency  
Directional Path Consistency  
k-consistency  
Strong k-consistency  
Constraint Propagation Algorithms  
Generic Iteration algorithms  
Consistency algorithms  
Implementation of incomplete constraint solvers  
Search  
Search trees  
Labeling trees  
Forward Checking  
Partial look ahead  
Maintaining arc consistency  
Search algorithms for labeling trees  
Backtrack free search  
Search algorithms for finite constrained optimization problems  
Heuristics for search algorithms  
Issues in Constraint Programming  
Modeling  
Choosing the right: variables, constraints and representation  
Global constraints  
Constraint Programming languages  
Constraint Propagation  
Constraint Solvers  
Building constraint solvers  
incrementality  
Simplification of constraints  
Search

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### **Qualifying Test (INF9267D)**

n/a

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### **PhD Seminar I (INF9268D)**

N/A

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### **PhD Seminar II (INF9269D)**

(same as for Seminário Doutoral I)



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**PhD Seminar III (INF9270D)**

(same as for Seminário Doutoral I)

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**PhD Seminar IV (INF9271D)**

(same as for Seminário Doutoral I)