e-Planning, Urban Science & Digital Transition

Knowledge Representation & Artificial Intelligence in Planning

2012-2023

Pedro Ferraz de Abreu

UL - UA - UNL

MIT - DUSP 11.S955 (grad) & 11.S189 (undergrad)

UL-UA-UNL Joint PhD Program on e-Planning

Artificial Intelligence in Planning

The Nature and Limits of A.I.

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Artificial Intelligence in Planning

The Nature and Limits of A.I.

- What is Artificial Intelli gence
- Introduction to Gödel and Tarski Theorems
- Towards an e-Planning Theory of Complexity
- How can AI help / hurt ... and be regulated

Artificial Intelligence in Planning

What is Artificial Intelligence

- What is Intelligence
- Turing Test, Eliza , Asimov Laws paradox
- Mycin expert system and accountability paradigm *1972 - Stanford*
- Minsky's robot & common sense knowledge paradigm
- Mental processes and Body exponentiation

  3 "schools" of AI: Stanford , Carneggie Mellon, MIT

Artificial Intelligence in Planning

What is Artificial Intelligence

3 "schools" of AI: Stanford , Carneggie Mellon, MIT

- Stanford: Predicate calculus, Logic, Deduction / Induction

- Carneggie Mellon: Expert Systems, Taxonomy, Lenat's common sense

- MIT: Psychology, Brain cognitive science, micro-worlds and Piaget

Artificial Intelligence in Planning

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Artificial Intelligence in Planning

Gödel Theorem - Incompleteness

Theorem 1. Any recursively enumerable axiomatic theory, capable of expressing basic truths of arithmetic cannot be, at the same time, **complete** and **consistent**. In other words, in a consistent theory, there are always prepositions that cannot be demonstrated to be either true or false.

Theorem 2. A recursively enumerable theory, capable of expressing basic truths of arithmetic and statements of ***proof theory,*** can prove its own **consistency** if, and only if, it is **inconsistent.**

Tarski Theorem - Undefinability

Tarski's undefinability theorem, stated and proved by Alfred Tarski in 1936, is an important limitative result in mathematical logic, the foundations of mathematics, and in formal semantics. Informally, the theorem states that *arithmetical truth cannot be defined in arithmetic*.

The theorem applies more generally to any sufficiently strong formal system, showing that truth in the standard model of the system cannot be defined within the system.

Artificial Intelligence in Planning

Gödel Theorem - Incompleteness

Can human-made AI overtake human Intelligence?

If Gödel Theorem applies - No.

Tarski Theorem - Undefinability

Can Humans design & create a Super-Human Species?

If Tarski Theorem applies - No.

Artificial Intelligence in Planning

Gödel Theorem - Incompleteness

Tarski Theorem - Undefinability

Then, How do we know if these theorems apply?

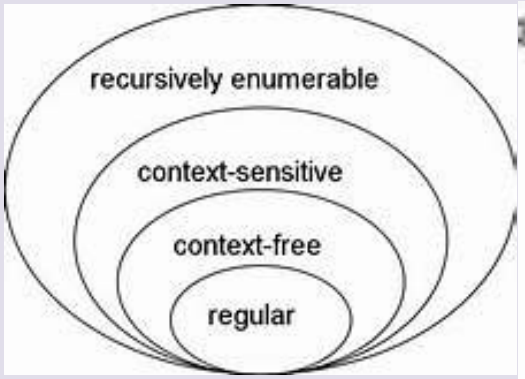
In other words, are we within the boundaries of validity?

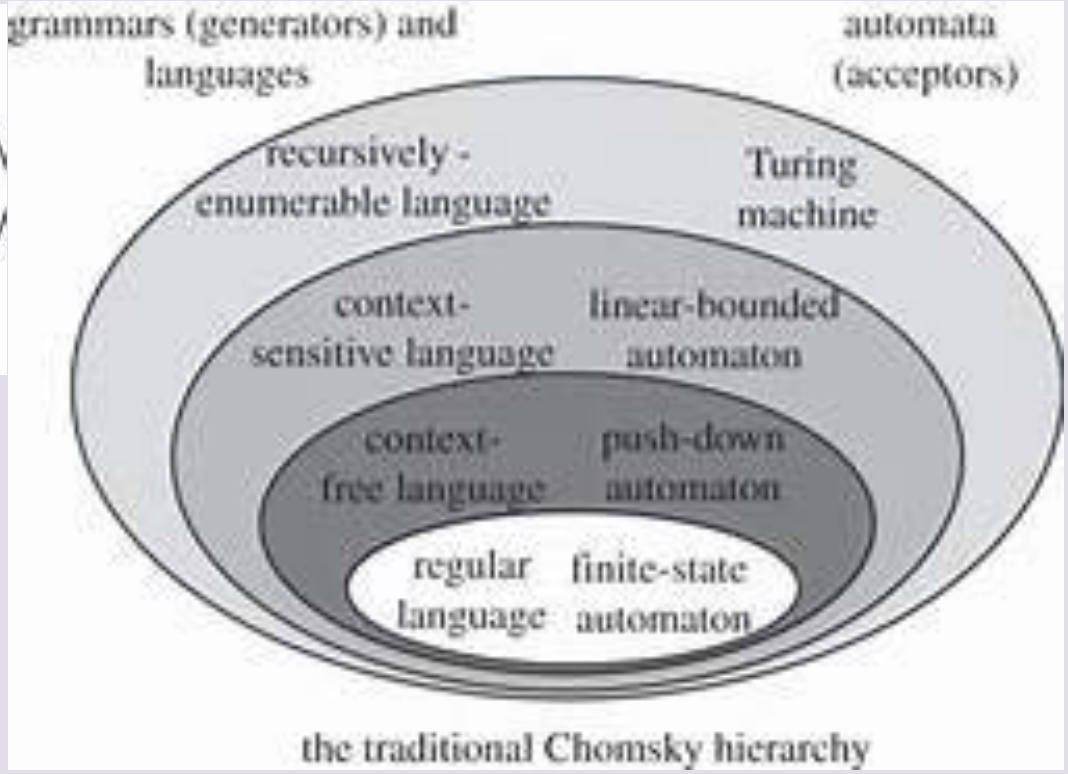
AI requires code; Code is a computer language;

Any Language is defined by an initial set of symbols and a set of "production rules" of its elements: **a Grammar.**

Artificial Intelligence in Planning

Regular Grammars

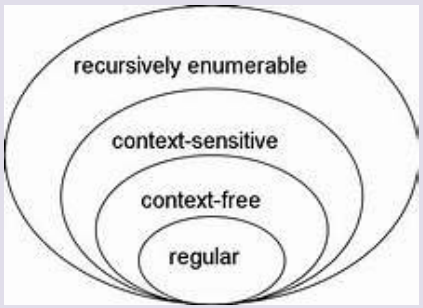


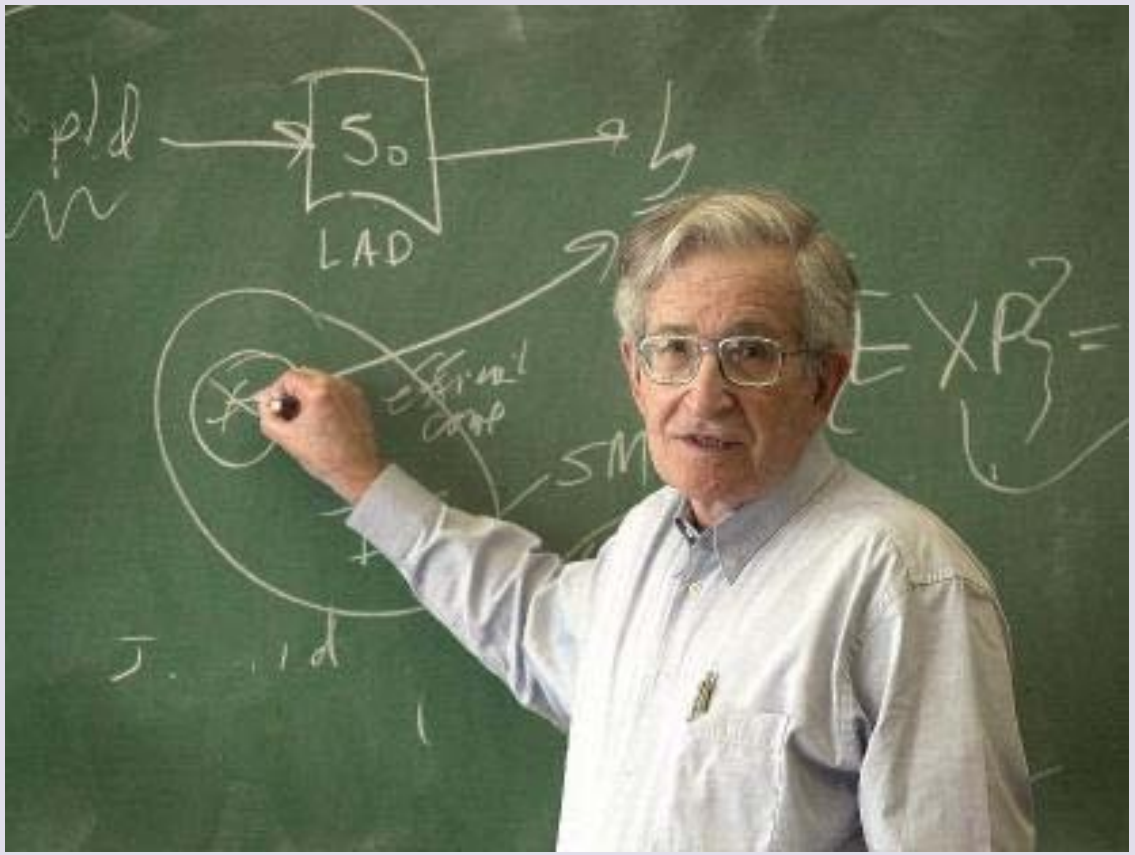


the traditional Chomsky hierarchy

Artificial Intelligence in Planning

Regular Grammars





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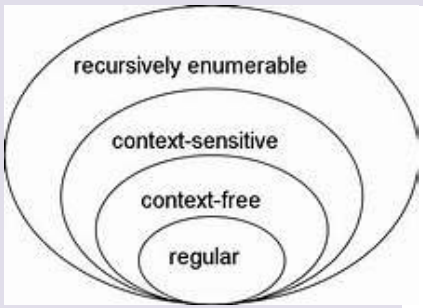
Regular Grammars

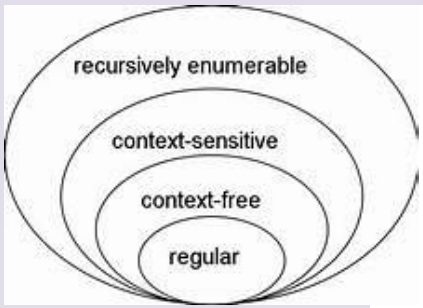


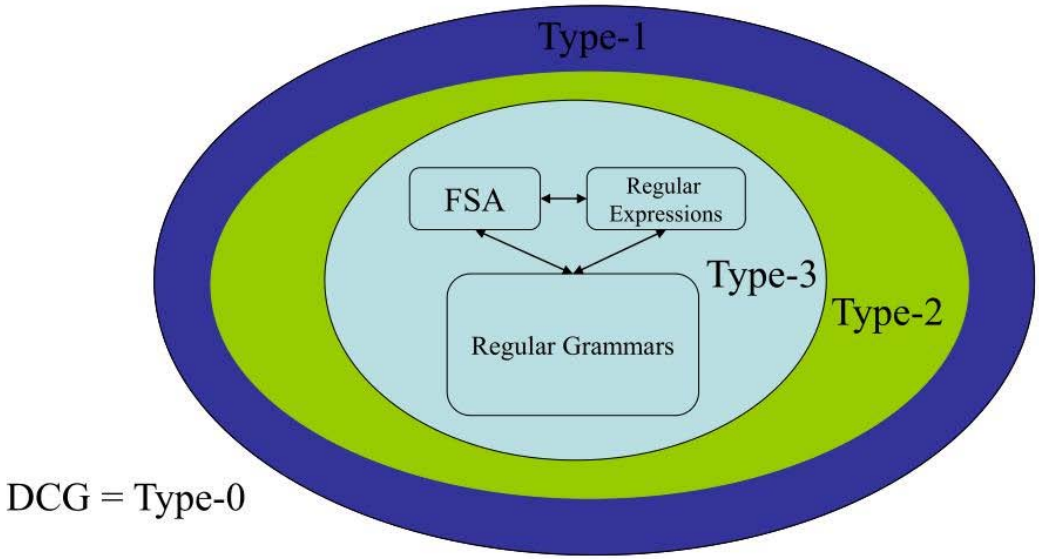
Chomsky Hierarchy

Grammars	Languages	Automaton	Restrictions (w1 → w2)
Type-0	Phrase-structure	Turing machine	w1 = any string with at least 1 non-terminal w2 = any string
Type-1	Context-sensitive	Bounded Turing machine	w1 = any string with at least 1 non-terminal w2 = any string at least as long as w1
Type-2	Context-free	Non-deterministic pushdown automaton	w1 = one non-terminal w2 = any string
Type-3	Regular	Finite state automaton	w1 = one non-terminal w2 = tA or t (t = terminal A = non-terminal)

Artificial Intelligence in Planning

Regular Grammars





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Artificial Intelligence in Planning

"Planning Complexity" & Chaos

Planning => Decision => from solution (space) to 1
⇒ introduce Human & Nature Constraints
⇒ More ordered environment => guiding the future
⇒ Reduce uncertainty => restrict alternative spaces

<=> Decrease entropy

Ergo... Requires Increase of Information
*In **society**, not just Planners, decision-makers*

Artificial Intelligence in Planning

"Computational Complexity" =

The cost of a program's execution

(running time, memory, ...)

rather than

The cost of the program

(# of statements, development time)

[In this sense, less-complex programs require *more* development time.]

Artificial Intelligence in Planning

"Planning Complexity" =

- Cost of a Plan Execution

  Implementation, management, monitoring, enforcement, evaluation, readjustaments

But also +

- Cost of ***Decision*** on a Plan

  User needs assessment, problem and solution space, prioritizing, impacts evaluation, risk assessement cost benefit analysis, opportunity costs, optimization, sustainable capacity assessment...

Rather than the cost of making a Plan...

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Artificial Intelligence in Planning

- **How can AI help**

  -Qualified & Quantified Search (problem & solution space)

  -Knowledge Libraries (for Intelligent Multimedia Geo-referenced Systems)

  -State Machines (graph theory)

  -Intelligent Models and Simulations (with inference engines)

  -Expert Systems and Predicate Calculus, Truth Maintenance Systems

  -Managing Distributed Systems and Participory Science-based Data

  -Data Mining - "Big Data Problem"

  -...

Artificial Intelligence in Planning

- **How can AI hurt**

-Displacing jobs - if development is directed that way vs complementing

-Losing transparency (knowledge & assumptions are encapsulated)

-Increasing the literacy gap (complexity is more demanding)

-Harder to debug (genetic "self-altering" algorythms and programming)

-Lost of Human heuristics (common-sense paradigm problem)

-False security & reliability ("shit in shit out" is time sensitive and amplified by inference jumps)

-Amplification, Replication and Exponentiation of mistakes and bad decisions

-...

Artificial Intelligence in Planning

- **How can we regulate A.I.**

- PROBLEM 1.

The main challenge of AI to Regulation and Compliance Enforcement, is its design to *learn* and *change its own code* - in other words, its OPACITY to non-experts, without AI Knowledge and AI Tools

- PROBLEM 2.

The power and potential of last generation AI Tools, is not based solely on its own sophistication levels; it is compounded, in a major and critical way, by the MASSIVE SCALE of DATA it has at its disposal.

-SOLUTION SPACE:

Any AI Regulation requires Societal real control of both Technology Development AND Data.
In other words: PROPERTY RIGHTS - on Technology and on Data - is the KEY issue.

ICT Qualitative Leap:

The Frog Qualitative Jump Paradigm

Without e-Planning

With e-Planning

• The Vision

e-Planning embodies a new paradigm of Technology with Social Sciences

Going past the traditional "blackbox" disciplinary approach…

Social Science	=>	Technology from a "user" point of view	=>	Outsource technology to Engineers
Technology	=>	Social science from a "consultant" point of view	=>	Outsource social study to Social Scientists

… the new e-Planning synoptical transdisciplinary approach:

Social Scientists	<=>	Develop technology with understanding of social science; and develop social science with understanding of technology	<=>	ICTechnology Scientists & Engineers

www.e-planning.org

e-Planning agenda

Joint PhD Program UA+UNL+[UL+UTL] (since 2008)

e-Planning scientific domains	Summary of key objectives
e-Planning knowledge infrastructure (e- infrastructure)	*Mapping of the knowledge society.* *Mapping of the planning knowledge.* *Develop the new ICT infrastructures and strategic frameworks*
e-Planning for the government of the future (e-government)	*More efficient and responsive government, closer to citizens; better enabling role; better services; better adjustment to the challenge and new potential of digital implementation of administrative procedures, beyond raw automation; two-way G2G, G2C, G2B.*
e-Planning for a new governance (e-governance)	*Foster institutional culture towards the common good, more equity and less exclusion; build strategic institutional capacity within globalized world; better institutions; better regulation framework and handling of market failures, aware of the new ICT context; better balance of security & efficiency vs. freedoms, liberty and accountability.*
e-Planning for the city of the future (e-city) and territory	*Build the cities of the future, as sustainable environments with new functionality that breed innovation; foster cities with better quality of life, more attractive and competitive; better spatial planning, promoting social and territorial cohesion, incorporating new structural impacts of ICTs.*
e-Planning for a new citizenship (e-citizenship)	*Enable a better informed and educated citizen, more participative, more critical, more responsible; better balance of technology challenges with ethics & individual freedoms & privacy.*

e-Planning Consortium (informal – since 2006)

Participatory Science

CITIDEP PROGRAMS Citizenship & ICT

Contact nodes: since 1996 pfa@mit.edu

Charlote De Kock	Belgium
Timothy Sieber	USA
Luis Rionda	Mexico
Muriel Gavira	Brasil
Clelia Guinazu	Argentina
Valérie Aillaud	France
Laura Colini	Italy
Vesna Dolnicar	Slovenia
Pedro Ferraz de Abreu	Portugal

www.citidep.net

- ICT & participatory science
- ICT & participatory democracy
- ICT, inclusion & cooperation
- ICT, policy & strategy

CITIDEP +
e-Planning Lab
@ CAPP/TSG

Laboratórios de Tecnologia para as Ciências Sociais

2007-2012 **ISCSP-UTL**

www.labtec-cs.net

- ICT & Inclusion, Literacy, Cooperation
- Smart Cities, Cohesion & Participatory Systems
- Internet Governance, Open Data, Security & Privacy

Laboratórios de Tecnologia e Sociedade

FC-UL

2013-2014

CITIDEP +
e-Planning Lab
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- **ICT & Inclusion, Literacy, Cooperation**
- **Smart Cities, Cohesion & Participatory Systems**
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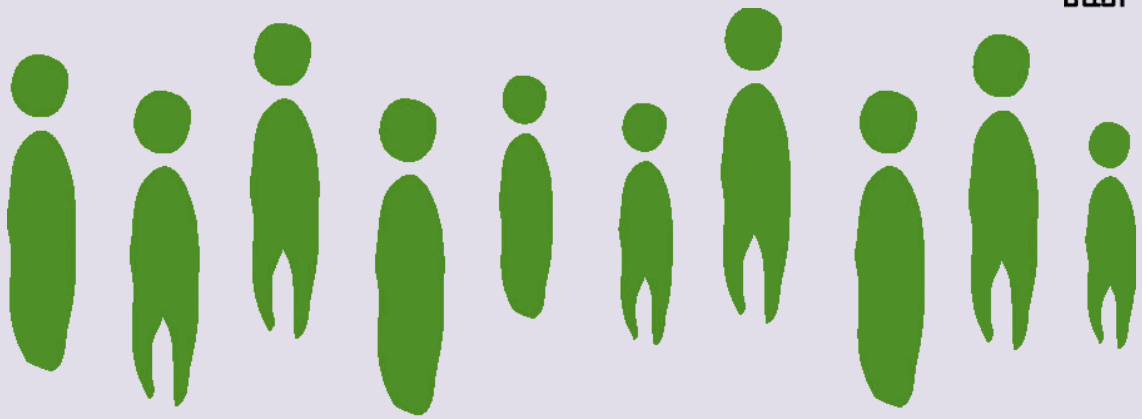

Laboratórios de Tecnologia e Sociedade

UA

2015-2018

CITIDEP +
e-Planning Lab
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(ficou em fase de proposta na UA)

- **ICT & Inclusion, Literacy, Cooperation**
- **Smart Cities, Cohesion & Participatory Systems**
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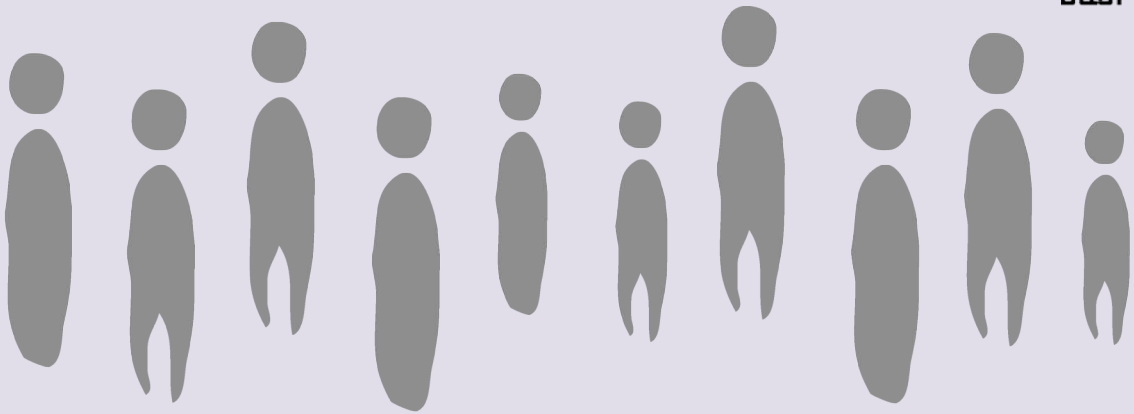

Laboratórios de Tecnologia e Sociedade

FA-UL

2019-2023

CITIDEP +
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@ CIAUD

www.labtec-cs.net

(em fase de proposta na FA-UL)

- **ICT & Inclusion, Literacy, Cooperation**
- **Smart Cities, Cohesion & Participatory Systems**
- **Internet Governance, Open Data, Security & Privacy**

Laboratories of Technology and Society

2023-????

MIT-DUSP

CITIDEP +
Urban Science? http://web.mit.edu/uis/e-planning2023/

MIT Proposal ?

www.e-planning.org

www.labtec-cs.net

www.citidep.net

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