

# Artificial Intelligence and the Law

## CSCM23

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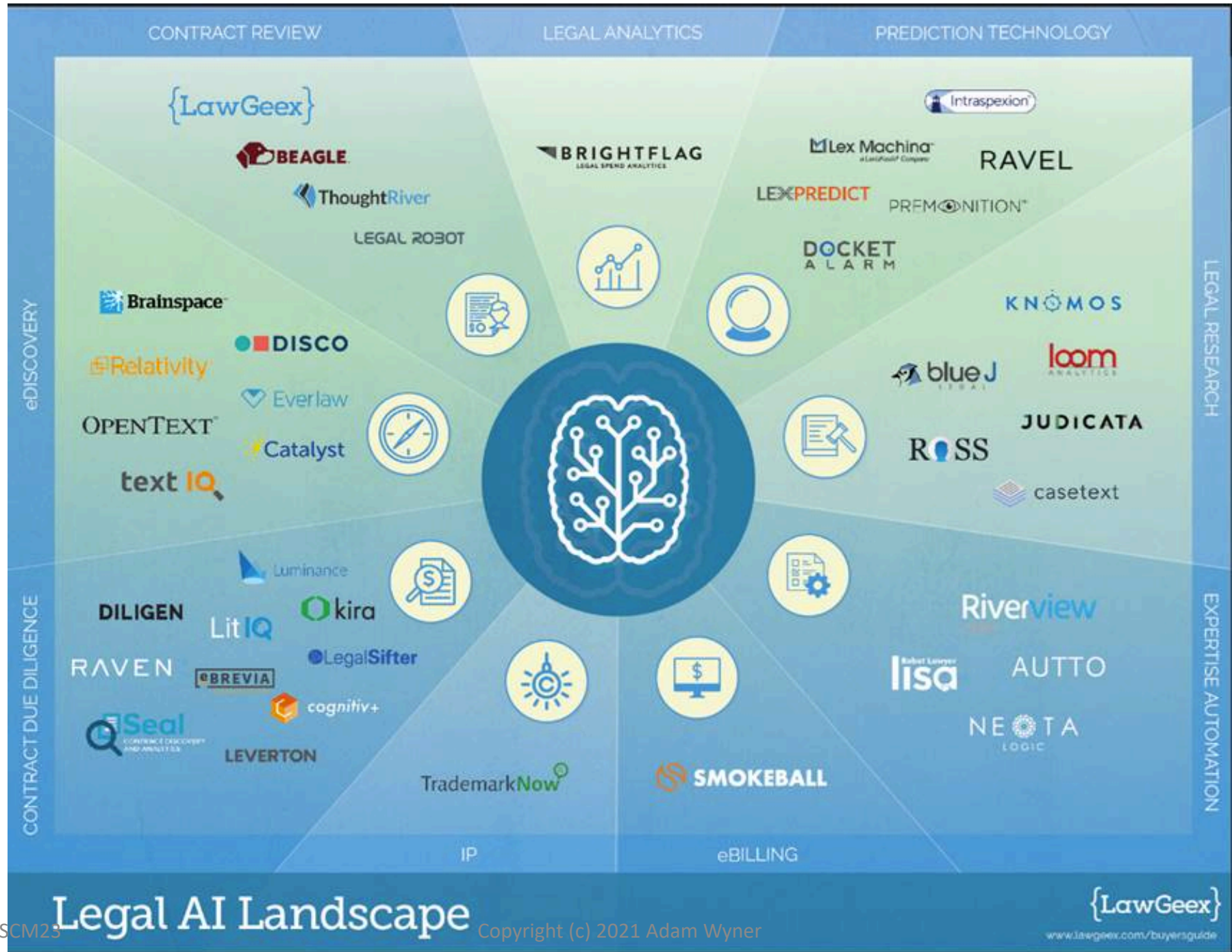
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# My background

- PhD Linguistics (Cornell University, 1994) – syntax and semantics of adverbial modification.
- PhD Computer Science (King's College 2008) – formalisation and implementation of an abstract contract calculator
- Subsequent research, publication, and teaching on various topics in AI and law.

# CSCM23 Relevance

- How does the law relate to computational systems?
  - AI applied to Law - Computational analysis of legal information or systems, i.e., information extraction, decision systems, analysis of process.
  - Law applied to AI – Legislated constraints on computational systems
- In these lectures, we will look at both ‘angles’.
- We start with how legal information or systems can be automated.



# Legal AI Landscape

{LawGeex}

# Established Companies, Startups, and Indices

- Service providers (e.g. Thomson Reuters) and law firms (e.g. Linklaters, Pinsett Masons, etc).
- Some links to companies and startups (most allow access, some need an email, some access on a trial basis):
  - <https://www.legalgeek.co/startup-map/>
  - <https://angel.co/legal-tech-1>
  - <https://www.crunchbase.com/search/organizations/field/organizations/categories/legal>
  - <https://techindex.law.stanford.edu/>

# LegalTech Blogs I

- <https://blog.lawgeex.com/>
- <https://www.artificiallawyer.com/>
- <https://www.lawtechnologytoday.org/>
- <https://europe-legaltech.org/blog/>
- <https://www.cambridge.org/core/journals/natural-language-engineering/article/law-and-word-order-nlp-in-legal-tech/E8CC6743F2FCCFD29FBC16A82F7F9B2A/core-reader>
- <https://blog.rossintelligence.com/>

# LegalTech Blogs II

- <https://www.vable.com/blog/30-titles-to-keep-you-on-top-of-innovation-in-legal-tech>
- <http://aitechnologylaw.com/>
- <https://law-tech-a2j.org/>
- <https://www.reddit.com/r/legaltech/>
- <https://www.legalitprofessionals.com/>
- <https://legaltechnology.com/latest-newsletter/>
- <https://www.lawsitesblog.com/category/lawnext>
- <https://www.lawsitesblog.com/tech-competence>

# Interdisciplinary space

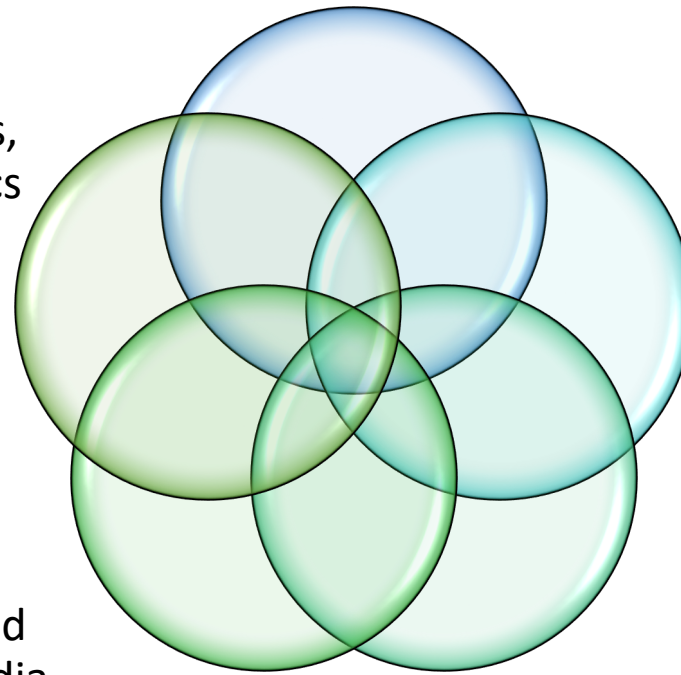
Computer Science - AI, argumentation, NLP (annotation, classification, logic, information extraction, norms, ontologies, data science, visualisation, XML/Knowledge Graph, CBR

Law –policy-making, contracts, access to justice, various topics

Linguistics – POS, syntax, semantics, lexicon, word/phrase distribution

Public participation and consultation, social media

Management, government, social science





# The Law

- Statement of deontic concepts (obligations, permissions, prohibitions) and legal definitions.
- How the deontic concepts bear on actions or states by parties.
  - Smoking is not permitted anywhere on the premises.
- States the conditions under which the deontic concepts are violated.
  - Smoked in the kitchen.
- States the reparations (penalty).
  - Pay 5 GBP.

# Example – legislation

<https://www.legislation.gov.uk/ukpga/1981/61>

8 Schedules

52 sections

Dozens of repeals

Hundreds of footnotes

- What questions would you want to have answered?
- What questions do you think others would want to have answered?
- What problems do you think you would need to address?

- 1 **Acquisition by birth or adoption.**
- (1) A person born in the United Kingdom after commencement **[F<sup>1</sup>**, or in a qualifying territory on or after the appointed day,] shall be a British citizen if at the time of the birth his father or mother is—
- (a) a British citizen; or
- (b) settled in the United Kingdom **[F<sup>2</sup>** or that territory].
- [F<sup>3</sup>(1A)** A person born in the United Kingdom or a qualifying territory on or after the relevant day shall be a British citizen if at the time of the birth his father or mother is a member of the armed forces.]
- (2) A new-born infant who, after commencement, is found abandoned in the United Kingdom **[F<sup>4</sup>**, or on or after the appointed day is found abandoned in a qualifying territory,] shall, unless the contrary is shown, be deemed for the purposes of subsection (1)—
- (a) to have been born in the United Kingdom after commencement **[F<sup>5</sup>** or in that territory on or after the appointed day]; and
- (b) to have been born to a parent who at the time of the birth was a British citizen or settled in the United Kingdom **[F<sup>6</sup>** or that territory].
- (3) A person born in the United Kingdom after commencement who is not a British citizen by virtue of subsection (1) **[F<sup>7</sup>**, (1A)] or (2) shall be entitled to be registered as a British citizen if, while he is a minor—
- (a) his father or mother becomes a British citizen or becomes settled in the United Kingdom; and
- (b) an application is made for his registration as a British citizen.
- [F<sup>8</sup>(3A)** A person born in the United Kingdom on or after the relevant day who is not a British citizen by virtue of subsection (1), (1A) or (2) shall be entitled to be registered as a British citizen if, while he is a minor—
- (a) his father or mother becomes a member of the armed forces; and
- (b) an application is made for his registration as a British citizen]
- (4) A person born in the United Kingdom after commencement who is not a British citizen by virtue of subsection (1) **[F<sup>9</sup>**, (1A)] or (2) shall be entitled, on an application for his registration as a British citizen made at any time after he has attained the age of ten years, to be registered as such a citizen if, as regards each of the first ten years of that person's life, the number of days on which he was absent from the United Kingdom in that year does not exceed 90.
- [F<sup>10</sup>(5)** Where—
- (a) any court in the United Kingdom **[F<sup>11</sup>** or, on or after the appointed day, any court in a qualifying territory] makes an order authorising the adoption of a minor who is not a British citizen; or
- (b) a minor who is not a British citizen is adopted under a Convention adoption,
- that minor shall, if the requirements of subsection (5A) are met, be a British citizen as from the date on which the order is made or the Convention adoption is effected, as the case may be **[F<sup>12</sup>** effected under the law of a country or territory outside the United Kingdom].
- (5A) Those requirements are that on the date on which the order is made or the Convention adoption is effected (as the case may be)—
- (a) the adopter or, in the case of a joint adoption, one of the adopters is a British citizen; and
- (b) in a case within subsection (5)(b), the adopter or, in the case of a joint adoption, both of the adopters are habitually resident in the United Kingdom **[F<sup>13</sup>** or in a designated territory].
- (6) Where an order **[F<sup>14</sup>** or a Convention adoption] in consequence of which any person became a British citizen by virtue of subsection (5) ceases to have effect, whether on annulment or otherwise, the cesser shall not affect the status of that person as a British citizen.
- (7) If in the special circumstances of any particular case the Secretary of State thinks fit, he may for the purposes of subsection (4) treat the person to whom the application relates as fulfilling the requirement specified in that subsection although, as regards any one or more of the first ten years of that person's life, the number of days on which he was absent from the United Kingdom in that year or each of the years in question exceeds 90.
- (8) In this section and elsewhere in this Act "settled" has the meaning given by section 50 **F<sup>15</sup>**, . . .
- [F<sup>16</sup>(9)** The relevant day for the purposes of subsection (1A) or (3A) is the day appointed for the commencement of section 42 of the Borders, Citizenship and Immigration Act 2009 (which inserted those subsections).]

# Example – arguing a case

- A new case comes to court and is argued before a judge(s) and (sometimes) a jury, who decide the case in accordance with the law (statutes), precedence, and evidence.
- Common law system (UK, US), the argument is done with respect to precedents – previously decided cases. Case-based reasoning.
  - The current case and the precedents are compared and contrasted.
  - The law is conservative - stare decisis.
- Civil law legal system (EU), a judge may determine how a statute applies to the facts.
- How would one facilitate CBR?
- What sorts of particular information would be required?

# Example – contract negotiation, construction, execution, and compliance monitoring

- What questions would you want to have answered?
- What questions do you think others would want to have answered?
- What problems do you think you would need to address?

1. Parties  
The parties to this Agreement are \_\_\_\_\_, hereinafter called "Landlord," and \_\_\_\_\_, hereinafter called "Tenant." If Landlord is the agent of the owner of said property, the owner's name and address is: \_\_\_\_\_

2. Property  
Landlord hereby lets the following property to Tenant for the term of this Agreement: (a) the real property known as: \_\_\_\_\_ and (b) the following furniture and appliances on said property: \_\_\_\_\_

3. Term  
This agreement shall run: \_\_\_\_ (a) for the period of \_\_\_\_\_ to \_\_\_\_\_, or \_\_\_\_ (b) month-to-month.

4. Rent  
The monthly rental for said property shall be \$\_\_\_\_\_, due and payable by check on the \_\_\_\_ day of each month.

5. Utilities  
Landlord agrees to furnish the following services and/or utilities:  
\_\_\_\_ Electricity \_\_\_\_ Gas \_\_\_\_ Garbage Collection  
\_\_\_\_ Snow Removal \_\_\_\_ Water \_\_\_\_ Oil

6. Deposits  
Tenant will pay the following deposits and/or fees: \_\_\_\_\_ to \_\_\_\_\_.

This amount will be refunded (plus interest) within thirty days following the termination of the tenancy; unpaid rent, charges for damages beyond normal wear and tear, and costs for reasonable cleaning may be deducted.

**In Addition It Is Agreed:**

1. Tenants shall not lease, sublease, or assign the premises without the prior written consent of the Landlord (but this consent shall not be withheld unreasonably).
2. Landlord may enter the premises at reasonable times for the purposes of inspection, maintenance, or repair, and to show the premises to buyers or prospective tenants. In *all* instances, except those of emergency or abandonment, the Landlord shall give Tenant reasonable notice (at least one day) prior to such entry.
3. Tenant agrees to occupy the premises and shall keep the same in good condition, reasonable wear and tear excepted, and shall not make any alterations thereon without the written consent of the Landlord.
4. Landlord agrees not to use the premises in such a manner as to disturb the peace and quiet of other tenants in the building. Tenant further agrees not to maintain a public nuisance and not to conduct business or commercial activities on the premises.
5. Tenant shall, upon termination of this Agreement, vacate and return dwelling in the same condition that it was received, less reasonable wear and tear, and other damages beyond the Tenant's control.
6. In a dispute between the Landlord and Tenant which gives rise to any action in court, the losing party will pay the court costs and reasonable attorney fees of the successful party.

7. Additional Terms: \_\_\_\_\_

\_\_\_\_\_  
We, the undersigned, agree to this Rental Agreement:  
Landlord: Tenant:

_____ Name	_____ Name
_____ Signature	_____ Signature
_____ Date	_____ Date

## Example – legal consultation

- A citizen wants to know their entitlements, obligations, penalties, and reparations.
- <https://www.gov.uk/benefits-calculators>
- <https://www.fixedlaw.com/>
  - Fix your parking ticket

## Benefits calculators

Use an independent benefits calculator to find out:

- what benefits you could get
- how to claim
- how your benefits will be affected if you start work

These are free to use, anonymous, and have replaced the Benefits Adviser service.

### Calculators

Use one of the following:

- [entitledto](#) - for information on income-related benefits, tax credits, contribution-based benefits, Council Tax Reduction, Carer's Allowance, Universal Credit and how your benefits will be affected if you start work
- [Turn2us](#) - for information on income-related benefits, tax credits, Council Tax Reduction, Carer's Allowance, Universal Credit and how your benefits will be affected if you start work or change your working hours
- [Policy in Practice](#) - for information on income-related benefits, tax credits, contribution-based benefits, Council Tax Reduction, Carer's Allowance, Universal Credit, how these are calculated and how your benefits will be affected if you start work or change your working hours

## Other Use Cases

- Access to justice
- Document classification
- e-Discovery
- Contracts
- Negotiation
- Mediation
- Legal compliance
- Intellectual property
- Social/Organisational simulation
- Text information extraction
- Modeling legal information processing in organisations
- Legal argumentation
- Prediction technology
- Legal research
- Expertise automation
- eBilling

## Other Use Cases

- Translating from 'ordinary' descriptions to legal concepts
- Addressing particular legal issues (challenge a fine or apply for a building permit)
- Jurisdictional variation (how do automated cars know what laws to abide by when moving from one state to another, where the driving laws might vary)

# Legal topic areas

- Administrative
- Advertising
- Antitrust
- Consumer Protection
- Election Laws (U.S.)
- Employment
- Environmental
- Family, Patent
- Intellectual Property
- Islamic
- Maritime Law
- Martial
- Mass Communications
- Military Justice
- Obscenity
- Sexual Assault
- Smoking
- Space
- Water Rights
- Any human activity where people interact and may disagree, where boundaries or constraints are needed....



# Computer Science Topics in AI and Law

- Logic and reasoning
- Defeasible logic, argumentation, argumentation schemes
- Legal concepts
- Ontologies
- Machine learning and law
- Case-based reasoning
- Text analysis
- XML, LegalDocML, LegalRuleML
- Dialogue/Discourse, chatbots, and dispute resolution
- Contract modeling

# Introducing AI and Law

- Overview of AI applied to the Law
- Outcomes – sense of the AI and Law landscape, where AI students and researchers ‘fit in’, pointers to further material
- Contrast
  - ‘Traditional legal practice’ – reading, writing, thinking, talking, using some tools from legal informatics companies (WestLaw, ThomsonReuters, etc) to retrieve documents. Law journals summarising legal developments.
  - With changes in legislation, data access, and a new economic environment (pushback against billable hours), the legal profession is embracing AI and law.

# Caveats

- Lots of topics – some familiar and some not
- No presumption of familiarity about AI, technology, or the law.
- Breadth rather than depth
  - A topic is introduced along with a sample of how it might be done.
  - Lightweight with respect to technical or formal depth.
- No pretense at covering all recent literature in all topics.

# What is Artificial Intelligence?

- Essential elements for the Turing Test (Russell and Norvig 2018\*):
  - Natural language processing to enable it to communicate successfully in English (or other natural language).
  - Knowledge representation to store what it 'knows'. Abstract and instantiated models of human knowledge. Acquisition bottleneck – NLP for information extraction into an ontology.
  - Automated reasoning to use the stored information to answer questions and to draw new conclusions. Monotonic and non-monotonic/defeasible reasoning. Human rules.
  - Machine learning to adapt to new circumstances and to detect and extrapolate patterns. Often statistical classification, but there are other ways.

\*<http://aima.cs.berkeley.edu/>

# How does AI apply to Law?

- Use natural language in communication of legal information (e.g. process legal texts).
- Represent legal knowledge in abstract and instantiated models. Acquire knowledge.
- Legal reasoning with rules that may be defeasible. Argumentation.
- Acquire new information from sources and extrapolate patterns. Information extraction to models. Classification of documents/clauses; prediction of legal outcomes.
- A key challenge is to make AI and Law more 'realistic', modelling tasks that government officials, lawyers, judges, law students, and citizens perform with the textual materials they use.

# Grand challenges

- Representing legislation for both inference and maintenance
- Representing and reasoning with open-textured concepts
- Representing and reasoning with normative concepts
- Simulating the process of expert legal prediction/advising
- Reasoning and arguing using examples as well as rules
- Understanding and generating legal texts

(Ashley and Gordon 2005)

# Goals of AI and law

- Practical: to semi-automate or fully automate tasks that have been intellectually demanding, yet tedious in the analysis and management of legal information. This ought to release lawyers to focus on more valuable and strategic tasks.
- Intellectual: to understand the law and legal reasoning (perhaps in ways not transparent to lawyers).

# Goals of AI and law

- Provide fairer, more efficient system of justice
  - Reduce high transaction cost of legal services
  - Facilitate legal compliance and alternative dispute resolution
  - Advance public understanding of / participation in law and legal system
  - Improve public access to legal materials and expertise
- Improve lawyers' training and skill:
  - precise drafting of legal documents
  - rational management of risk
  - efficient, effective management of information

(Ashley)



# Goals of AI and law

- Contribute to Jurisprudence, Cognitive Science, AI
- Avoid potential for abuse:
  - Computers as tools for legal decision makers to make better decisions,
  - NOT as legal decision makers themselves.
- As AI & Law tools become available, they may change the nature of legal practice.

(Ashley)

# Sources of Legal Information

- Cases
- Statutes
- Regulation
- Contracts
- Textbooks/training/exam materials
- Interfaces with legal officials and organisations, where the law is implemented

# What Are Some of the General Problems

- Lots of legal information, highly diverse, complex reasoning, specific terminology
- Most legal information is in text/natural language
- Very fine-grained, highly structured source and target information
- Reasoning is (often) essential. Non-monotonic and defeasible
- Quality of analysis must be high
- There ought to be explanations – ground of law, appeals, linked reasoning of law (precedents, reuse of rules), the consultation process.
- The knowledge acquisition and representation bottleneck
- Pragmatics/sociological
- Interpretation

# Developments Motivating LegalTech

- AI is applicable
- Change in legal service provision - more services done by more providers has introduced competition, which drives down costs
- Supply and demand in legal education - change in what is relevant legal training for what jobs. The old jobs are not the new jobs (See Susskind in references).

# Focus

- Computational Models of Legal Reasoning
  - Theoretical models or implementations of aspects of human legal reasoning, whether reasoning in a form similar to what humans do or not.
- Analysing a situation or question, relating the situation or question to legal concepts and rules, applying legal rules to the situation or answering the question, perhaps predicting an outcome or making a legal argument.
- Algorithms applied to legal information from the input information (situation or question) to output (legal determination or answer)
- The algorithms may apply legal and domain knowledge.
- Getting to or instantiating the models requires substantial analysis and/or information extraction.

# Relates to a Range of AI Techniques

- Machine learning – a range of approaches
- Knowledge representation and reasoning (logic – monotonic and non-monotonic)
- Natural language processing – information extraction, text analysis, parsing, semantic representation
- Ontologies/knowledge graphs

# Relates to a Range of AI Techniques

- Semantic web/XML/Knowledge Graph
- Case-based reasoning
- Question-answering
- Argument mining and reasoning
- Network analysis
- Visualisation
- Others....

# Not Touched On Here (found elsewhere)

- Law applied to AI (what the law says about digital privacy).
- Robotics. Vision. Planning. Network analysis. Modelling of organisations and procedures. Planning. Multi-agent systems. Distributed ledger. Semantic web representations. Management of intellectual property. Identity. Negotiation. Mediation. Compliance management. Question answering. Predicting legal outcomes. Legal values. Argument retrieval. Robo-lawyers. Legal apps.



# Selected General References and Resources

- K. Ashley. 2017. *Artificial Intelligence and Legal Analytics*. Cambridge University Press.
- G. Sartor, M. Palmirani, E. Francesconi, and M.A. Biasiotti (Eds.) 2011. *Legislative XML for the Semantic Web: Principles, Models, Standards for Document Management*. Springer.
- R. Susskind. *Tomorrow's Lawyers: An Introduction To Your Future*. Oxford University Press.
- Journal of Artificial Intelligence and Law
  - <https://link.springer.com/journal/10506>
- International Conference on Artificial Intelligence and Law (ICAAIL)
  - <http://www.iaail.org/>
- JURIX conference
  - <http://jurix.nl/>
- AI and law research is appearing more generally in conferences on NLP, AI, Data-mining, etc

# Basic/recurrent tools - generic/abstract

- Logical reasoning – monotonic, non-monotonic, defeasible
- Deontic concepts – obligations, permissions, prohibitions
- Ontologies – legal and domain. Structure and instances. Related to logic
- Case-based reasoning – reusing prior solutions
- Machine learning – gold standards, gradedness, purpose (sorts of uses and questions answered)

# Basic/recurrent tools - instantiated

- Timed automata – simulating legal actions and states over time
- Text analysis and information extraction – finding particular pieces of information and structuring their relations (named entities, relations, properties, relating them). Instantiates ontology
- Controlled natural language – instantiates ontology, translates to a logic
- XML – machine readable logic and linked data

# Logical reasoning

- Propositional logic: propositions, connectives, models, inference
- Predicate logic: propositional logic + predicates, variables, quantifiers
- Sufficient to represent natural language semantics? Higher order quantifiers (most) and modal operators (obligation)
- Description logics – fragments of first-order logic and their properties
- Propositional and predicate logic are monotonic – inferences once made cannot be withdrawn.

# Logical reasoning

- Human reasoning is often non-monotonic and/or defeasible
  - Over time or in alternative circumstances, facts or rules change
  - Rules can be inapplicable in circumstances and/or with respect to some 'higher principle' such as Lex Specialis.
- Non-monotonicity is a property of consequence notions
- Defeasibility is a property of inference rules. An inference rule is defeasible if there are situations in which its conclusion does not have to be accepted even though all its premises must be accepted. (Prakken)

# Machine learning – automated pattern matching

- Identify a corpus
- Determine the classifications/annotation, what is classified, and how (manual and IAA)
- Establish a ‘gold standard’ classification with annotations and high IAA
- Set features for classification of some text (document, passage, sentence)
- Create a model – statistically weight the features such that the features ‘predict’ the classification of the text
- Evaluate the performance of the model against the gold standard. Out of the results:
  - precision – how many are correct wrt selected. How useful are the results.
  - recall – how many are correct wrt the GS. How complete are the results.

# Machine learning

- Unsupervised systems. Data is not annotated. For example, can automatically cluster data and identify outliers. One example of unsupervised ML technology is commonly referred to as 'clustering' documents that are similar (in some way).
- Supervised systems. Uses annotated data, the 'gold standard', set by annotators with respect to a manual and evaluated with respect to IAA.

# Machine learning – sample techniques

- Decision tree
- Naïve Bayes
- SVM
- Neural nets/Deep learning – tries to identify the features
- Others....



# Machine learning - issues

- Classifications/annotations
- IAA
- The feature and what we learn from them
- Results – F1 in 70% zone is acceptable, though this may depend on the purpose
- Complexity of classification/annotation set – how to learn 15-20 classifications at once or to combine separate models

# Machine Learning 2

- Features that are used in developing the model
  - single words, punctuation, sentence length, ngrams, part-of-speech, terminology....
- What do the features signify? Are they mutable, e.g. if the feature of capital initial letter is significant for named entity recognition, what happens where that feature varies?
- Annotation of texts for supervised learning. A manual that is used by annotators to annotate; degrees of IAA; small pools; deriving a rule-based system from information of the manual and from the annotators.
- Fine-grainedness – how many dimensions of a texts can be classified? Obligation classification v agent or causal analysis?
- Lots of work in the annotation and feature selection
- Sometimes the features most highly rated are counter-intuitive.

# ML v. Logic

- Statistical/machine learning approaches
  - + large/high volume datasets, speed, low resource, outcome simplicity, generic
  - opacity, not malleable, no trace/explanation, no proof, hard to understand, modest accuracy, not sufficiently structured for models/inference.
- Logic/knowledge approaches
  - + transparent, systematic, malleable, outcome complexity, inference/models, easier to understand, high value data, higher accuracy
  - smaller datasets, slower development, higher resource, specific
- Interleave approaches as and where.
- Some deeper relationship (Explainable AI)

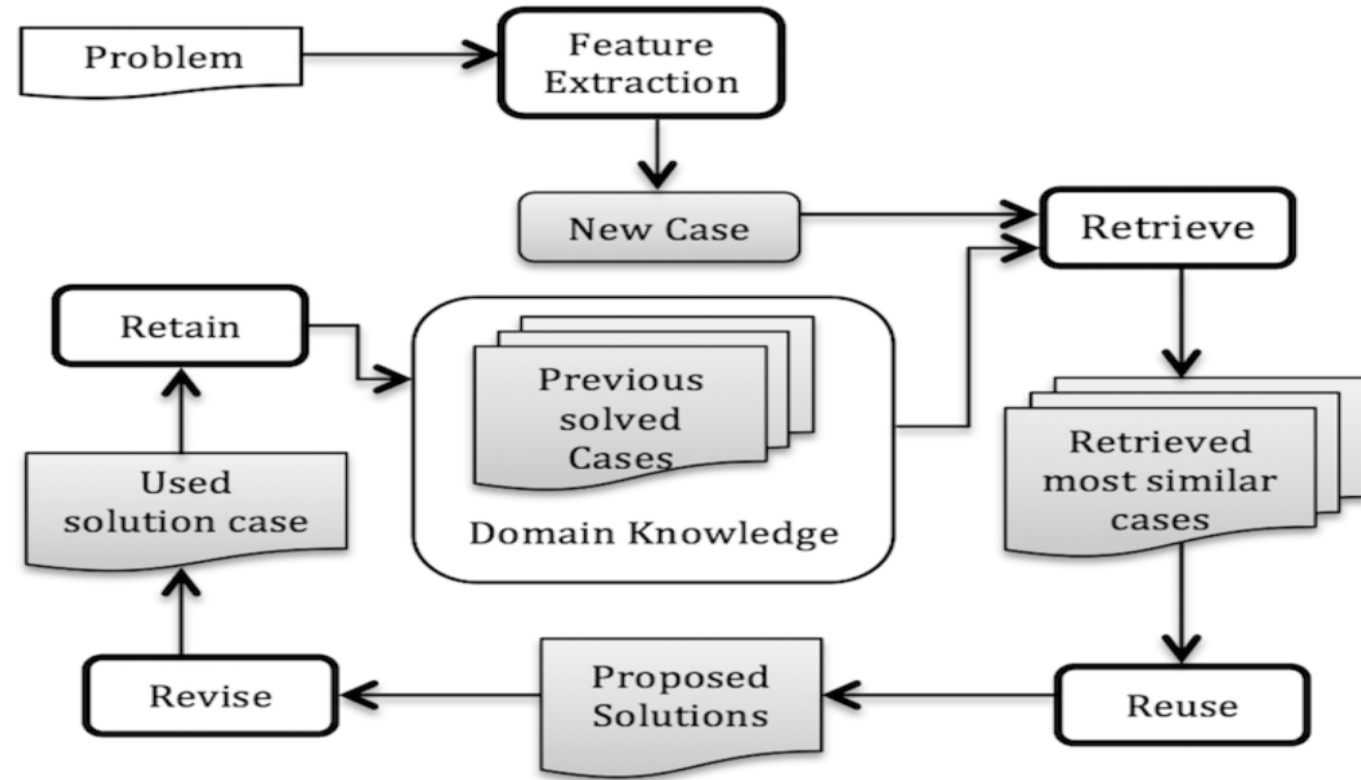
# Deontic concepts

- Modal operators to express notions of
  - obligation, permission, prohibition
- Apply to actions or states and with respect to the agent (sometimes beneficiary) of the action
- Forms
  - Standard Deontic Logic – deontic operators apply to expressions of propositional logic
  - Action Logic – deontic operators apply to expressions in an action logic of preconditions and post-conditions
  - Sees-to-it-that (STIT) – operators apply to the generic action and focus on the result
- Can have full or lightweight analyses (SDL or without connectives)

# Ontologies – OWL 2 - formal representation of domain knowledge

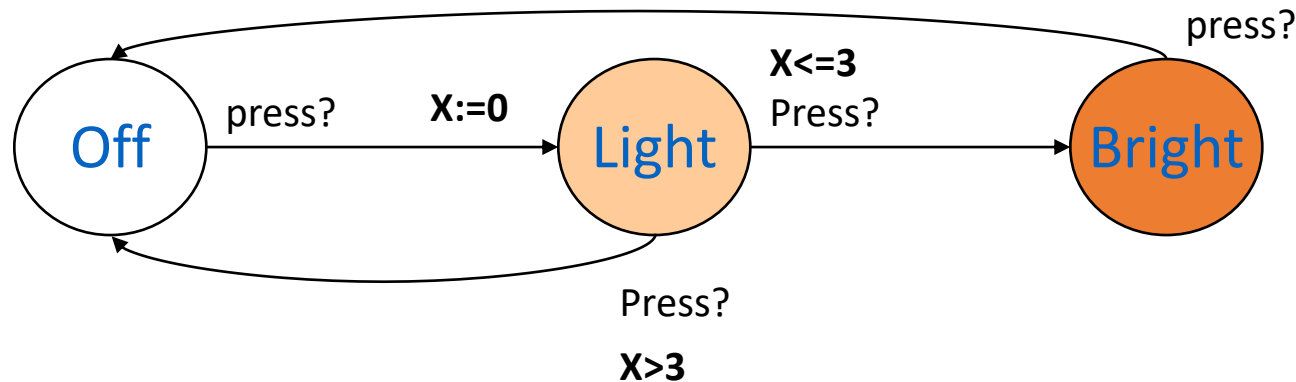
- Classes and subclasses; object and data properties; data values; individuals; constraints; some quantification
- Stored as Semantic Web documents (Resource Description Framework)
- Inheritance in the class hierarchy
- Can be represented in a description logic. OWL 2 is compatible with SROIQ
- Can be evaluated for consistency
- Can draw inferences, e.g. If class B is a subclass of class A, where class A has property p, then b in B has p
- Can infer implicit aspects (individual in a class follows the same structure)
- Enables SWRL using the ontology information

# Case-based reasoning



# Timed Automata

- A timed automaton is a finite automaton with a finite set of real-valued clocks.
- Can be used to model and analyse systems where temporal sequence is essential, e.g. contract execution.
- Light switch example. If press is issued twice quickly (in a limited time) then the light will get brighter, otherwise the light is turned off.



# Text analysis and information extraction

- Finding particular pieces of information and structuring their relations (named entities, relations, properties, relating them). Can be used to instantiate an ontology.
- Uses the NLP 'stack'.
- Not legal 'data', e.g. statistics or spreadsheets from law enforcement, the judicial system, the government, etc.



# Controlled natural language – Attempto

- A 'looks like English' formal language
- Fixed (but large and extensible) lexicon and constrained grammar
- Written as Prolog Definite Clause Grammar
- Well-formed expressions are parsed and translated to Discourse Representation Structures (FOL)
- Deterministic (no ambiguity), assisted by construal rules
- Translation to RuleML, a markup language for rules
- Issues of deep semantic interpretation
- Useful for building consistent knowledge bases and inference
- Others C&C/Boxer, Grammatical Framework, SBVR

# XML and linked data

- eXtensible Markup Language (XML)
- Using University Resource Identifiers (URIs), we can link data across resources
- RuleML - machine readable logic
- LegalRuleML – RuleML plus additional representation for legal concepts (PrescriptiveStatement, Obligation)

```
<lrml:PrescriptiveStatement key="ps1">
  <ruleml:Rule key=":rule1" closure="universal">
    <ruleml:if>
      <ruleml:Atom key=":atom6">
        <ruleml:Rel iri=":terminateProcessingOperations"/>
        <ruleml:Ind iri=":personalData">X</ruleml:Ind>
        <ruleml:Ind iri=":dataSubject">Y</ruleml:Ind>
        <ruleml:Ind iri=":controller">C</ruleml:Ind>
      </ruleml:Atom>
    </ruleml:if>
    <ruleml:then>
      <lrml:Obligation>
        <ruleml:Or key=":or1">
          <ruleml:Atom key=":atom1">
            <ruleml:Rel iri=":destroy"/>
            <ruleml:Ind>C</ruleml:Ind>
            <ruleml:Ind>X</ruleml:Ind>
          </ruleml:Atom>
          <ruleml:Atom key=":atom2">
            <ruleml:Rel iri=":assign"/>
            <ruleml:Ind>C</ruleml:Ind>
            <ruleml:Ind>X</ruleml:Ind>
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          </ruleml:Atom>
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            <ruleml:Ind>X</ruleml:Ind>
            <ruleml:Ind>C</ruleml:Ind>
          </ruleml:Atom>
          <ruleml:Atom key=":atom4">
            <ruleml:Rel iri=":transferForScientificPurposes"/>
            <ruleml:Ind>C</ruleml:Ind>
            <ruleml:Ind>X</ruleml:Ind>
            <ruleml:Ind iri=":thirdParty">K</ruleml:Ind>
          </ruleml:Atom>
        </ruleml:Or>
      </lrml:Obligation>
    </ruleml:then>
  </ruleml:Rule>
</lrml:PrescriptiveStatement>
```