Logical English

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Logic + English + Computing

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Imperial College London

World Logic Day
University of Texas at Dallas
14 January 2021

Logical English as a Computer Language

- A general-purpose computer language based on logic programming.
- Inspired in part by the language of well-written legal documents.
- Applications to the automation of
  legal regulations and smart contracts.
- Easier to write than conventional logic programs?
- Readable without training in mathematics, computing or logic.

Implementations

Three implementations of variants of LE in Prolog, focussed primarily on legal applications

Davila, 2017	rock-paper-scissors http://demo.logicalcontracts.com/example/RockPaperScissorsBaseEN.pl
Karadotchev, 2019	ISDA Master Agreements MSc thesis. Imperial College London.
Fu, 2020	Simplified loan agreement MSc thesis. Imperial College London.

For more information:

Logical English

Position paper presented at LPOP 2020,

Logic and Practice of Programming (LPOP) 2020, 15 November 2020.

Logical English Meets Legal English for Swaps and Derivatives

Draft paper with Akber Datoo, D2 Legal Technology, London,

20 November 2020, revised 28 December 2020.

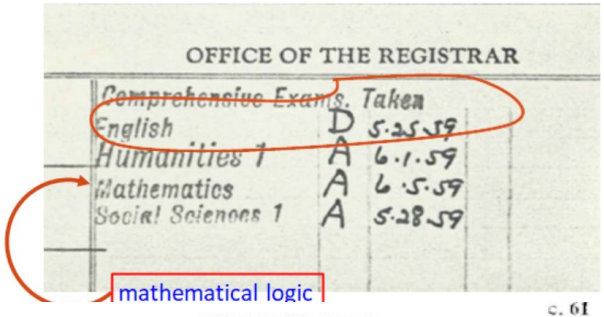
Relationships with other work

- Controlled natural languages, implemented in Prolog, for general knowledge representation:
  Attempto Controlled English (ACE) [Fuchs and Schwitter, 1996; Fuchs et al, 2008; Fuchs, 2013]
  PENG [Schwitter, 2002]

- English-like domain-specific languages for legal applications, based on logic programming
  Blaux [Morris, 2020]
  Lexon [Diedrich, 2020]

- Syntactic sugar for the logic programming language ASP + Event Calculus
  $PENG^{ASP}$ [Guy and Schwitter, 2017]

A short, personal history of Logical English


OFFICE OF THE REGISTRAR

Comprehensive Exams. Taken

English	D	5.25.59
Humanities 1	A	6.1.59
Mathematics	A	6.5.59
Social Sciences 1	A	5.28.59

mathematical logic

INFORMATION PROCESSING 74 – NORTH-HOLLAND PUBLISHING COMPANY (1974)

PREDICATE LOGIC AS PROGRAMMING LANGUAGE*

Robert KOWALSKI

University of Edinburgh, Department of Computational Logic
Edinburgh, Scotland

c. 61

ELIZABETH II

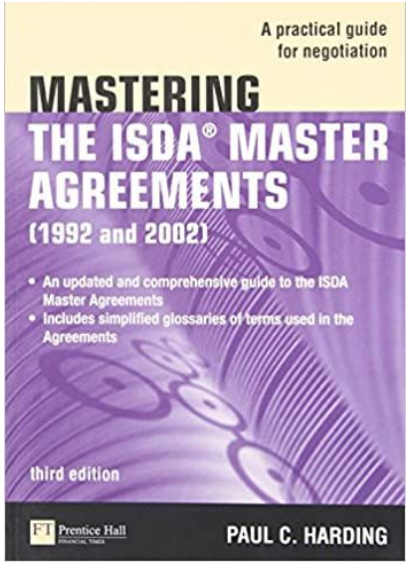
British Nationality Act 1981

1981 CHAPTER 61

An Act to make fresh provision about citizenship and nationality, and to amend the Immigration Act 1971 as regards the right of abode in the United Kingdom.
[30th October 1981]

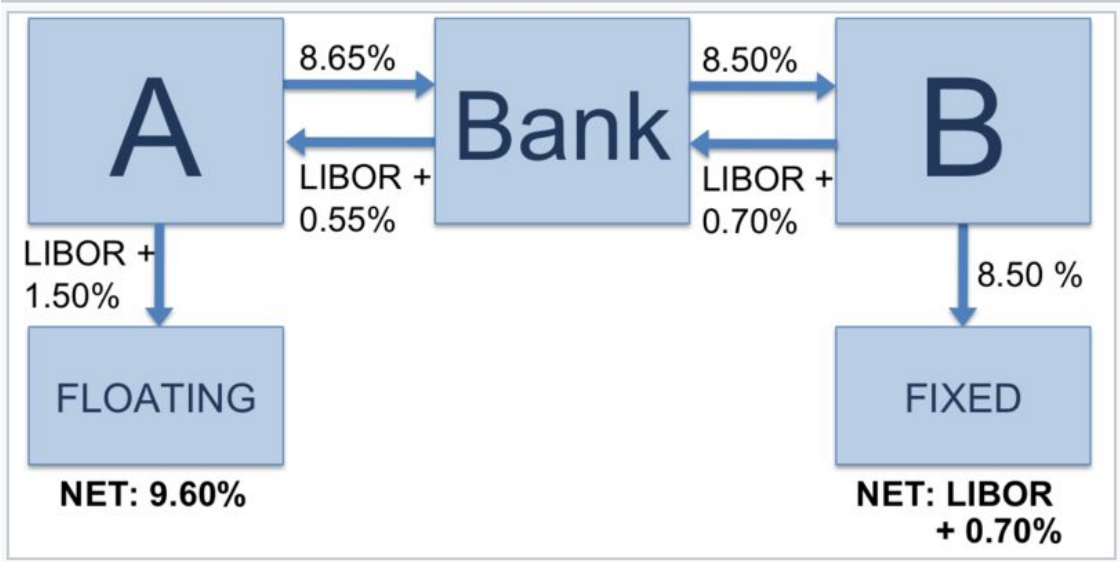

Children learn the logic of computing

Robert Kowalski and his 11-year-old daughter



Logical English

- Overview
- Logical English meets Legal English for Swaps and Derivatives



A is currently paying floating, but wants to pay fixed. B is currently paying fixed but wants to pay floating. By entering into an interest rate swap, the net result is that each party can 'swap' their existing obligation for their desired obligation. Normally, the parties do not swap payments

The plan is to develop LE as a series of extensions, starting from the basic form

The balance in an account **becomes** A + B
when an amount A is transferred into the account
and the balance in the account is an amount B.

Basic Form of LE:

The balance in an account is an amount C at a time T2
if an amount A is transferred into the account at a time T1
and T1 is immediately before T2
and the balance in the account is an amount B at T1
and C = A+B.

Variables in conditions are universally quantified with scope the sentence in which they occur

The balance in an account is an amount C at a time T2
if an amount A is transferred into the account at a time T1
and T1 is immediately before T2
and the balance in the account is an amount B at T1
and C = A+B.

Variables are symbols such as A, B, C, T1, T2,
or signalled by “a”, “an” or “the” before a common noun (like “an account”)
which represents the type of the variable.
“a” and “an” are used for the first occurrence of the variable.
“the” is used for later occurrences of the same variable in the same sentence.

Prepositions (“into”, “from”, “at”) indicate the role of an argument.

The Basic form of Logical English

Clauses of the form

conclusion if conditions.

+ Infix notation for predicates.

+ Implicit universally and existentially quantified variables signalled by “a”, “an” and “the”.

+ Typed variables indicated by common nouns

In extended LE, roles can be omitted, added or written in any order.

an amount A2 is transferred into Mary's account from Bob's account at a time T2
If an amount A1 is transferred into Bob's account at a time T1
and A2 = A1/2
and T2 is immediately after T1.

an amount A2 is transferred from Bob's account into Mary's account at a time T2
If another amount A1 is transferred into Bob's account at a time T1
and A2 = A1/2
and T2 is immediately after T1.

Some distinguishing features of Logical English

- To reduce ambiguity LE has no pronouns, such as “he”, “she”, or “it”.
- To reduce or eliminate the need for a dictionary,
  all nouns and verbs are expressed in the singular.
- All verbs are in the present tense.
  Possible because of the explicit reference to time.

Logical English

- Overview
- Existentially quantified variables with wide scope
- Logical English meets Legal English
  for ISDA (International Swaps and Derivatives)

Atomic sentences can contain variables,
which are existentially quantified.

An amount is transferred into Bob's account
from Alice's account on 23/11/2020.

means

Some amount is transferred into Bob's account
from Alice's account on 23/11/2020.

Existentially quantified variables have wide scope
beyond the sentence in which they are introduced.

The amount is greater than or equal to £10.

Atomic sentences can contain variables,
which can replaced by “skolem constants”

An amount is transferred into Bob's account from Alice's account on 23/11/2020.

means

Some amount a0017 is transferred into Bob's account from Alice's account on 23/11/2020.

a0017 is greater than or equal to £10.

Any variable in the conclusion of a sentence that is not in a condition of the sentence is existentially quantified with “wide scope”.

An amount is transferred into Bob’s account from Alice’s account on a day **if** the day is the first day of a month.

The amount is greater than or equal to £10.

If Logical English is so good, why don’t you use it yourself?

Any variable in the conclusion of a sentence **that** is not in a condition of the sentence is existentially quantified with “wide scope”.

Logical English:

A variable is existentially quantified with “wide scope”
if the variable is in **the** conclusion of a sentence
and the variable is not in a condition of the sentence.

- ”that” can be ambiguous: that conclusion? that sentence?

- “the conclusion” (instead of “a conclusion”) indicates that a sentence has only one conclusion (the relationship is functional).

Logical English

- Overview
- Existentially quantified variables with wide scope
- Logical English meets Legal English
  for ISDA (International Swaps and Derivatives)

ISDA®

International Swap Dealers Association, Inc.

MASTER AGREEMENT

dated as of December 20, 2005

Ambac Financial Services, LLC and The Public Building Authority of Blount County, Tennessee

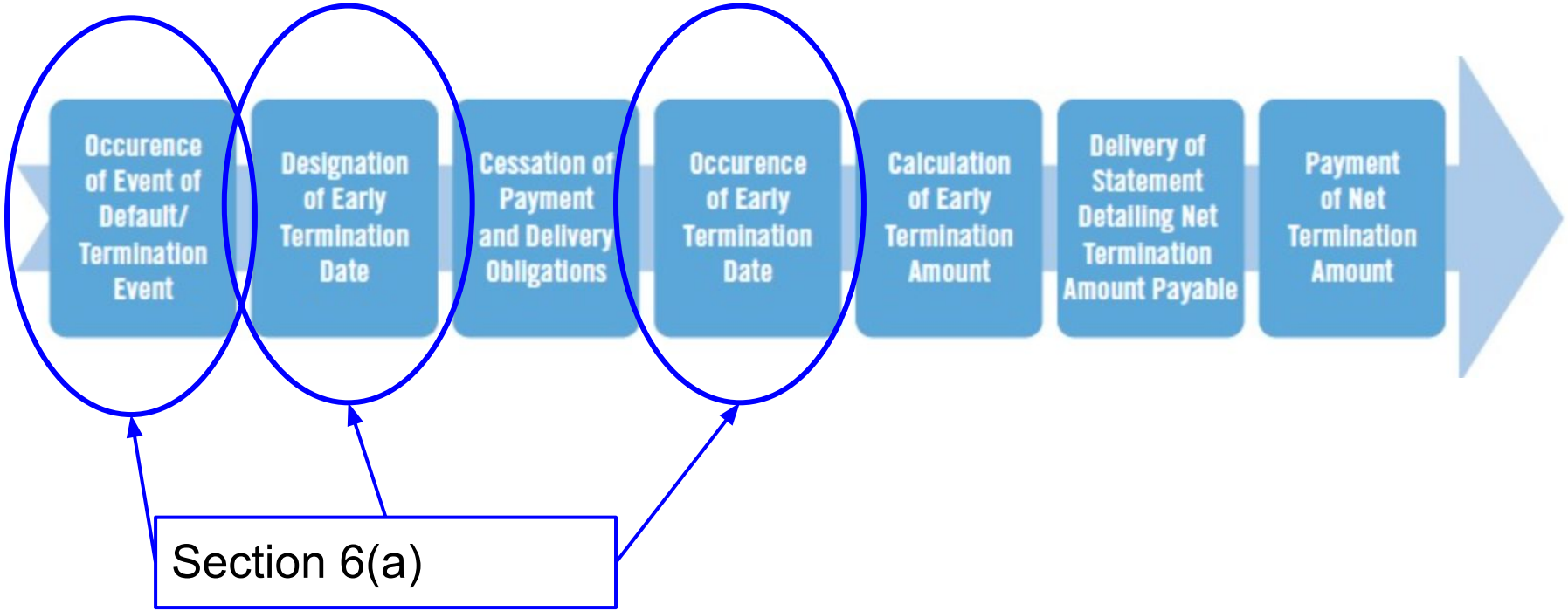
have entered and/or anticipate entering into one or more transactions (each a "Transaction") that are or will be governed by this Master Agreement, which includes the schedule (the "Schedule"), and the documents and other confirming evidence (each a "Confirmation") exchanged between the parties confirming those Transactions.

one or more Transactions

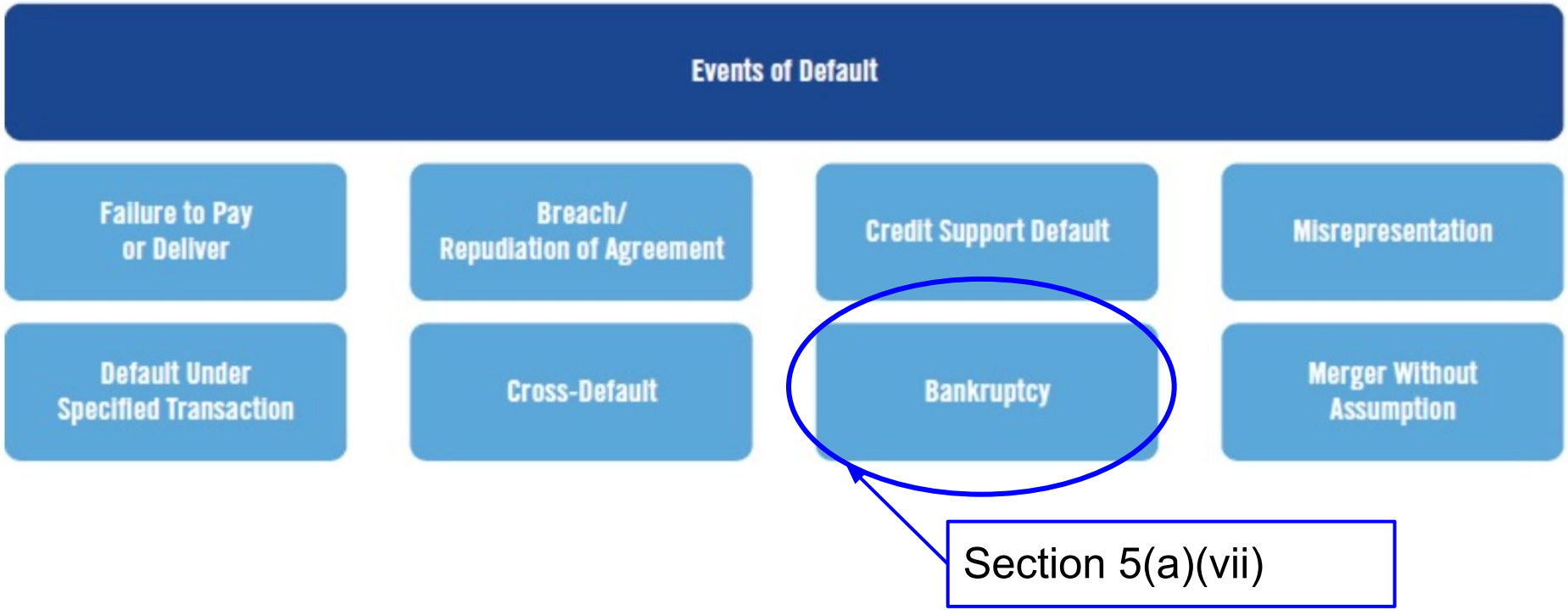
governed by this Master Agreement

includes the Schedule

From https://wikibanks.cz/event-of-default-isda/



From https://wikibanks.cz/event-of-default-isda/



Section 6(a) Early Termination upon the occurrence of an Event of Default

Two cases:

The non-defaulting party has the right to designate
the occurrence of an Early Termination Date.

If Automatic Early Termination is specified in the Schedule
and the Event of Default is a certain kind of Bankruptcy Event (Section 5(a)(vii))
then an Early Termination Date occurs Automatically.

ISDA 2002 Master Agreement - Early Termination following Event of Default

6(a) Right to Terminate Following Event of Default. **If** at any time an Event of Default with respect to a party (the “Defaulting Party”) has occurred **and** is then continuing, the other party (the “Non-defaulting Party”) **may**, by not more than 20 days notice to the Defaulting Party specifying the relevant Event of Default, designate a day not earlier than the day such notice is effective as an Early Termination Date in respect of all outstanding Transactions.

If, however, “Automatic Early Termination” is specified in the Schedule as applying to a party, **then** an Early Termination Date in respect of all outstanding Transactions **will occur** immediately upon the occurrence with respect to such party of an Event of Default specified in Section 5(a)(vii)(1), (3), (5), (6) or, to the extent analogous thereto, (8),

and as of the time immediately preceding the institution of the relevant proceeding or the presentation of the relevant petition upon the occurrence with respect to such party of an Event of Default specified in Section 5(a)(vii)(4) or, to the extent analogous thereto, (8).

A variable in the conclusion of a sentence is existentially quantified with wide scope if the variable does not occur in the conditions of the sentence

If, however, “Automatic Early Termination” is specified in the Schedule as applying to a party, **then** an Early Termination Date in respect of all outstanding Transactions will occur immediately upon the occurrence with respect to such party of an Event of Default specified in Section 5(a)(vii)(1), (3), (5), (6) or, to the extent analogous thereto, (8),

Logical English:

An Early Termination Date in respect of all outstanding Transactions occurs at a time T
if an Event of Default of type Section 5(a)(vii)(1), (3), (5), (6)
or, to the extent analogous thereto, (8) occurs for a party at T
and the Schedule specifies that Automatic Early Termination applies
to the party for the Event of Default.

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If, however, “Automatic Early Termination” is specified in the Schedule as applying to a party, **then** an Early Termination Date in respect of all outstanding Transactions **will occur….**

as of the time immediately preceding the institution of the relevant proceeding or the presentation of the relevant petition upon the occurrence with respect to such party of an Event of Default specified in Section 5(a)(vii)(4) or, to the extent analogous thereto, (8).

Logical English:

An Early Termination Date in respect of all outstanding Transactions occurs at a time T
if an Event of Default of type Section 5(a)(vii)(4) or, to the extent analogous thereto, (8) occurs for a party at T1
and the institution of the relevant proceeding for the Event of Default occurs at time T2 or the presentation of the relevant petition for the Event of Default occurs at T2
and the Schedule specifies that Automatic Early Termination applies to the party for the Event of Default **and** T is immediately before T2.

A variable in the conclusion of a sentence is existentially quantified with wide scope if the variable does not occur in the conditions of the sentence

If, however, “Automatic Early Termination” is specified in the Schedule as applying to a party, **then** an Early Termination Date in respect of all outstanding Transactions **will occur….**

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and the Schedule specifies that Automatic Early Termination applies to the party for the Event of Default **and** T is immediately before T2.

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ISDA 2002 Master Agreement - Early Termination following Event of Default

6(a) Right to Terminate Following Event of Default. **If** at any time an Event of Default with respect to a party (the "Defaulting Party") has occurred **and** is then continuing, the other party (the "Non-defaulting Party") **may**, by not more than 20 days notice to the Defaulting Party specifying the relevant Event of Default, designate a day not earlier than the day such notice is effective as an Early Termination Date in respect of all outstanding Transactions.

If, however, "Automatic Early Termination" is specified in the Schedule as applying to a party,

conclusion **if** conditions.
however, **if** other conditions then other conclusions

means

conclusion **if** conditions **and it is not the case that** other conditions.
other conclusion **if** other conditions.

Permission can be represented by meta-order or high-order predicates.

6(a) Right to Terminate Following Event of Default. **If** at any time an Event of Default with respect to a party (the "Defaulting Party") has occurred **and** is then continuing, the other party (the "Non-defaulting Party") **may**, by not more than 20 days notice to the Defaulting Party specifying the relevant Event of Default, designate a day not earlier than the day such notice is effective as an Early Termination Date in respect of all outstanding Transactions.

Logical English:

It is permitted that a party designates by a notice at a time T2 to another party that an Early Termination Date respect of all outstanding Transactions occurs at a time T3
if an Event of Default occurs with respect to the other party at time T1
and the Event of Default is continuing at T2
and the notice specifies the Event of Default
and T2 ≤ T3 **and** T3-T2 ≤ 20 days
and **it is not the case that** the Schedule specifies that Automatic Early Termination applies to the other party for the Event of Default.

Rights and permissions can be represented by meta-order or high-order predicates.

An event occurs at a time T2
if it is permitted that an agent designates by an action at a time T1
that the event occurs at T2
and the agent performs the action at T1.

Prolog:

```
happens(Event, T2) :-
permitted(Agent, designate(Action, T1, Event, T2)),
happens(Action, T1).
```

Conclusions - Logical English is a better computer language

- Manual translation of Legal English into Logical English is not easy. Automatic translation is even harder.

- Logical English is sometimes easier to read than Legal English.

- Logical English is a candidate general-purpose computer language for the future, including logic programs + types + functional expressions.

Conclusions - Logical English is a practical Logic and a good guide to the meaning of English communications

Logical English can be used to teach
Logic,
English and
Computing
all at the same time.

Logical English

We need to stop teaching humans to think like computers.

We need to teach computers to think like humans.