

Logical English for legal applications



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What is Logical English (LE)?

Historical development of LE

Examples of LE

Lessons Learned and Prospects for the Future

Legal applications of LE

- expert systems
- computable and smart contracts
- rules as code
- plain English laws

Basic Logical English (LE)

extensible

- syntactic sugar for logic programs (**pure** Prolog):
 - conclusion **if** conditions form
 - infix predicates
 - implicit quantification of variables
 - higher-order (or meta? or modal?) predicates.
- unambiguous:
 - no pronouns (he, she, it, they)
 - one word = one meaning
 - no inflection
 - time, but no tense
 - no lexicon.
- readable without training in mathematics, computing or logic.

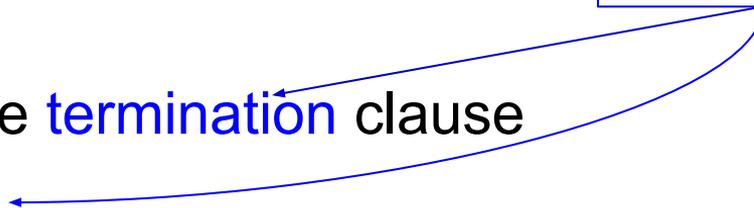
Relationships with other work

- Controlled natural languages, implemented in Prolog:
Attempto Controlled English ([ACE](#)), [PENG](#), etc.
- English-like domain-specific languages for legal applications,
based on logic programming:
[Blaux](#), [Oracle Intelligent Advisor](#)
- Syntactic sugar for the logic programming language ASP:
[PENG^{ASP}](#)
- RegelSprak?

Outline of the talk

- The University of Michigan lease **termination** clause
- The British Nationality Act
- ~~Rock Paper Scissors Smart Contract*~~
- ISDA (International Swaps and Derivatives) Early **Termination**
- Australian Small Business Rollover*
- The **default** clause of the Flood-Goodenough loan agreement*

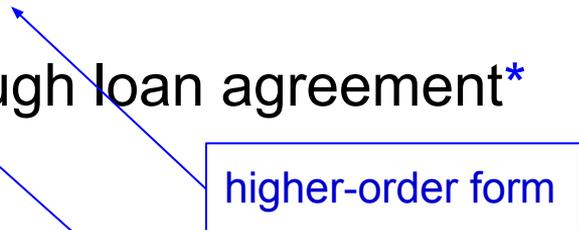
LP logical form



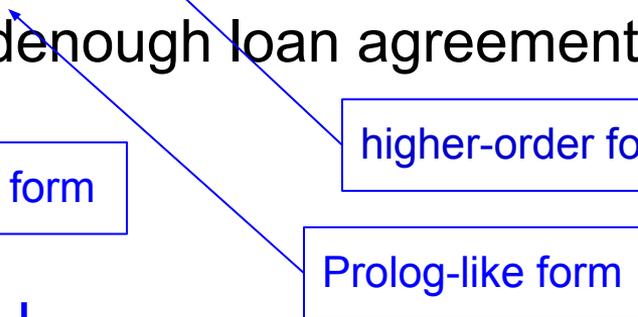
style is as important as form



higher-order form



Prolog-like form



*with online implementation in SWISH

LEIBNIZ AS LEGAL SCHOLAR

Matthias Armgardt*



Gottfried Wilhelm Leibniz (1646-1716)

At the beginning, Leibniz develops a **general theory of conditions**.
Later on, he modifies this theory for moral or legal conditions.

According to Leibniz, a condition is a structure consisting of two parts (propositiones partialibus): **the “if” part (conditio) and the “then” part (conditionatum)**.

Allen, Layman E.

Professor Emeritus of Law



Symbolic logic: a razor-edged tool for drafting and interpreting legal documents,
Yale Law J. 66 (1957) 833–879.

The University of Michigan lease termination clause - Allen and Saxon 1984

The University may terminate this lease when the Lessee, having made application and executed this lease in advance of enrolment, is not eligible to enrol or fails to enrol in the University or leaves the University at any time prior to the expiration of this lease, or for violation of any provisions of this lease, or for violation of any University regulations relative to residence or for health reasons, by providing the student with written notice of termination 30 days prior to the effective time of termination, unless life, limb or property would be jeopardised, the Lessee engages in the sale or purchase of controlled substances in violation of Federal, state, or local law, or the Lessee is no longer enrolled as a student, or the Lessee engages in the use of firearms, explosives, inflammable liquids, fireworks or other dangerous weapons within the building or turns in a false alarm in which case a maximum of 24 hours notice would be sufficient.

The University may terminate this lease

when the Lessee,

having made application

and executed this lease in advance of enrolment,

is not eligible to enrol

or fails to enrol in the University

or leaves the University at any time prior to the expiration of this lease,

or for violation of any provisions of this lease,

or for violation of any University regulations relative to residence

or for health reasons,

by providing the student with written notice of termination 30 days prior to the effective time of termination,

unless

life, limb or property would be jeopardised,

the Lessee engages in the sale or purchase of controlled substances in violation of Federal, state, or local law,

or the Lessee is no longer enrolled as a student,

or the Lessee engages in the use of firearms, explosives, inflammable liquids, fireworks or other dangerous weapons within the building

or turns in a false alarm in which case a maximum of 24 hours notice would be sufficient.

The clause has the ambiguous form:

A if A1 and A2 or A3 or A4 or A5 or A6 or A7
unless B1 or B2 or B3 or B4 or B5 in which cases B.

Allen & Saxon (1984) conclude that the intended interpretation is:

((A IF ((A1 AND (A2 OR A3)) OR A4 OR A5 OR A6 OR A7))
IF NOT (B1 OR B2 OR B3 OR B4 OR B5))
AND (IF (B1 OR B2 OR B3 OR B4 OR B5) THEN B)
AND (IF NOT (B1 OR B2 OR B3 OR B4 OR B5) THEN NOT B

The intended meaning has logic programming form:

((A IF ((A1 AND (A2 OR A3)) OR A4 OR A5 OR A6 OR A7))
~~IF~~ **AND** NOT (B1 OR B2 OR B3 OR B4 OR B5)).

~~AND~~ (IF (B1 OR B2 OR B3 OR B4 OR B5) THEN B).

~~AND (IF NOT (B1 OR B2 OR B3 OR B4 OR B5) THEN NOT B~~

In Logical English with indentation instead of parentheses

A

IF A1
 AND A2
 OR A3

 OR A4
 OR A5
 OR A6
 OR A7

B

IF B1
OR B2
OR B3
OR B4
OR B5.

AND NOT
 B.

unless B



Well-written legislation has logic programming form:

ARTICLES

THE BRITISH NAT AS A LOGIC PROG

Communications of the ACM May 1986 Volume 29

- 1.-(1) A person born in the United Kingdom after commencement shall be a British citizen if at the time of birth his father or mother is
- (a) a British citizen; or
 - (b) settled in the United Kingdom.

As a first approximation, 1.-(1)(a) can be represented by the rule

```
x is a British citizen
if x was born in the U.K.
and x was born on date y
and y is after or on commencement
and z is a parent of x
and z is a British citizen on date y
```

http://demo.logicalcontracts

5 the templates are:

6 *a person* acquires british citizenship on *a date*,
7 *a person* is born in the uk on *a date*,
8 *a date* is after commencement,
9 *a person* is the mother of *a person*,
10 *a person* is the father of *a person*,
11 *a person* is a british citizen on *a date*,
12 *a person* is settled in the uk on *a date*.

14 the knowledge base citizenship includes:

15 a person acquires british citizenship on a date
16 if the person is born in the uk on the date
17 and the date is after commencement
18 and an other person is the mother of the person
19 or the other person is the father of the person
20 and the other person is a british citizen on the date
21 or the other person is settled in the uk on the date.

23 scenario one is:

24 john is born in the uk on 2016-06-02.
25 2016-06-02 is after commencement.
26 mary is the mother of john.
27 mary is settled in the uk on 2016-06-02.

29 query one is:

30 which person acquires british citizenship on which date.

 answer("query one with scenario one").

 expanded LE to [predicates([7]),(acquires_british_citizenship_on(_15802,_158204),_158204 after commencement),is_the_mother_of(_158244,_158244);is_a_british_citizen_on(_158244,_158204);is_settled_in_the_uk_on(_158244,_158204);born_in_the_uk_on(john,1464825600.0):-true),(1464825600.0 after commencement):-true),(is_settled_in_the_uk_on(mary,1464825600.0):-true)],true)],(n(_158070,_158072))]

Query one with one : a person acquires british citizenship on a date

Answer: john acquires british citizenship on 2016-6-2T0:0:0.0

true



?- answer("query one with scenario one").

TaxLog

An expert system shell midway between
Prolog and Logical English

Miguel Calejo
Bob Kowalski
Jacinto Dávila

with support from and collaboration with
Bruce and Chris Mennell, Aora, London
Andrew Noble, LodgeIT, Perth

The Aora Nationality Determiner provides legal opinions for claims to British nationality and Irish citizenship. It uses a unique combination of fact-finding, workflow and legal reasoning technologies to provide accurate, audited, and reliable determinations.

HOW IT WORKS



Example: **R&D Tax Reliefs**

http://demo.logicalcontracts.com:8082/p/research_and_development_tax_reliefs.pl

<https://www.gov.uk/guidance/corporation-tax-research-and-development-rd-relief>

Example: **Net Asset Value**

http://demo.logicalcontracts.com:8082/p/cgt_maximum_net_asset_value.pl

<https://www.ato.gov.au/general/capital-gains-tax/small-business-cgt-concessions/basic-conditions-for-the-small-business-cgt-concessions/maximum-net-asset-value-test/>

Example: **Rollover**

http://demo.logicalcontracts.com:8082/p/cgt_concessions_sb_restructure_rollover.pl

<https://www.ato.gov.au/general/capital-gains-tax/small-business-cgt-concessions/small-business-restructure-rollover>

Example: **Affiliates**

http://demo.logicalcontracts.com:8082/p/cgt_affiliates.pl

<https://www.ato.gov.au/general/capital-gains-tax/small-business-cgt-concessions/basic-conditions-for-the-small-business-cgt-concessions/affiliates/>

Example: **Reserve Tax reliefs**

http://demo.logicalcontracts.com:8082/p/stamp_duty_reserve_tax_reliefs.pl

<https://www.gov.uk/guidance/stamp-duty-reserve-tax-reliefs-and-exemptions>

Example: **Statutory residence**

http://demo.logicalcontracts.com:8082/p/statutory_residence_test_guidance.pl

<https://www.gov.uk/hmrc-internal-manuals/residence-domicile-and-remittance-basis/rdrm11040>



Australian Government

Australian Taxation Office

Small business restructure rollover

The small business restructure rollover allows small businesses to transfer active assets from one entity (the transferor) to one or more other entities (transferees), on or after 1 July 2016, without incurring an income tax liability.

This rollover applies to the transfer of active assets that are capital gains tax (CGT) assets, trading stock, revenue assets or depreciating assets.

You can access this concession if your aggregated turnover is less than \$10 million.

47 the small business restructure rollover applies to an event
48 if the event occurs at a time
49 and the time is after 2016-07-01
50 and the event is a transfer of an asset by a transferor to a transferee
51 and the asset is an eligible asset
52 and the event is part of genuine restructuring as informed by a source
53 and the event meets the ultimate ownership test at the time

54 and for all cases in which

55 a party is a party of the event

56 and an amount is the aggregated turnover of the party

57 it is the case that:

58 the party is an eligible party

59 and the amount < 10000000.

60
61 an event meets the ultimate ownership test at a time
62 if the event is a transfer of an asset by a transferor to a transferee
63 and a previous time is immediately before the time

64 and for all cases in which

65 an entity is an ultimate owner of the asset at the time

66 and the entity has a share in the asset at the time

67 it is the case that:

68 the entity is an ultimate owner of the asset at the previous time

69 and the entity has a share in the asset at the previous time.

Translates into
forall in Prolog.

Logical English meets legal English for swaps and derivatives

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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, **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).

It is permitted

that a party designates by a notice at a time T2 to an other party

that an Early Termination Date in respect of a Transaction occurs at a time T3

if the Transaction is outstanding at T3

and an Event of Default occurs with respect to the other party at a time T1

and the Event of Default is continuing at T2

and the notice specifies the Event of Default

and $T2 \leq T3$ and $T3 - T2 \leq 20$ 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.

Adds an exception
to the rule

Higher-order or Metalevel or Modal predicates

An event happens at a time T2

if it is permitted **that** a party designates by an action at a time T1 **that** the event happens at T2
and the party designates by the action at T1 **that** the event happens at T2.

T2 could be after T1

5 the templates are:

6
7 it is permitted that **an eventuality**,
8 **a party** designates by **an action** at **a time** t
9 **an event** happens at **a time**,
10 **a party** performs **an action** at **a time**.
11 **a time** is on or before **a time**.

12
13 the knowledge base metaevent includes:

14
15 An event happens at a time T2
16 if it is permitted that a party designates by an
17 and the party designates by the action at T1 that

18
19 scenario test is:

20 it is permitted that bob designates by email at a
21 if T1 is on or before T2.

22
23 bob designates by email at Monday that this meeti
24 Monday is on or before Friday.

25
26 query one is:

27 which event happens at which time.
28

 answer("query one with scenario test").

 expanded LE to [predicates([5]),(happens_at(_61
_at(_6146,_6148))),designates_by_at_that(_6162,
_that(designates_by_at_that(bob,email,_6070,hap
b,email,Monday,happens_at(this_meeting,Friday))
6020,_6022))]

Query one with test : an event happens at a time

Answer: this meeting happens at Friday

true

?- answer("query one with scenario test").

15-04 | March 26, 2015
Revised March 27, 2017

Contract as Automaton: The Computational Representation of Financial Agreements

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Table 2: A Streamlined Loan Agreement

Agreement

This loan agreement dated June 1, 2014, by and between Lender Bank Co. ("Lender") and Borrower Corp. (Borrower), will set out the terms under which Lender will extend credit in the principal amount of \$1,000 to Borrower with an un-compounded interest rate of 5% per annum, included in the specified payment structure.

1. The Loan:

At the request of Borrower, to be given on June 1, 2014, Lender will advance \$1000 to Borrower no later than June 2, 2014. If Borrower does not make such a request, this agreement will terminate.

2. Repayment:

Subject to the other terms of this agreement, Borrower will repay the loan in the following payments:

- (a) Payment 1, due June 1, 2015, in the amount of \$550, representing a payment of \$500 as half of the principal and interest in the amount of \$50.
- (b) Payment 2, due June 1, 2016, in the amount of \$525, representing a payment of \$500 as the remaining half of the principal and interest in the amount of \$25.

3. Representations and Warranties:

The Borrower represents and warrants, at the execution of this agreement, at the request for the advance of funds and at all times any repayment amount shall be outstanding, the Borrower's assets shall exceed its liabilities as determined under an application of the FASB rules of accounting.

4. Covenants:

The Borrower covenants that at the execution of this agreement, at the request for the advance of funds and at all times any repayment amount shall be outstanding it will make timely payment of all state and federal taxes as and when due.

5. Events of Default:

The Borrower will be in default under this agreement upon the occurrence of any of the following events or conditions, provided they shall remain uncured within a period of two days after notice is given to Borrower by Lender of their occurrence (such an uncured event an "Event of Default"):

- (a) Borrower shall fail to make timely payment of any amount due to Lender hereunder;
- (b) Any of the representation or warranties of Borrower under this agreement shall prove untrue;
- (c) Borrower shall fail to perform any of its covenants under this agreement;
- (d) Borrower shall file for bankruptcy or insolvency under any applicable federal or state law.

A default will be cured by the Borrower (i) remedying the potential event of default and (ii) giving effective notice of such remedy to the Lender. In the event of multiple events of default, the first

to occur shall take precedence for the purposes of specifying outcomes under this agreement.

6. Acceleration on Default

Upon the occurrence of an Event of Default all outstanding payments under this agreement will become immediately due and payable, including both principal and interest amounts, without further notice, presentment, or demand to the Borrower.

7. Choice of Law:

This agreement will be subject to the laws of the State of New York applicable to contracts entered into and performed wholly within that state.

8. Amendments and Waivers:

Any purported amendment to, or waiver of rights under, this agreement will only be effective if set forth in writing and executed by both parties.

9. Courts and Litigation:

Any legal action brought to enforce, interpret or otherwise deal with this agreement must be brought in the state courts of the State of New York located in New York County, and each of the parties agrees to the jurisdiction of such courts over both the parties themselves and over the subject matter of such a proceeding, and waives any claim that such a court may be an inconvenient forum.

10. Time of the Essence; No Pre-Payment

Timely performance is required for any action to be taken under this agreement, and, except as may otherwise be specifically provided herein, failure to take such action on the day specified will constitute a binding failure to take such action. Payments shall only be made on or after the dates specified in Section 2 or on or after such other date as may be required under Section 6; pre-payments made on earlier dates shall not be accepted.

11. Notices

Notices provided for in this agreement will be given by an email to the email addresses set out below and will be effective upon receipt.

[Lender email here]

[Borrower email here]

Accepted and agreed:

LENDER BANK CO.

BORROWER CORP.

By: _____

By: _____

Title: _____

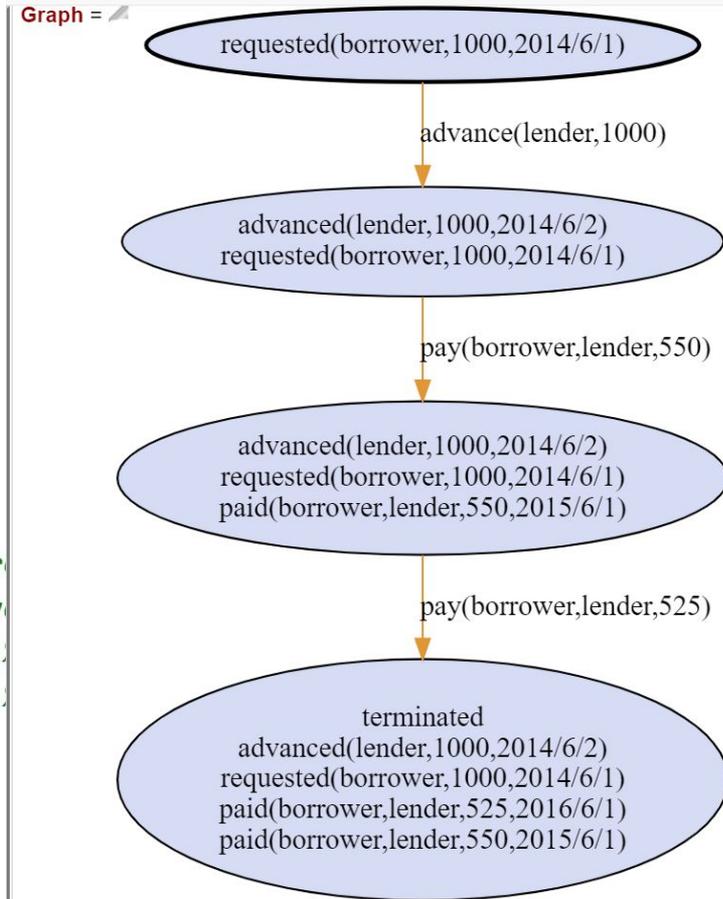
Title: _____

[NOTE: Statute of Limitations on debt obligations in NY is 6 years]

Draft of July 23, 2014

The loan agreement in LPS simulating DFA

```
70 % The simplest case with no complications:  
71 %  
72 observe request(borrower, 1000) at '2014-06-01'. % r  
73 observe advance(lender, 1000) at '2014-06-01'. % adv  
74 observe pay(borrower, lender, 550) at '2015-06-01'.  
75 observe pay(borrower, lender, 525) at '2016-06-01'.  
76
```



?- state_diagram(Graph).

The English formulation of the loan agreement is incoherent.

An event of default occurs **retroactively** when one of the events (a)-(d) occurs if the borrower does not cure the event within two days after the lender notifies the occurrence.

5. Events of Default

The Borrower will be in default under this agreement upon the occurrence of any of the following events or conditions, provided they shall remain uncured within a period of two days after notice is given to Borrower by Lender of their occurrence (such an uncured event an "Event of Default"):

- (a) Borrower shall fail to make timely payment of any amount due to Lender hereunder;
- (b) Any of the representation or warranties of Borrower under this agreement shall prove untrue;
- (c) Borrower shall fail to perform any of its covenants under this agreement;
- (d) Borrower shall file for bankruptcy or insolvency under any applicable federal or state law.

All outstanding payments need to be made **immediately (and retroactively)** as soon as the Event of Default occurs.

6. Acceleration on Default

Upon the occurrence of an Event of Default all outstanding payments under this agreement will become immediately due and payable, including both principal and interest amounts, without further notice, presentment, or demand to the Borrower.

A more direct representation of the loan agreement in LE, with only events and without states/fluents

17 *the borrower has obligation1.*

18 *obligation1 is that the borrower pays 550 to the Lender on 2015-06-01.*

19

20 *the borrower has obligation2.*

21 *obligation2 is that the borrower pays 525 to the Lender on 2016-06-01.*

22

23 *the borrower defaults on a date D3*

24 *if the borrower has an obligation*

25 *and the borrower fails on a date D0 to fulfil the obligation*

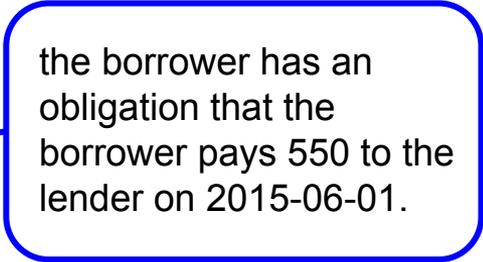
26 *and the Lender notifies the borrower on a day D1 that the borrower fails on D0 to fulfil the obligation*

27 *and D3 is 2 days after D1*

28 *and it is not the case that*

29 *the borrower cures on a day D2 the failure of the obligation*

30 *and D2 is on or before D3.*



the borrower has an
obligation that the
borrower pays 550 to the
lender on 2015-06-01.

22 the borrower defaults on a date D3
 23 if the borrower has an obligation
 24 and the borrower fails on a date D0 to fulfil the obligation
 25 and the lender notifies the borrower on a day D1 that the borrowe
 26 and D3 is 2 days after D1
 27 and it is not the case that
 28 the borrower cures on a day D2 the failure of the obligation
 29 and D2 is on or before D3.

30

31 the borrower fails on a date to fulfil an obligation
 32 if the obligation is that the borrower pays an amount to the Le
 33 and it is not the case that
 34 the borrower pays the amount to the Lender on the date.

35

36 the borrower cures on a first date the failure of an obligation
 37 if the obligation is that the borrower pays an amount to the Le
 38 and the borrower pays the amount to the Lender on the first dat

39

40 A date D1 is on or before a date D2
 41 if D2 is a X days after D1
 42 and $X \geq 0$.

43

44 scenario one is:
 45 the Lender notifies the borrower on 2016-06-02 that the borrower
 46 % the borrower pays 525 to the Lender on 2016-06-02.

47

48 query one is:
 49 which person defaults on which day.

 answer("query one with scenario one").

 expanded LE to [predicates([8]),(has(the_borrower,wer,550,the_lender,1433116800.0)):-true),(has(the_borrower,525,the_lender,1464739200.0)):-true,(408),fails_on_to_fulfil(the_borrower,_310414,_310408),is_day_borrower,_310458,_310408),is_on_or_before(_310458,-is_that(_310324,pays_to_on(the_borrower,_310342,the_lender,_310322)),(cures_on_the_failure_of(the_borrower,_310290,the_lender,_310294)),pays_to_on(the_borrower,10232):-is_days_after(_310232,_310244,_310230),_310232,the_borrower,1464825600.0,fails_on_to_fulfil(the_borrower,_310146,_310148)),query(two ,notifi

Query one with one : a borrower defaults on a date

Answer: the borrower defaults on 2016-6-4T0:0:0.0

true

?- answer("query one with scenario one").

Examples▲

History▲

Solutions▲

Lessons learned

- It is hard to design a CNL that
is a simple and powerful computer language,
is natural to read in English,
has very wide coverage.
- Important to have easy-to-use editing, debugging and exploration tools.
- Essential to have a free, easy-to-use online implementation (e.g. on SWISH).

Prospects for the Future

- All computer languages should be readable without training.
- But learning to write will be harder than learning to read.
- Learning to write well will be much harder.
- We need a corpus of well-written examples.
- Legal applications are a good place to start.

Online implementation soon to be available from:

<http://logicalcontracts.com>