TSINGHUA LECTURES ON LOGIC AND NATURAL LANGUAGE

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LECTURE 2

NATURAL LANGUAGE EXPRESSION OF LOGICAL OPERATORS

We compare several logical properties of natural languages (NLs) with standard Predicate Logic (PL). We assume some verbal familiarity with LECTURE 1.

1. Generalizing Generalized Quantifiers (GQs)

How natural is it to treat GQs – *all / most students* – as taking n+1 place predicates (P_{n+1}s) as arguments, rather than just P_1s? This makes some uneasy.

In answering this question I feel a bit like the famous bank robber Willie Sutton, who, when asked why he robbed banks, looked puzzled for a second and then answered "Because that's where the money is".

If you think it is unnatural for NPs to combine with P_{n+1}s to form P_ns you must ask yourselves why they so obviously do: *Most students* gave *every teacher more than one apple*. Mathematically $P_{n+1} \Rightarrow P_n$ is the natural generalization; specific evidence would be needed to support that GQs could take P_1s as arguments but not P_ns for n > 1. We support what I shall call:

THE FIRST HEURISTIC

Assume things are as they appear until evidence to the contrary

Humans mostly do not inadvertently step in front of speeding cars or walk off the roofs of twenty storey buildings. But such situations are too recent to have exercised evolutionary influence over us. Nor do schools give lessons in how to walk on the roofs of twenty storey buildings. Still our brains and senses stand us in good stead here. So we should rely on them until our minds tell us otherwise. We should not disparage Ptolemy, but rather acknowledge Copernicus, Brahe, Kepler, Galileo and Newton for insights that took us beyond the obvious.

Here we show that linguistic study essentially includes that of relations between P_ms and P_ns for various values of n,m (the *valency* or *arity* of the predicates). We begin with some traditional topics in bound morphology.

1. Verbal Morphology

1.1 Valency decreasing Operations

Many languages present bound morphology that converts an (active) P_2 to a (passive) P_1. Bantu languages (Kinyarwanda, Swahili) are examples, as are languages of the Philippine type (Tagalog, Malagasy) and Latin, Turkish, Sre (Mon-Khmer), Welsh, K'ekchi (Mayan), and many others.

(1) a. Hasan bavul-u aç-ti Turkish (Perlmutter 1983)
Hasan suitcase.acc open-past
Hasan opened the suitcase

b. Bavul-∅ (Hasan tarafından) aç-il-di
Suitcase-nom Hasan by open-pass-past
The suitcase was opened (*by Hasan*)

Hasan tarafından is optional (often rejected), so the verb *açildi* is a P_1. The shape of the passive morpheme is phonologically conditioned: *-in* after laterals (like *l* and *r*), mere *-n* after vowels, and *il* otherwise. And as elsewhere in Turkish, its vowel harmonizes in backness, so *in* may appear as *un*.

Now this morphology also applies to P_1s to form P_0s, as in (2). (Keenan 2013). (3) is a Latin example (from Virgil).

(2) Burada düş-ül-ür
here fall-pass-aorist
Here one falls ("It is fallen by people").

(3) Sic itur ad astra
Thus go.pass to stars
Thus one goes to the stars

Similar cases of passive morphology on both P_2s and P_1s exist in Sesotho (Bantu; S. Africa) and Tariana (Arawakan; Brazil). European languages usually form passives with an auxiliary verb (BE, BECOME) + a morphological modification of the P_2 (past participle). Dutch (4) and German use this form with P_1s as well.

(4) a. De jongens fluiten
The boys whistle
The boys are whistling

b. Er wordt (door de jongens) gefloten
There becomes (by the boys) whistled
There is whistling (by the boys)

Finally and somewhat surprisingly, passive morphology may iterate: $P_2 \Rightarrow P_1 \Rightarrow P_0$.

(5) Bu oda-da döv-ül-ün-ür Turkish (Özkaragöz 1986a)
this room-loc hit-pass-pass-aorist
One is beaten (by one) in this room

Such iteration also applies in Irish Gaelic (Keenan 2013), Lithuanian (Timberlake 1982) and Sanskrit (Legate et al 2020). (In all these cases Legate et al argue that that the $P_1 \Rightarrow P_0$ step is effected by an operation technically different from the one that derives P_1s from P_2s, though it uses the same morphology).

Also, usually a passive morphology which derives P_1s from P_2s also applies to P_3s like *give*, *offer*, *serve* to derive P_2s – *was given*, etc. Languages vary with regard to whether e.g. the passive of *give* takes the recipient of the giving as subject or the object given (or either – Kinyarwanda, Malagasy).

(6) a. Nanome ny antsy azy Rabe — Malagasy
pst.act.give the knife him Rabe — (Austronesian, Madagascar)
Rabe gave the knife to him

b. Nomen-dRabe (nomena + Rabe) ny antsy izy
pst.give.pass-Rabe the knife he
He was given the knife by Rabe

c. Nomen-dRabe (nomena+Rabe) azy ny antsy
pst.give.pass-Rabe him the knife
The knife was given to him by Rabe

1.2 Valency Increasing Operations

Commonly enough (Song 2005) languages present causative affixes that derive P_{n+1}s from P_ns: *the children cried* / *John made-cry the children*. We find such affixes in Japanese, Turkic, Bantu, and Philippine type languages. Here are some Malagasy examples. They illustrate in order $P_1 \Rightarrow P_2$, $P_2 \Rightarrow P_3$ and $P_3 \Rightarrow P_4$.

(7) a. m-atory izy
pres.act-sleep he
He is sleeping

b. m-amp-atory azy ny lahateninao
pres-cause-sleep him the speech.your
Your speech is making him sleep

(8) a. manasa lamba izy
wash clothes she
She is washing clothes

b. m-amp-anasa lamba azy aho
pres-cause-wash clothes her I
I am making her wash clothes

(9) a. mandroso vary ny vahiny izy
serve rice the guest she
She serves rice to the guest

b. m-amp-androso vary ny vahiny azy aho
pres-make-serve rice the guest her I
I make her serve rice to the guest

And as with passive morphology it is often awkward to iterate causative morphology even when it is semantically reasonable and phonologically innocuous. Still, (10c) from Malagasy (Keenan and Ralalaoherivony 2020) and (11b) from Turkish (Özkaragöz 1986b) attest to its possibilities:

(10) a. n-ihomehy Rabe
pst-laugh Rabe
Rabe laughed

b. n-amp-ihomehy an-dRabe aho
pst-cause-laugh acc-Rabe I
I made Rabe laugh

c. n-amp-amp-ihomehy an-dRabe azy aho
pst-cause-cause-laugh acc-Rabe him I
I made him make Rabe laugh

(11) a. kadin kasab -a et -i kes-tir-di
woman butcher-dat meat-acc cut-cause-pst
The woman had the butcher cut the meat

b. Ben Sema-yi Turhan vasitasiyle koş-tur -t -tu -m
I Sema-acc Turhan by.means.of run-cause-cause-pst-1sg
I made Turhan make Sema run

NLs like Turkish, Japanese and Malagasy with rich verbal derivational morphology allow passive to apply to causative predicates. By applying causative then passive in succession we can go from $P_1 \Rightarrow P_2 \Rightarrow P_1$. Turkish (12) shows two applications of passive after causative (Legate et al 2020). Neither Malagasy nor Turkish allow causativizing a passive, in Japanese it is marginal to bad (T. Ishizuka, pc) but apparently is allowed in Inuktitut[1] (Legendre 1995).

(12) ampanasain-dRabe (∅-amp-anasa-ina+Rabe) lamba izy Malagasy
pres-cause-wash-pass+Rabe clothes she
She is made to wash clothes by Rabe

(13) harp-te asker-ler tarafından vur-dur-ul-un-uyor-du Turkish
war-loc soldier-pl by shoot-cause-pass-pass-prog-pst
In war, one used to be made to shoot by soldiers

(14) a. Nutara-up arna-mut angut aktuq-ti-taa Inuktitut (Eskimo)
child-erg woman-all man-abs touch-cause-3s/3s
The child made a woman touch the man

b. Natura-up angut arna-mit aktuq-tau-ti-tas
child-erg man-abs woman-abl touch-pass-cause-3s/3s
The child made the man be touched by the woman

Other valency decreasing morphologies in NL are reflexives (*shame oneself*), reciprocals (*criticize each other*) and middles (*The door closed*). Applicatives, as in Latin: *ferre* 'to carry' a P_2 ⇒ *in+ferre* 'carry into' a P_3; *trans+ferre* 'carry across', *circum+ferre* 'carry around', *ex+ferre* 'carry from'). Applicatives are prominent in Bantu but we see them in Caucasian languages and in Totonac (Central America) as well. The most widespread applicative is a Benefactive: *speak* ⇒ *speak for*/*on behalf of* (Polinsky 2005).

2. Binding

Generative grammar has been concerned to define the distribution of essential anaphors like *himself* in (15a,c,d) and the meaning difference in (15a,b).

(15) a. Ed embarrassed himself b. Ed embarrassed him
c. *Himself embarrassed Ed d. *Himself laughed (* = ungrammatical)

To semantically interpret (15a), e.g. to understand who is embarrassed, we must understand that *himself* is "bound" to the subject NP, *Ed*. So Ed got embarrassed. But *himself* cannot be treated as a mere syntactic replacement for *Ed* as this does not generalize to Ss like (16a), not logically equivalent to (16b). Replacing *every* by *some*, *no*, or *exactly one* preserves the meaning differences.

(16) a. Every student embarrassed himself ≠
b. Every student embarrassed every student

Comparing (15a,d) we see that reflexives like *himself* don't combine with P_1s but do with P_ns, n > 1. So again the valency (arity) of Predicates is basic in current grammatical theory. Accounting for the distribution and interpretation of reflexive pronouns in English requires positing a *relation* (*binding*) between two or more arguments of a predicate. So we have P_2s. As the predicates increase in valency so does the complexity of the binding, there is a greater variety of possible antecedents – even ambiguities, as in *John protected Bill from himself.*

Our point is that reflexive binding requires predicates with two or more arguments. Suppose that all verbs in English were P_1s. Then the catalogue of facts we noted concerning (15a-d) would not exist. Moreover, once a language has P_2s a large variety of traditional linguistic concern arise – *verb agreement*,

case marking, and *fixity of word order* – all of which are used to distinguish the two or more arguments of (di)transitive verbs (which is important. If you tell me *X killed Y* we want to know who is dead, and who is responsible). So, many of the topics of traditional linguistics only arise at the level of P_ns, n > 1.

3. Expressive power The question of P_2s has an unexpected consequence for NL semantics in terms of expressive power. *Another lesson from PL*. Recall that in Sentential Logic – A set of unanalyzed atomic formulas closed under the formation of boolean compounds – there is an algorithm which when applied to any formula tells us whether it is valid or not. The algorithm just computes the truth table for the formula. In First Order PL we have a stock of atomic formulas – P_ns combined with n terms, the whole set then closed under boolean compounding and quantification. In general validity is not decidable (algorithmic) in these languages – with one systematic exception: if a first order language has only one place predicates, no P_ns for n>1, then validity is once again decidable. Add a single freely interpreted P_2 to your language and you lose decidability (Boolos and Jeffrey 1989, Ch 25). Thus we see that the existence of P_ns, n>1 in a NL tells us something about its logical expressive power.

4 The role of common nouns in quantified NPs

4.1 Conservativity In Ss of the form [Det+CNP]+P_1 e.g. *Most poets daydream*, the role of the common noun(phrase), *poet* here, is to restrict the domain of objects under consideration to those it denotes. Thus NL quantifiers overwhelmingly satisfy the Conservativity constraint in (17). (see Zuber and Keenan 2019 for a modest generalization): For D a Determiner denotation, A and B sets:

(17) $D(A)(B) = D(A)(A \cap B)$ Conservativity (CONS)

Requiring Ds to satisfy CONS guarantees the logical equivalence in (18):

(18) Most swans are white ≡ Most swans are swans and are white
≡ Most swans are swans that are white

This equivalence seems trivial: the predicate *are swans that are white* repeats information in the CNP. Surprisingly CONS strongly limits possible quantifier denotations: In a universe E with n elements there are $2^n \cdot 2^n = 4^n$ pairs of subsets of E and thus 2 to 4^n functions from such pairs into {0,1}. But only 2 to 3^n of those functions are conservative (Thysse 1983, Keenan & Stavi 1986). So over a

universe E with just two elements there are $2^{16} = 65{,}536$ functions from pairs of properties to truth values, only $2^9 = 512$ of which are conservative! So CONS rules out most of the functions of the relevant type. The mathematically natural equi-cardinality function F below fails CONS, as sets A and B may be the same size but A and A∩B not (e.g. let A,B be non-empty disjoint sets of the same size: then $|A| = |B|$ but $0 < |A| \neq |A \cap B| = 0$):

Now the restricting action of CNPs carries over to the object argument of a P_2:

(19) $(D_1A)((D_2B)(R)) \quad = \quad (D_1A)(D_2B)((A \times B) \cap R)$

So we don't have to know about all pairs (x,y) in R, but only those with x in A and y in B. To evaluate *No student criticized each teacher* we only need consider pairs (x,y) in the **criticize** relation where x is a student and y is a teacher.

Thus when Quantified NPs (QNPs) combine with P_2s they constrain reference in just the same way as they do when they combine with P_1s. Moreover in two respects NLs incorporate this idea more than PL does. First, standard quantifiers in PL – **all**, **some**, and other definable ones, like **no** and **exactly 2**, allow us to eliminate the restricting effect of the CNP by eliminating it, quantifying instead over all entities in E, and forming a new predicate from boolean compounds of the original CNP and P_1: the (a,b) pairs below are logically equivalent:

(20) a. Some swans are white (Some x)(swan(x) ∧ white(x))
b. Some individuals are both swans and white

(21) a. All swans are white (All x)(swan(x) → white(x))
b. Any individual who is a swan is white

(In mathematical discourse **if-then** is boolean: *if p then q* ≡ *either not p or q*). In beginning courses we have our students practice these paraphrases, as though ordinary English were logically inadequate. And NLs <u>do</u> present simple Ss in which the restricting effect of CNPs is not dismissable in this way. Let H be *any* two place boolean function (one defined in terms of *and, or, not, if-then,* etc).

(22) a. Most poets daydream ≠ (Most x)(H(poet(x),daydream(x))

We take *most = more than half*. (Use *more than half* in the example if you like). In fact almost all *proportionality* Dets behave like *most* above: *at least / exactly / more than ten per cent of*, *between a third and a half*, etc. So NLs make essential use of the CNP restriction and are not **sortally reducible**, in distinction PL.

Second, of deeper interest, the restricting role of common nouns extends beyond the QNPs we have seen to date. We have treated QNPs as mapping binary relations to truth values stepwise: first $P_2 \Rightarrow P_1$, then $P_1 \Rightarrow P_0$. We could however also think of the "composition" of the two GQs as a function that directly maps a binary relation to a truth value – a *type 2* function as we shall say, it reduces arity by 2: $P_{n+2} \Rightarrow P_n$. The GQs we have been considering are of *type 1*, reducing arity by 1. Let us define, for F,G quantifiers of type 1 and R a binary relation, the composition of F with G, noted F∘G (read: F *compose* G):

(23) F∘G is that type 2 function given by: (F∘G)(R) = F(G(R))

Only a small portion of type 2 functions are compositions of type 1 ones. E.g. for |E| = 2 the total number of type 2 functions is 2^{16} = 65,536; the composite ones number ≤ 2^{10} = 1,024. The number of properties of binary relations grows incomprehensibly fast. For |E| =3 type 2 functions number 2^{64} which approaches the number of microseconds since the Big Bang (Harel 1987:156)[1].

Query: Can NLs express type 2 functions other than by composing type 1 ones?

The answer is **yes** (Keenan 1992, 1996). One case already seen is *anaphors*. *Every student criticized himself* / *everyone but himself* has no paraphrase in which *himself* (or *everyone but himself*) is replaced by a QNP interpreted as a type 1 function. But there are other types of interest here, ones also built from CNPs:

(24) a. Different people like different things
b. Different students answered different questions (on the exam)
c. The two students support rival football teams
d. Every student answered the same questions (on the exam)

These Ss consist of a P_2 and two expressions of apparent form [Det+CNP]. But in each case the Det on the object QNP is interpretatively dependent on the subject in some non-trivial way, a dependency that would be lost if we interpreted this QNP as a type 1 function. Provably there are no type 1 functions F, G such that e.g. (24a) is interpreted as (F∘G)(**like**). *But the CNPs still constrain the relation*. E.g. to verify (24b) we need not consider all the pairs (x,y) in the **answer** relation, it suffices to consider x's that are students and y's that are questions.

Sentences of this sort have not, to my knowledge, been much studied cross linguistically. However as I reflected on the few languages where I can marshal examples on my own I find each has some colloquial phrases that express the kind

of one-oneness condition we see in (24a). And I now find that Mandarin does too (Minqi Liu, pc.), and also Hebrew (Yael Sharvit, Yoad Winter pc.).

(25) a. English: Different strokes for different folks
To each his own

b. French: A chacun son gout (to each his taste)

c. Malagasy: Samy manana ny azy (ny olon-drehetra)
all has the his/her (the people-all)
Everyone has his own opinion

d. Mandarin: luobo vaicai, ge you suo ai
radish, cabbage, each have SUO love
Everyone has his/her own like

e. Hebrew: ish be′emunat-o yixye ish ish le nafsh-o
man prep′faith-his fut.live man man to soul-his
For each man his own faith *To each his own*

Mandarin and Hebrew also present full Ss with the same relational dependency between GQs:

(26) a. butong xuesheng huida le butong wenti
different student answer perf different question
Different students answered different questions

b. mei-ge xueshenh dou huida le butong wenti
every-clf student DOU answer perf different question
Every student answered different questions

(27) kol talmid ana al she′ela axeret
every student answered prep question other
Each student answered a different question

5. The Cross-linguistic Expression of Boolean Operators

The ubiquity of boolean structure discussed in Lecture 1 suggests that the boolean operators AND, OR, NOT, NEITHER...NOR... would be widely expressed in natural languages. Where we have knowledge this seems to be true, but there are qualifications. First, OR and NEITHER...NOR... have not, to my knowledge been the subject of extensive cross linguistic study so we don't know much about their cross linguistic distribution. AND and NOT have been typologically studied.

5.1 AND An expression for AND is well attested cross linguistically, though we note that the words used may vary with the category of expression coordinated. For NP conjunction a form homophonous with *with*, a comitative adposition or verb, is about as frequent as an independent word (Stassen 2005). For P_1s and P_0s (VPs and Ss) mere juxtaposition of expressions may function as coordination. Several languages use juxtaposition between NPs as well (Haspelmath 2005). About 5% of the languages in Haspelmath's sample use juxtaposition for AND in all categories. Also several NLs use a discontinuous form for coordination: French: *et Jean et Marie* 'both John and Mary', as well *ou...ou...* and *ni...ni...* for 'either...or...' and 'neither...nor...'. See Zhang 2009.

5.2 Negation is the most widely studied boolean operator (see WALS:Chs 112 – 115), Payne 1985, Horn 1989, Dahl 1979, Dobrin et al 1993 and Kahrel & van den Berg 1993). From Dryer's 2005 study of negation in over 1,000 languages – there are about 7,000 in the world – we can say with confidence that all NLs present some form of negation in simple Ss. In Ss of NP+predicate form, where the NP is individual denoting, negation serves to deny that the predicate holds of the NP. When a simple S posits existence of something the negation serves to deny existence. In more complex Ss negation is (considerably) more complex.

5.2.1 Forms of Negation

The most common expression of negation (boolean complement) is with an independent particle (from Dryer: 477 of 1011, plus an additional 66 with negative morphemes discontinuously flanking the P_1). The next most common is with a verbal affix (339 of 1011). These options cover almost 90% of the languages inventoried. I illustrate them in order:

(28) a.1 Tsy nanenjika azy Rabe — Malagasy
not chased him Rabe
Rabe didn't chase him

a.2 tā bu shi Zhōngguó rén — Mandarin
3sg neg be China person — Li & Thompson 1981
S/he is not Chinese

b. Yārinyā <u>bà</u> ta dāwō <u>ba</u> — Hausa (Chadic)
girl neg she return neg — Kraft & Kirk-Greene 1973
The girl hasn't returned

c. Met numö-ge el-jaqqa-te-je — Kolyma Yukaghir
1sg house-loc neg-achieve-fut-intran.1sg — Dryer (op cit)
I will not reach the house

English falls into the minority ten per cent as it, unusually, introduces a carrier verb *do* which hosts negation in an otherwise normal way:

(29) a. Ed buys flowers here — b. Ed does not / doesn't buy flowers here

Also, unsurprisingly, NL negation particles may vary in shape with the context they are in. Negations tightly bound to the verb, as affixal ones, may vary in shape with the tense and aspect of the verb, e.g. Puluwat (Oceanic; Micronesia, Dryer 2005). Negations of existential P_0s (*There's a cat on the mat*) may be different from that used with P_1s (Hebrew, Mandarin):

(30) a. Hu lo sameax
He not happy
He is not happy

b. Ein li mexonit Hebrew
Neg.exist to.me car
I don't have a car

(31) méi (yǒu) rén zài wàimian
not exist person at outside
There is no one outside

(Compare with negation *bu* in (a.2))

Similarly the negation used in imperatives *Don't do that!* usually differs from that in declaratives (van der Auwer and Lejeune 2005) as in Malagasy (32a,b).

(32) a. Aza manao izany!
Neg do that
Don't do that!

b. Tsy manao izany Rabe
Neg do that Rabe
Rabe doesn't do that

5.2 Negation is "Marked" in both NL and PL

In PL we form negations by adding a sign, such as ¬, to a formula φ to form a negative formula ¬φ. In NL we also negate expressions by adding pronounceable material to a non-negative form[2]. In very many cases it is the verb, or auxiliary verb, that carries the added material. In Verb Initial languages a negative particle precedes the verb, so we do not know immediately whether it attaches to the Verb Phrase or directly to the S. Analogous claims hold for V-final languages, save that here a negative particle often does occur before the verb (Evenki: Nedyalkov 1993). So possibly NL negation builds marked P_1s rather than P_0s.

However the morpho-syntactic markedness of negative Ss in NL correlates with a deep pragmatic bias: asserting affirmative Ss is usually understood to be informative, whereas a negative assertion primarily functions to deny the affirmative one it is built from, not to communicate new information. You can imagine many pictures that would answer the question *What is John doing?*. More difficult is to picture *What isn't John doing*? If I tell you it isn't raining you look for some reason to justify my claim – Did we expect it to rain? Did I say it would? The negative claim does not present the world as different from earlier, so it literally gives no new information. As a survival trait:

THE SECOND HEURISTIC

Assume tomorrow will be like today pending evidence to the contrary

In PL the range of situations covered by a negative S is not different from that covered by an affirmative one. Specifically, every sentence φ is logically equivalent to some negative one, ¬ψ (choose ψ to be ¬φ). Negation in standard logic is **self-inverting**: ¬¬φ ≡ φ.

An unexpected reflex of the NL differences between affirmative and negative Ss shows up in polar (yes-no) questions in English. The affirmative question *Is it raining?* is neutral as to whether it is raining or not. Affirmative and negative responses are equally acceptable. But the question formed from the negative S: *Isn't it raining?* is biased – the speaker expects an affirmative answer[3]. If the affirmative and negative declarative Ss were fully comparable we would expect their yes-no questions to be comparable as well. But they're not.

4.3 Reversing Truth?

In standard PL, φ and ¬φ always have different truth values. Is this true in NL? Here are two phenomena, perhaps unexpected, that give us cause for pause. The first is *pleonastic* (*expletive*) *negation*, well cited in French grammar. We now know it is more widespread. Jin & Koenig 2020 attests various sorts of pleonastic negation in some 70 languages. Another case is:

(33) a. Mandrara anao tsy hanao izany aho Malagasy
Forbid you.acc not fut.do that I
I forbid you from doing that

b. Nisakana ahy tsy hiteny amin-dRabe ny reniko
pst.prevent 1sg.acc not fut.speak with-Rabe the mother.my
My mother prevented me from speaking with Rabe

These are cases where negative verbs, here *forbid* and *prevent*, license the presence of ordinary "sentential" negation, here and in (28a.1) *tsy*, but that negation is not interpreted as boolean complement. It is just a repetition of the negativity in the verb. It is not even an emphatic construction. (I have found some 30 examples of this sort in Malagasy newspapers, children's stories, novels, and twice in descriptive grammars written by Malagasy).

A slightly different sort of multiple negation occurs in Romance (and Middle English) which have been called *negative concord* languages. In (34a) in French *rien* has a negative meaning, but in the full negative S in (34b) we do not have two negations which semantically cancel each other, rather *rien* just reinforces, emphatically, the basic negation.

(34) a. Qu'est-ce que tu fais, toi? – Rien (du tout)
What is-it that you are doing, you? – Nothing (at all)

b. Je ne comprends plus rien, moi.
I neg understand longer nothing me
I don't understand anything anymore

There are varieties of English where multiple negations reinforce rather than cancel: *He don' do nothin'* = "He doesn't do anything". 'Anything' itself is not a negated word. But its presence is licensed by negative words, more exactly, monotone decreasing contexts:

(35) a. *He saw <u>any</u> birds on the walk b. He didn't see <u>any</u> birds on the walk

a. *Someone here has <u>ever</u> done that b. No one here has <u>ever</u> done that

NLs often present a small class of words, like *any* and *ever* above, whose presence is licensed by negation (inter alia). These are called *negative polarity items* and their presence again distinguishes NL from PL.

A quite different kind of case, where negation *is* interpreted as the boolean operator but does not change truth, is given by Ss like (36a,b) in English:

(36) a. Exactly half the pupils passed/didn't pass the exam
b. Between a third and two thirds of the pupils passed/didn't pass the exam

In these Ss we can hold the subject constant and negate the predicate standardly without altering truth value. This is due to the nature of the QNP subjects (See

Keenan 2005 and Westerståhl 2012). For most choices of QNP the truth value changes. Still the examples show that negating the predicate does not by itself force a flip in truth value.

6. Wrapping up

We have just probed a bit the NL/PL interface. As someone who finished a doctorate in linguistics in 1969 I can only marvel at how much more we know today about the syntactic and semantic properties of NLs than we did then. As I see it we're in the latter part of the "natural history" phase of linguistics, still walking through the forest looking for interesting plants and animals. But we're making friends with languages we'd never heard of when I was a student. We are getting increasingly sophisticated grammars of the world's languages, and we have seen significant advances in formal models – they were just coming into being when I was a student. I can envy those of you starting on your research path today as I think back on the path I hewed for myself, often clumsily and with little idea where I was headed. You have much to discover and to then teach to others. Discovery is exciting, and enlightening, formulating your discoveries carefully, clearly, precisely is very satisfying. If I could do it all over again...I would do it all over again.

FOOTNOTES

[1] The number of type 2 functions is depends on the number of pairs of subsets of E. The number of reducible ones on the number of cross products of subsets of E, which is much less, as different pairs yield the same product when one is empty.
[2] For completeness I must point out that Old Tamil (Pederson 1993) had a common negation that consisted in omitting tense marking (on verbs that took animate arguments). It did have one "heavy" negative marker that has evolved into negation in the daughter Dravidian languages. Also verbs with non-animate arguments retained the "light" negative suffix.
[3] Thanks to Dominique Sportiche for discussion of this point.

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