Solutions to Exercises for *Introduction to Logic*

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Please note that the suggestions for formalization here are given as an aid to understanding what the logical form could be. You are not expected to be able to know how to translate English into perfect formal logic at *this* point in the course!

Exercise 2.1
(We suggested that the following are declarative: 1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 16, 17 18. Further, note that some of the following analyses would be controversial: sometimes logical form is not obvious, and views on what the logical form of a given sentence is depend on philosophy.)

1. Yes, simple. (On balance, $\mathit{Friend}(\mathit{anna}, \mathit{herb}) \wedge \mathit{Friend}(\mathit{herb}, \mathit{anna})$ is *not* a good understanding, since if $\mathit{Friend}(\mathit{anna}, \mathit{herb})$ means that Anna and Herb are friends, then $\mathit{Friend}(\mathit{herb}, \mathit{anna})$ doesn't add anything; but if $\mathit{Friend}(\mathit{anna}, \mathit{herb})$ just means that Anna has friendly feelings towards Herb, then $\mathit{Friend}(\mathit{anna}, \mathit{herb}) \wedge \mathit{Friend}(\mathit{herb}, \mathit{anna})$ doesn't capture the fact that they're *friends*—since two people who have friendly feelings towards each other need not be friends.)
2. No: $\mathit{Popular}(\mathit{anna}) \wedge \mathit{Popular}(\mathit{herb})$.
3. No: $\mathit{Unhappy}(\mathit{anna}) \wedge \mathit{Unhappy}(\mathit{herb})$, or even $\neg\mathit{Happy}(\mathit{anna}) \wedge \neg\mathit{Happy}(\mathit{herb})$.
4. Yes, simple. (Similar remarks apply as for question (1).)
5. No: $\mathit{Loves}(\mathit{anna}, \mathit{herb}) \wedge \mathit{Loves}(\mathit{herb}, \mathit{anna})$.
6. No: $\neg(\mathit{Unhappy}(\mathit{anna}) \wedge \mathit{Unhappy}(\mathit{herb}))$. (On reflection, $\neg(\neg\mathit{Happy}(\mathit{anna}) \wedge \neg\mathit{Happy}(\mathit{herb}))$ is probably different: it has been well argued that not being unhappy doesn't make someone happy—they might be merely content. But there is room for debate here.)
8. No: $\mathit{Drove}(\mathit{anna}, \mathit{town}) \rightarrow \mathit{In}(\mathit{anna}, \mathit{office})$.
9. No: $\mathit{Engaged}(\mathit{theRoot}, \mathit{pl}) \wedge \mathit{LovesMoreThan}(\mathit{theRoot}, \mathit{chopin}, \mathit{penguins})$.
10. No: $\mathsf{K}_I 7 + 5 = 11$.
11. No: $\mathit{Ionian}(\mathit{thales}) \wedge \mathit{Philosopher}(\mathit{thales}) \wedge \mathit{Predicted}(\mathit{thales}, \mathit{theEclipse})$.
12. No: $\mathit{Said}(\mathit{theBandit}, \text{“}\mathit{MoneyLife}\text{”}) \wedge \mathit{Took}(\mathit{theBandit}, \mathit{Life}) \wedge \mathit{Took}(\mathit{theBandit}, \mathit{Money})$.
16. No: one proposal has been $\exists e(\mathit{Committing}(e, \mathit{austria}, \mathit{neutrality}) \wedge \mathit{In}(e, \mathit{stateTreaty1955}))$.
17. No: $\mathsf{O}\mathit{Goes}(\mathit{theAmendment})$.
18. Yes: $\mathit{Love}(\mathit{I}, \mathit{thisSong})$. ⌟

Exercise 2.2
1. Yes, (6) is the negation of (3).
2. No. The negation of 'Anna is not happy and Herb is not happy' of course has the form $\neg(\neg H(a) \wedge \neg H(h))$, and (3) is $\neg H(a) \wedge \neg H(h)$.
3. (2), (3) and (5) are definitely conjunctions. (6) is definitely not a conjunction. About (1) and (4) there can be discussion; I would say, they are *not* conjunctions..
4. 'It is not raining today, or the streets are wet'.
5. 'If Anna is happy, then Herb is happy', or 'If Herb is happy, then Anna is happy'. (Maybe also, 'If Anna is happy and Herb is happy, then Herb is not happy', etc., *ad infinitum*.)
6. There's no negation, it's non-declarative.
7. True (if we read the 'if-then' as the material conditional). ⌟

Exercise 2.3
(For the sentences from 1.4 which are declarative—and noting the analyses suggested above for justification.)

1. No, not sententially decomposable.
2. Yes.
3. Yes.
4. No.
5. Yes.
6. Yes.
8. Yes.
9. Yes.
10. No, not *sententially* decomposable.
11. Yes.
12. Yes.
16. No (on the analysis given).
17. No.
18. No (because simple, and so not decomposable at all... probably). ⌟

Exercise 2.4
(In the following, 'decomposable' on its own just means 'sententially decomposable'. A good strategy for the difficult cases here is to think what the '*main*' connective would have to be—there are only five or six. Then think, for each of those connectives, what the sentences would have to be.)

1. No, not decomposable. Arguably not simple. (Try and think what the form would be.)
2. Not decomposable. Not simple. (What would be the main connective? And what, the connected sentences?)
3. Not decomposable. Not simple. (Think why $\neg$*RainingInLondon* $\rightarrow$ *HailingOrSnowingInLondon* and other such offerings don't work.)
4. Not decomposable. Simple. (*HasAnnoyingPlans*(*trump*), or something.)
5. Decomposable (therefore, not simple). (The sentence is a negation of 'The English word 'mind' can be translated into German. Is this *latter* sentence sententially decomposable?)
6. Decomposable (thus, not simple). (It's a conditional.)
7. Not decomposable, not simple. (This is not just 'Austria joined the EU and Austria's economy took a turn for the better', or 'If Austria joined the EU then Austria's economy took a turn for the better', which are the only two sentential decompositions someone might be tempted to propose.)
8. Not sententially decomposable; not simple. (If this were a material conditional, what could the antecedent and consequent be?)
9. Decomposable (thus, not simple). (*AnnaIsAPhilosopher* $\wedge$ $\neg$*AnnaIsSociallyAwkward*.)
10. Decomposable (so not simple). (*PopperPhil* $\wedge$ *AdornoPhil* $\wedge$ $\neg$*PopperAndAdornoGetOn*.)
11. Decomposable (so not simple). (*ForLunchFalafel* $\wedge$ *ForLunchSalad* $\wedge$ *ForLunchFish*.)
12. Not decomposable, not simple. (The possibilities would use '$\wedge$' or '$\vee$' or '$\curlyvee$'. But in none of these cases would a decomposition have the same truth-conditions.)
13. Not decomposable, not simple.
14. Decomposable, ergo not simple. (*Shiny*(*silver*) $\wedge$ *GoldMoreShinyThanSilver*.)
15. Not decomposable, probably not simple.
16. Not decomposable, not simple. (This looks like a universal quantification, roughly: $\forall x(B(x) \rightarrow P(x))$.)
17. Decomposable, not simple. (*AllStudentsStudyLogic* $\wedge$ *SomeStudentsNotLogicEnthusiasts*.)
18. Decomposable, not simple. (*ThePoliticalSituationWillWorsen* $\rightarrow$ *DarkTimesWillCome*.) ⌟