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Imperatives: a judgemental analysis

Abstract. This paper proposes a framework for formalising intuitions about the behaviour of imperative commands. It seeks to capture notions of satisfaction and coherence. Rules are proposed to express key aspects of the general logical behaviour of imperative constructions. A key objective is for the framework to allow patterns of behaviour to be described while avoiding making any commitments about how commands, and their satisfaction criteria, are to be interpreted. We consider the status of some conundrums of imperative logic in the context of this proposal.

Keywords: imperatives, satisfaction, consistency, coherence, paradoxes

Introduction and overview

The objective of this paper is to propose a framework for formalising intuitions about the behaviour of imperatives. We take imperatives to be commands that require some action, activity or state of affairs to be brought about, or avoided, for them to be deemed *satisfied*. A typical example is

(1) *"Close the door!"*

Such an imperative may be judged to be satisfied if the door is closed by the intended recipient of the imperative.

For the purposes of this paper, it is not necessary to know exactly which linguistic forms and interpretations are appropriately characterised as "imperatives", nor exactly what constitutes "satisfaction" of a given imperative. All that we assume is that imperatives exist, that they have satisfaction criteria, and that, furthermore, some imperatives (or their satisfaction criteria) may be judged to be inconsistent with each other.

We will take *satisfaction* to play a role somewhat akin to that of *truth* in accounts of indicative assertions. We will use a notion of *consistency* of imperatives, or their satisfaction criteria, to determine whether a 'commanding authority' is *incoherent*. These notions of consistency and coherence can be seen to impose constraints on what it is to be a *rational* authority.

A key objective is to allow intuitions about imperatives to be formulated and expressed as directly as possible, without assuming any particular

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interpretation, such as possible worlds, actions, or non-classical notions of entailment. The aim is for us to be able to consider imperatives in isolation, without being confounded and distracted by other, independent, foundational issues.

1. Imperatives in Natural Language

Imperatives can be combined with each other and with indicatives. Here we provide some examples. These examples are not intended to be exhaustive. They merely highlight some key aspects of the behaviour of imperatives that we seek to capture (§2). Some of these linguistic constructions will also feature in the discussion of various conundrums and paradoxes (§3).

1.1. Conjunction

Imperatives can be conjoined with each other.

(2) *"Jump out of the window, and land on the pile of mattresses!"*

In general, we should avoid assuming this is equivalent to commanding the individual conjuncts separately. For example, we should not assume that (2) entails the command *"Jump out of the window!"*. This can be seen by considering the case where partial satisfaction is explicitly stated to be undesirable,, as in *"... But don't* just *jump out of the window, ...!"* [19].

Of course, it would be incoherent to command (2) while also commanding (3).

(3) *"Don't jump out of the window!"*

The case made here is that such a notion of *(in)coherence* can stand as a weak proxy for *validity*. Instead of saying that there is a valid entailment from command $a \wedge b$ to command b, for example, we can argue that it is *incoherent* for an authority to command both $a \wedge b$ and $\neg\, b$ at the same time, as their satisfaction criteria are inconsistent with each other (§2.2.3).

1.2. Free-Choice Disjunction

Disjunctive imperatives (4) often give rise to a free choice as to how they are to be satisfied [21].

(4) *"Go to the beach or play in the park!"*

With free-choice disjunction there is a sense in which "permission" is granted to do either, by indicating a space of legitimate possibilities [8]. In this regard it appears incoherent to combine the command (4) with (5), unless the latter is taken to be a correction, or implicit refinement.

(5) *"Don't go to the park!"*

Given this permissive, free-choice interpretation of disjunction, it seems we should not be able to "introduce" a disjunctive command (cf. §3.1). That is (4) should not follow from the command (6), even though the satisfaction conditions of the latter should also satisfy the former.

(6) *"Play in the park!"*

There is a question as to whether free-choice disjunction supports an *exclusive* or *inclusive* interpretation. Under an exclusive interpretation of (4), going to the beach *and* playing in the park is not permissible and would fail to satisfy the command. We will formulate both weak (inclusive) and strong (exclusive) interpretations (§2.2.1).

1.3. Weak Disjunction

An alternative interpretation of disjunctive examples such as (4) is where the subject has been commanded to go to the beach or to play in the park, but it is underspecified as to which is the case. This is sometimes referred to as *weak disjunction*. It might be analysed by some form of meta-level disjunction. This paper focuses on the free-choice interpretation.

1.4. Negation

Commands can contain negation, as in (7).

(7) *"Don't go to the beach!"*

It is incoherent to command something and its negation. Indeed it is incoherent to endorse any commands with satisfaction criteria that are inconsistent (§2.2.3).

These cases are to be distinguished from the 'meta-level' negation of (8), where the existence of a command is being denied.

(8) (a) *"It is not the case that you are commanded to go to the beach!"*

(b) 'There is no command of the form *"Go to the beach!"*'

This paper focuses on object-level negation.

1.5. Conditionals

Conditionals may be formed where the antecedent is a proposition, and the consequent is an imperative (9).

(9) *"If you see John, say hello!"*

If the antecedent is true, then the satisfaction conditions of the consequent become salient.

We may wonder whether we can infer that *"say hello!"* has actually been commanded *as such* in the event that John is seen[1] or whether the conditional command is effectively irreducible (cf. §2.2.1).

It is conceivable that *avoiding John* counts as satisfaction of (9). This interpretation is perhaps more salient in cases where the antecedent is morally questionable, as with (10).[2]

(10) *"If you hit John, then apologise!"*

1.6. Pseudo Imperatives

Pseudo-imperatives are another form of expression in which imperatives are combined with propositions [7, 11, 10, 23, 33]. Syntactically we can consider two variants, one involving disjunction, the other conjunction.

1.6.1. Pseudo-Or

Disjunctive pseudo-imperatives are expressions such as (11).

(11) *"Take another drink, or you will be thirsty!"*

This appears to have imperative force—namely *"Take another drink!"*—combined with propositional information—*"If you fail to take another drink, you will be thirsty"* (cf. [11]). This might be considered a variant of free-choice disjunction, where the second disjunct will come about "by default" if the first disjunct is not satisfied. We may question whether the propositional interpretation is effectively offering any kind of *guarantee* that the propositional component will be false if the imperative component is satisfied. It would appear somewhat incoherent to say (11) together with (12) (§2.2.3).

(12) *"Don't take another drink!"*

[1] This is known as "propositional detachment".

[2] Such cases might be expressed more naturally as in *"If you hit John, then you must apologise!"*, using modal propositions.

1.6.2. Pseudo-And

Conjunctive pseudo-imperatives appear to come in two flavours, exemplified by (13a) and (13b).

(13) (a) *"Take another step and you will die!"*

(b) *"Take another step and you will see the treasure!"*

These can be taken to correspond to a threat, or a promise, respectively [22]. Arguments have been made that conjunctive pseudo-imperatives are essentially propositional in nature, and are not imperatives as such. They are judged to be true propositions if the propositional conjunct is true when the "imperative" conjunct is satisfied [11]. Determining what counts as a promise or a threat requires a value judgement, either of the outcome itself, or some evaluation of the outcome weighed against the cost of satisfying the imperative clause. We will not consider such pragmatic issues here.

As with the disjunctive case, we may question other aspects of the logical behaviour of such expressions, in this case whether it behaves like material implication, or whether it is better characterised in some other way—as a "causative" or "hypothetical" conditional, for example.

The fact that conjunctive pseudo-imperatives appear to be embeddable within other propositional contexts offers some confirmation that they are essentially propositional in nature.

2. Formalisation

The formalisation that follows is intended to be used as a framework for expressing theories about the semantics of imperatives. Where possible, only minimal ontological commitments are made. For example, imperatives will not be required to have, or be related to, overtly propositional content, and their satisfaction criteria will not be tied to any particular notion, such as the post-conditions of actions. That is not to say that the content of an imperative cannot be characterised as relating to some agentive sentence [6], or that their satisfaction cannot be expressed in terms of actions, merely that no such commitment is made here.

First we give the syntax and notation, and then rules for the judgements of inconsistency, incoherence, satisfaction, and truth.[3] An abbreviated no-

[3]For compactness, the syntax is given in BNF notation. An alternative would be to present the entire theory, including the syntax, in terms of judgements, as with Typed Predicate Logic [36].

tation for systems-of-commands is used in the analysis of inconsistency and incoherence. A notion of an "obedient subject" is also discussed.

2.1. Syntax

To formalise the interpretation of imperatives and propositions, and express judgements about them, we must have a syntax for their representation. Given that imperatives may be combined with propositions, there is some interplay between these two categories.

After the object level syntax has been presented, the notation for expressing judgements about members of the categories of imperatives and propositions can be given. This language of judgements is used to express rules governing the behaviour of imperatives and propositions (§2.2). To improve the readability of some of these rules, abbreviations for systems of commands are introduced.

2.1.1. Imperatives

We assume there is a category of expressions i that represents the substantive content of atomic commands, sometimes known as *practives*. More complex imperatives can then be formed from these atomic commands.

(14) *Basic imperatives*

$$I_b ::= i \mid \neg I_b \mid I_b \wedge I_b \mid I_b \vee_{FC} I_b$$

Such practives may be distinct from propositions [6]. Where possible, the formalisation will remain neutral on such ontological issues.

The operators $\vee_{FC}$ is used to highlight the intended free-choice interpretation, although it may be appropriate just to use $\vee$ (especially if we take the view that weak disjunctive commands are not to be expressed with a narrow scope disjunction).

The category of conditional imperatives can be given as in (15).

(15) *Conditionals*

$$I_c ::= P \rightarrow I_b \mid P \rightarrow I_c$$

where P is a proposition.

This syntax assumes that the conditional structure can nest, provided only the right-most, final consequent is a basic imperative.

The category that represents the content of all imperatives, including basic, conditional, and disjunctive pseudo-imperatives is given by (16).

(16) *Imperatives*

$I ::= I_b \mid I_c \mid I_b \vee P_c$

where P_c is a classical proposition.

We will typically use "a" to denote an individual imperative when discussing judgements about imperatives or imperative constituents.

2.1.2. Propositions

Classical propositions can have their usual representation.

(17) *Classical Propositions*

$P_c ::= p_c \mid \neg P_c \mid P_c \wedge P_c \mid P_c \vee P_c \mid P_c \rightarrow P_c$

where p_c represents atomic classical propositions.

The category of classical propositions can be extended to a more general category that includes the propositional characterisation of pseudo-imperative expressions.

(18) *Propositions*

$P ::= P_c \mid I_b \wedge P \mid I_b \vee P_c$

Typically, we will use "p" to denote an individual proposition when discussing judgements involving propositions, or propositional constituents.

2.1.3. Judgements

A critical part of the proposed framework is a collection of *judgements* that can be made about imperatives, and propositions. Patterns of entailment can be formulated using these judgements. In the case of propositions (P), we have judgements corresponding to whether they are true or false. In the case of individual imperatives (I), there are judgements as to whether they have been commanded, satisfied, or not satisfied. Given a collection of imperatives $(I, \ldots, I)$, there are judgements as to whether they, or their satisfaction criteria, are inconsistent, and whether the agent responsible for commanding them is incoherent.

(19) *Judgements*

$J ::= P\ \mathsf{True} \mid P\ \mathsf{False} \mid I\ \mathsf{Commanded}_\alpha \mid I\ \mathsf{Satisfied}_\sigma \mid I\ \mathsf{unSatisfied}_\sigma \mid$
$(I, \ldots, I)\ \mathsf{Inconsistent} \mid \alpha\ \mathsf{Incoherent}$

Some of the judgements are subscripted with α, indicating the relevant authority, and σ to represent the subject. Although technically redundant in the current presentation, this notation can help clarify the intended agent when it comes to commanding and satisfying an imperative.[4]

The judgement p True (p False) mean that p is judged to be true (false, respectively). For complex propositions, we will assume that such judgements behave in a way that corresponds to a classical logic for propositions.

The judgement "a $\mathsf{Commanded}_\alpha$" means that authority α has issued the command a. The content of the commands is assumed to be highly 'inscriptional' in nature: even if b True follows from a True, it does not mean that b $\mathsf{Commanded}_\alpha$ necessarily follows from a $\mathsf{Commanded}_\alpha$.

The judgement "a $\mathsf{Satisfied}_\sigma$" means that subject σ has satisfied the (putative) command a. We assume that a $\mathsf{Satisfied}_\sigma$ (and indeed a $\mathsf{unSatisfied}_\sigma$) does *not* imply or presuppose a $\mathsf{Commanded}_\alpha$. This allows us to consider entailments between satisfaction conditions without giving rise to any inappropriate entailments concerning what has actually been commanded.[5]

The judgement "a $\mathsf{unSatisfied}_\sigma$" means that subject σ has *not* satisfied the (putative) command a. We aim to be neutral as to whether "a $\mathsf{Satisfied}_\sigma$" and "$a$ $\mathsf{unSatisfied}_\sigma$" are *contradictory* as opposed to being merely *contrary*. Being contrary, then it should not be possible to maintain both "a $\mathsf{Satisfied}_\sigma$" and "$a$ $\mathsf{unSatisfied}_\sigma$" simultaneously (23). If they were also contradictory, then all imperatives would have to be satisfied, or not satisfied. It can be argued that this is not the necessarily the case. The command (20) is clearly satisfied if the bill is paid within the twenty-one days. It is unsatisfied if no payment is made by the end of the twenty-one days.

(20) *"Pay this bill within twenty-one days!"*

But within the twenty-one days, while the bill remains unpaid, we might wish to maintain that (20) is not (yet) "satisfied" nor "unsatisfied". There is perhaps a debate to be had about the most appropriate terminology to describe such notions unambiguously.

The judgement "$I_1, \ldots, I_n$ $\mathsf{Inconsistent}$" indicates that the imperatives are inconsistent. The intuition is that if $I_1, \ldots, I_n$ were translated into

[4] In this account we do not explicitly represent the intended recipient of a command. Where relevant, it can be assumed that the authority α is expecting subject σ to comply.

[5] Given that a $\mathsf{Satisfied}_\sigma$ does not presuppose there was a command a $\mathsf{Commanded}_\alpha$, it follows that a $\mathsf{Satisfied}_\sigma$ cannot mean that a command was *intentionally* satisfied: there may have been no such command. Satisfaction is then an 'extensional' notion, that can be contrasted with the intensional, or inscriptional, flavour of a $\mathsf{Commanded}_\alpha$. Additional machinery would be required if it were necessary to distinguish between intentional and incidental satisfaction of a command.

propositions, either directly or by way of their satisfaction criteria, they would be inconsistent with each other, in the sense that if the corresponding propositions were all true together, they would allow the derivation of any proposition.

The final judgement, "α Incoherent", is used to indicate that authority α seeks to impose inconsistent commands. We assume that a rational authority would seek to avoid issuing commands that give rise to a judgement of incoherence. But the logic should be able to cope with an incoherent authority.

A Reduction We could try to reduce *satisfaction* of an imperative a to *truth* of a propositional analogue a' of that imperative, with an implicit subject σ. In particular, a $\mathsf{Satisfied}_\sigma$ could be reduced to a'_σ True. We could go further, and have imperatives a belong directly to the category of propositions, making a $\mathsf{Satisfied}_\sigma$ a notational variant of a_σ True. Both of these moves will be avoided in the current account in order to leave open the possibility of alternative notions of satisfaction, for example where satisfaction is characterised directly by actions rather than propositions. It also allows us to maintain a clear ontological distinction between imperatives and propositions.[6]

2.1.4. Abbreviation for Systems of Commands

It is helpful to have a notation for representing a system of commands, not just individual commands. This can be used to represent a context in which a collection of commands are to be considered together, as in §2.2.3. For this purpose we will use Σ to refer to the collection of commands $a_1, \ldots, a_n$, Σ $\mathsf{Commanded}_\alpha$ to represent the judgement that all these commands have indeed been commanded, and Σ $\mathsf{Satisfied}_\sigma$ to represent the judgement that they have been satisfied (21).

(21) (a) "Σ" stands for "$a_1, \ldots, a_n$".

(b) "Σ $\mathsf{Commanded}_\alpha$" stands for "$a_1$ $\mathsf{Commanded}_\alpha, \ldots, a_n$ $\mathsf{Commanded}_\alpha$".

(c) "Σ $\mathsf{Satisfied}_\sigma$" stands for "$a_1$ $\mathsf{Satisfied}_\sigma, \ldots, a_n$ $\mathsf{Satisfied}_\sigma$".

No temporal ordering or precedence is intended when we write $a_1, \ldots, a_n$.

2.2. Rules

The rules governing core aspects of the behaviour of imperatives are given using rules of the form (22) over judgements J (19).

[6] This is not to say that no reduction from imperatives to propositions is possible.

282 (22) $\dfrac{J_1 \quad \ldots \quad J_n}{J}$

283 Essentially, (22) expresses the claim that judgement J follows from the
284 judgements $J_1, \ldots, J_n$.
285 In some cases we initially give rules that characterise a generally un-
286 controversial core behaviour, followed by stronger rules that may be more
287 contentious.

288 2.2.1. Satisfaction

289 We use I $\mathsf{Satisfied}_\sigma$ and I $\mathsf{unSatisfied}_\sigma$ to express the judgements that impera-
290 tive I has been satisfied, or not, by subject σ. As previously noted (cf. §2.1.3),
291 we do not seek to reduce notion of satisfaction to something else, such as a
292 propositional description of a state, or an action. All that is required is for
293 there to be such a notion for every imperative, even if the satisfaction criteria
294 are not actually realisable in some cases.
295 It would be inconsistent to assert that the same imperative had both been
296 satisfied and not satisfied.[7]

297 (23) $\dfrac{a\ \mathsf{Satisfied}_\sigma \quad a\ \mathsf{unSatisfied}_\sigma}{\bot}$

298 While a $\mathsf{Satisfied}_\sigma$ and a $\mathsf{unSatisfied}_\sigma$ are contrary, we wish to avoid
299 requiring that they be contradictory. This means that it is sometimes necessary
300 to formulate rules for both the positive and negative cases explicitly, as in
301 (24).
302 As mentioned before (2.1.3), here judgements of the form a $\mathsf{Satisfied}_\sigma$,
303 and a $\mathsf{unSatisfied}_\sigma$, do *not* presuppose or imply a $\mathsf{Commanded}_\alpha$.

304 **Conjunction** Conjunction is subject to the expected rules for satisfaction.
305 Both conjuncts must be satisfied for their conjunction to be satisfied. The
306 conjunction is judged to be unsatisfied if either conjunct is not satisfied.

307 (24) *Conjunction*

308 (a) $\dfrac{a\ \mathsf{Satisfied}_\sigma \quad b\ \mathsf{Satisfied}_\sigma}{(a \wedge b)\ \mathsf{Satisfied}_\sigma}$

[7] For a specific theory of satisfaction it is appropriate to ensure that there are no counter-intuitive results, including those that lead to formal inconsistency of judgements, and the derivation of $\bot$. We do not do so here; the proposed rules are intended only to exemplify the general approach (cf. §2.5).

(b) $\dfrac{a\ \mathsf{unSatisfied}_\sigma}{(a \wedge b)\ \mathsf{unSatisfied}_\sigma}$ (c) $\dfrac{b\ \mathsf{unSatisfied}_\sigma}{(a \wedge b)\ \mathsf{unSatisfied}_\sigma}$

(d) $\dfrac{(a \wedge b)\ \mathsf{Satisfied}_\sigma}{a\ \mathsf{Satisfied}_\sigma}$ (e) $\dfrac{(a \wedge b)\ \mathsf{Satisfied}_\sigma}{b\ \mathsf{Satisfied}_\sigma}$

(f) $\dfrac{(a \wedge b)\ \mathsf{unSatisfied}_\sigma \quad a\ \mathsf{Satisfied}_\sigma}{b\ \mathsf{unSatisfied}_\sigma}$

(g) $\dfrac{(a \wedge b)\ \mathsf{unSatisfied}_\sigma \quad b\ \mathsf{Satisfied}_\sigma}{a\ \mathsf{unSatisfied}_\sigma}$

Free Choice The core behaviour of free-choice disjunction is given by the rules in (25), where the disjunction is satisfied if either one of the disjunctions is satisfied (and the other is not), and is not satisfied if both are not satisfied.

(25) *Basic Free Choice*

(a) $\dfrac{a\ \mathsf{Satisfied}_\sigma \quad b\ \mathsf{unSatisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{Satisfied}_\sigma}$ (b) $\dfrac{a\ \mathsf{unSatisfied}_\sigma \quad b\ \mathsf{Satisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{Satisfied}_\sigma}$

(c) $\dfrac{a\ \mathsf{unSatisfied}_\sigma \quad b\ \mathsf{unSatisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{unSatisfied}_\sigma}$

(d) $\dfrac{(a \vee_{FC} b)\ \mathsf{Satisfied}_\sigma \quad b\ \mathsf{unSatisfied}_\sigma}{a\ \mathsf{Satisfied}_\sigma}$

(e) $\dfrac{(a \vee_{FC} b)\ \mathsf{Satisfied}_\sigma \quad a\ \mathsf{unSatisfied}_\sigma}{b\ \mathsf{Satisfied}_\sigma}$

(f) $\dfrac{(a \vee_{FC} b)\ \mathsf{unSatisfied}_\sigma}{a\ \mathsf{unSatisfied}_\sigma}$ (g) $\dfrac{(a \vee_{FC} b)\ \mathsf{unSatisfied}_\sigma}{b\ \mathsf{unSatisfied}_\sigma}$

We can strengthen this core behaviour by adopting an exclusive interpretation of free-choice, where satisfying both disjuncts leads to an explicit failure to satisfy the free-choice imperative.

(26) *Explicitly Exclusive Free Choice*

(a) $\dfrac{a\ \mathsf{Satisfied}_\sigma \quad b\ \mathsf{unSatisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{Satisfied}_\sigma}$ (b) $\dfrac{a\ \mathsf{unSatisfied}_\sigma \quad b\ \mathsf{Satisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{Satisfied}_\sigma}$

(c) $\dfrac{a\ \mathsf{unSatisfied}_\sigma \quad b\ \mathsf{unSatisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{unSatisfied}_\sigma}$ (d) $\dfrac{a\ \mathsf{Satisfied}_\sigma \quad b\ \mathsf{Satisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{unSatisfied}_\sigma}$

(f) $\dfrac{(a \vee_{FC} b)\ \mathsf{unSatisfied}_\sigma \quad b\ \mathsf{Satisfied}_\sigma}{a\ \mathsf{Satisfied}_\sigma}$

(g) $\dfrac{(a \vee_{FC} b)\ \mathsf{unSatisfied}_\sigma \quad a\ \mathsf{Satisfied}_\sigma}{b\ \mathsf{Satisfied}_\sigma}$

This captures the intuition that both *going to the beach* and *playing in the park* would not satisfy the exclusive interpretation of (4) *"Go to the beach or play in the park!"*.

In contrast, an inclusive free-choice is supported explicitly by (27).

(27) *Explicitly Inclusive Free Choice*

(a) $$\frac{a\ \mathsf{Satisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{Satisfied}_\sigma}$$ (b) $$\frac{b\ \mathsf{Satisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{Satisfied}_\sigma}$$

(c) $$\frac{a\ \mathsf{unSatisfied}_\sigma \quad b\ \mathsf{unSatisfied}_\sigma}{(a \vee_{FC} b)\ \mathsf{unSatisfied}_\sigma}$$

Negation The judgements of $a\ \mathsf{Satisfied}_\sigma$ and $a\ \mathsf{unSatisfied}_\sigma$ are exclusive.

(28) *Negation*

(a) $$\frac{a\ \mathsf{Satisfied}_\sigma}{(\neg a)\ \mathsf{unSatisfied}_\sigma}$$ (b) $$\frac{a\ \mathsf{unSatisfied}_\sigma}{(\neg a)\ \mathsf{Satisfied}_\sigma}$$

(c) $$\frac{(\neg a)\ \mathsf{Satisfied}_\sigma}{a\ \mathsf{unSatisfied}_\sigma}$$ (d) $$\frac{(\neg a)\ \mathsf{unSatisfied}_\sigma}{a\ \mathsf{Satisfied}_\sigma}$$

This does not mean that satisfaction is bivalent; there may be satisfaction gaps. We could have a double negation rule, so $(\neg \neg a)\ \mathsf{Satisfied}_\sigma$ if and only if $a\ \mathsf{Satisfied}_\sigma$ (similarly for $(\neg \neg a)\ \mathsf{unSatisfied}_\sigma$).

Conditionals Initially we give a very weak analysis of conditional imperatives. As conditionals have propositional content, the rules that govern them involve judgements of truth, in addition to satisfaction.

(29) *Conditionals*

(a) $$\frac{p\ \mathsf{True} \quad a\ \mathsf{Satisfied}_\sigma}{(p \to a)\ \mathsf{Satisfied}_\sigma}$$ (b) $$\frac{p\ \mathsf{True} \quad p\ \mathsf{unSatisfied}_\sigma}{(p \to a)\ \mathsf{unSatisfied}_\sigma}$$

(c) $$\frac{p\ \mathsf{True} \quad (p \to a)\ \mathsf{Satisfied}_\sigma}{a\ \mathsf{Satisfied}_\sigma}$$ (d) $$\frac{p\ \mathsf{True} \quad (p \to a)\ \mathsf{unSatisfied}_\sigma}{a\ \mathsf{unSatisfied}_\sigma}$$

We may wonder whether preventing the antecedent p from becoming true may count as satisfaction of the imperative. Such a view would justify (30).

(30) *Indirect Satisfaction of Conditionals*[8]

(a) $$\frac{p\ \mathsf{False}}{(p \to a)\ \mathsf{Satisfied}_\sigma}$$ (b) $$\frac{(p \to a)\ \mathsf{Satisfied}_\sigma \quad a\ \mathsf{unSatisfied}_\sigma}{p\ \mathsf{False}}$$

[8] Arguably the second of these rules falls under the remit of §2.2.2, which considers truth judgements.

In some cases it might seem perverse, but consider (10) *"If you hit John, then apologise!"*, which might be interpreted as an indirect command to avoid hitting John.

Contra-positives Further strengthenings, and extensions, may be suggested by considering *contra-positives*. In classical logic $p \to q$ is equivalent to its contra-positive $\neg q \to \neg p$. In the case of imperatives, we might want to reflect on (31).[9]

(31) (a) *"If it is not daytime, don't turn out the light"*

(b) *"Turn out the light only if it is daytime"*

These support the view that it may be appropriate to allow contra-positive forms, so I_c includes $I_b \to P$ (15) with satisfaction conditions that support (32).

(32) $(a \to p)$ $\mathsf{Satisfied}_\sigma$ iff $(\neg p \to \neg a)$ $\mathsf{Satisfied}_\sigma$

We can argue that for conditional imperatives there is another notion of contra-positive with respect to satisfaction, as follows.

(33) $(p \to a)$ $\mathsf{Satisfied}_\sigma$ if either

(a) if p True then a $\mathsf{Satisfied}_\sigma$

(b) if a $\mathsf{unSatisfied}_\sigma$ then p False.

Here, (33b) has the form of the contra-positive of (33a). The first disjunct (33a) is already captured by (29a) and (33b) is captured by (30b).

Pseudo-Or Disjunctive pseudo-imperatives have the same satisfaction criteria as their imperative constituent.

(34) *Pseudo-Or*

(a) $\dfrac{a\ \mathsf{Satisfied}_\sigma}{(a \vee p)\ \mathsf{Satisfied}_\sigma}$ (b) $\dfrac{a\ \mathsf{unSatisfied}_\sigma}{(a \vee p)\ \mathsf{unSatisfied}_\sigma}$

(c) $\dfrac{(a \vee p)\ \mathsf{Satisfied}_\sigma}{a\ \mathsf{Satisfied}_\sigma}$ (d) $\dfrac{(a \vee p)\ \mathsf{unSatisfied}_\sigma}{a\ \mathsf{unSatisfied}_\sigma}$

[9] Example (31) is based on an example due to [*anonymous in this draft*]. We may wish to reflect on the extent to which it is possible to represent *permission* by way of contra-positive and free-choice imperatives.

2.2.2. Truth

Finally we can consider the judgements of truth. Such judgements are required for the analysis of pseudo-imperatives and conditional imperatives.

(35) *Standard Connectives:* As for classical logic.

(36) *Pseudo-And*

(a) $$\frac{(a \wedge p)\ \mathsf{True} \quad a\ \mathsf{Satisfied}_\sigma}{p\ \mathsf{True}}$$

(b) $$\frac{a\ \mathsf{Satisfied}_\sigma \quad p\ \mathsf{True}}{(a \wedge p)\ \mathsf{True}}$$ (c) $$\frac{a\ \mathsf{Satisfied}_\sigma \quad p\ \mathsf{False}}{(a \wedge p)\ \mathsf{False}}$$

(37) *Pseudo-Or*

(a) $$\frac{(a \vee p)\ \mathsf{True} \quad a\ \mathsf{unSatisfied}_\sigma}{p\ \mathsf{True}}$$

(b) $$\frac{p\ \mathsf{True}}{(a \vee p)\ \mathsf{True}}$$ (c) $$\frac{a\ \mathsf{Satisfied}_\sigma}{(a \vee p)\ \mathsf{True}}$$

Note that here we talk of a pseudo-imperative *being true* (or *being false*) rather than *being asserted* (or *commanded*).[10]

Conjunctive pseudo-imperatives do not make any claim about whether the imperative component needs to be satisfied for the propositional conjunct to be true. From $(a \wedge p)\ \mathsf{True}$ and $a\ \mathsf{unSatisfied}_\sigma$ we would not wish to infer $p\ \mathsf{False}$.

As with propositional conditionals, we may still be interested in deciding what can and should be inferred in the case that the "antecedent" imperative conjunct is not satisfied. If it behaves like material implication, then we would have the following:

(38) *Strong Derivation of Pseudo-And*

$$\frac{a\ \mathsf{unSatisfied}_\sigma}{(a \wedge p)\ \mathsf{True}}$$

Pragmatically, it is not clear that such a pseudo-imperative would actually be asserted under these circumstances. Arguably the assertion of a conjunctive pseudo-imperative has some form of causative or counter-factual component in its meaning. This is not considered here.

The initial rules for Pseudo-Or (34) do not say anything about the truth of propositional component in the event that the imperative component is

[10] Pseudo-imperatives might be issued even if the relevant truth conditions are not satisfied. In such cases they could be characterised as "empty" threats or promises.

satisfied. To address this, we could have a "committed" version of Pseudo-Or (39) for which the propositional outcome will be averted in the event that the imperative is satisfied.

(39) *Committed Pseudo-Or*

$$\frac{(a \vee p)\ \mathsf{True} \quad a\ \mathsf{Satisfied}_\sigma}{p\ \mathsf{False}}$$

In this case, the rules for Pseudo-Or introduction (37b,c) can be replaced by those of (40).

(40) *Introduction of Committed Pseudo-Or*

(a) $\dfrac{a\ \mathsf{Satisfied}_\sigma \quad p\ \mathsf{False}}{(a \vee p)\ \mathsf{True}}$ (b) $\dfrac{a\ \mathsf{unSatisfied}_\sigma \quad p\ \mathsf{True}}{(a \vee p)\ \mathsf{True}}$

(c) $\dfrac{a\ \mathsf{Satisfied}_\sigma \quad p\ \mathsf{True}}{(a \vee p)\ \mathsf{False}}$

2.2.3. Inconsistency and Incoherence

Here we present rules concerning judgements about the *consistency* of commands and *coherence* authorities. These notions can be used to capture some of the intuitions about incoherent combinations of commands. They can be seen to correspond to a very weak form of validity. For example, although we do not require that $a\ \mathsf{Commanded}_\alpha$ follows from $(a \wedge b)\ \mathsf{Commanded}_\alpha$ (cf. 1.1), we can say that it is *incoherent* of an authority to command $\neg\, a$ at the same time as commanding $(a \wedge b)$.

In general, the satisfaction conditions of some putative commands can be at odds with the satisfaction of others. It would be inconsistent for them to be judged to be satisfied together. In such cases, the corresponding commands would be inconsistent with each other, that is, $(a_1, \ldots, a_n)$ Inconsistent, or Σ Inconsistent (2.1.4). This is formulated in (41), using the abbreviations given in §2.1.4.

(41)
$$\frac{\begin{array}{c}[\Sigma\ \mathsf{Satisfied}_\sigma] \\ \vdots \\ \bot\end{array}}{\Sigma\ \mathsf{Inconsistent}}$$

An alternative would be for the inconsistency of the commands themselves to be treated as a basic notion. It would then be inconsistent to claim such commands were all satisfied together (42).

(42) $\dfrac{\Sigma\ \mathsf{Inconsistent} \quad \Sigma\ \mathsf{Satisfied}_\sigma}{\bot}$

Whichever approach we take, there should be no *logical* difficulties in representing and making judgements about inconsistent collections of commands, *provided* that we avoid asserting that some mutually inconsistent commands are judged to have been satisfied.[11] It would however be incoherent for an authority to issue inconsistent commands (43).

(43) *Incoherent agents*

$$\frac{\Sigma\ \mathsf{Commanded}_\alpha \quad \Sigma\ \mathsf{Inconsistent}}{\alpha\ \mathsf{Incoherent}}$$

An authority will be judged incoherent for doing any of the following:

(a) issuing a conjunctive command in which the conjuncts are inconsistent.

(b) giving a free choice over things they have prohibited

(c) issuing a conditional command in which the imperative consequent is inconsistent with other commands, in the event the antecedent is true.

(d) issuing a pseudo-imperative where the imperative constituent is inconsistent with other commands.

These follow as a consequence of the satisfaction criteria given in §2.2.1.

We may wish to strengthen the treatment of coherence of conditional imperatives so that a conditional $(p \rightarrow a)$ with a consequent a that is inconsistent with other commands is itself inconsistent regardless of the truth of the antecedent proposition p.

(44) *Strong Consistency for Conditionals*

$$\frac{\Sigma\ \mathsf{Commanded}_\alpha \quad (p \rightarrow a)\ \mathsf{Commanded}_\alpha \quad (\Sigma, a)\ \mathsf{Inconsistent}}{\alpha\ \mathsf{Incoherent}}$$

This goes someway towards capturing the intuition that (9) *"If you see John, say hello!"* would be inconsistent with a command not to say hello to anyone. We might prefer to say that a commanding authority could only be judged incoherent if p were *possible*.

2.3. Obedience

We may judge that some form of *transgression* ($\mathcal{T}$) arises in the event that authority α has commanded something that subject σ has failed to satisfy [2, 9, 38].

[11] If $a\ \mathsf{Satisfied}_\sigma$ were reduced to $a_\sigma\ \mathsf{True}$ (§2.1.3), then this could be expressed directly in terms of classical consistency of propositions.

(45) *Transgression*

$$\frac{a\ \mathsf{Commanded}_\alpha \quad a\ \mathsf{unSatisfied}_\sigma}{\mathcal{T}_{\sigma,\alpha,a}}$$

Here the transgression $\mathcal{T}$ is indexed with the subject, the authority, and the command that has been transgressed. A more sophisticated analysis would be required if it were necessary to distinguish between intentional and co-incidental compliance. If a system of authority is inconsistent, it may not even be possible to comply. Here we do not consider the question of *when* the satisfaction of a command is to be evaluated.

A subject σ who is obedient with respect to authority α will seek to minimise the number of transgressions, perhaps with a pragmatic value-judgement in the case of an inconsistent authority, or conflicts between authorities. Similar value-judgements could no doubt be employed to determine appropriate actions in the case of free-choice permission, and disjunctive pseudo-imperatives.

This notion of a transgression might provide a suitable vehicle for a pragmatic re-interpretation of validity with respect to formal and informal specifications, as used in computer science for example. In effect, the account proposed here gives specifications an intensional, or inscriptional, characterisation which avoids a logical collapse when considering a specification that contains inconsistencies [1, p123], whilst allowing partial fulfilment of a specification.

2.4. Sequential Commands

One variety of command not considered so far is that of sequential commands of the form *"Do a and then do b!"* [34]. We may formulate this as in (46).

(46) (a) Add $a \wedge_T b$ to the language of imperatives, to represent *"and then"*.

(b) *Initial Coherence*

$$\frac{(a \wedge_T b)\ \mathsf{Commanded}_\alpha \quad \neg\, a\ \mathsf{Commanded}_\alpha}{\alpha\ \mathsf{Incoherent}}$$

(c) *Consequent Coherence (Strong)*

$$\frac{(a \wedge_T b)\ \mathsf{Commanded}_\alpha \quad \neg\, b\ \mathsf{Commanded}_\alpha}{\alpha\ \mathsf{Incoherent}}$$

(d) *Consequent Coherence (Weak)*

$$\frac{a\ \mathsf{Satisfied}_\sigma \quad (a \wedge_T b)\ \mathsf{Commanded}_\alpha \quad \neg\, b\ \mathsf{Commanded}_\alpha}{\alpha\ \mathsf{Incoherent}}$$

(e) *Satisfaction*

(i) $\dfrac{(a \wedge_T b)\ \mathsf{Satisfied}_\sigma}{a\ \mathsf{Satisfied}_\sigma}$ (ii) $\dfrac{(a \wedge_T b)\ \mathsf{Satisfied}_\sigma}{b\ \mathsf{Satisfied}_\sigma}$

(iii) $\dfrac{a\ \mathsf{Satisfied}_\sigma \text{ AND THEN } b\ \mathsf{Satisfied}_\sigma}{(a \wedge_T b)\ \mathsf{Satisfied}_\sigma}$

This assumes some appropriate interpretation of "AND THEN" in the language of judgements.

A more refined approach could be to add a temporal dimension to systems of commands and their satisfaction, thus providing the means to formalise dynamic command systems.

2.5. Models for Imperative Theories

A model can be constructed in order to help demonstrate the consistency of any specific proposed collection of inference rules. In the case of the framework proposed here, one approach would be to model the propositions P and imperatives I, and the operators that can combine them, as classes of terms in a combinatory calculus. Closure rules would then need to be given to reflect the syntax of P and I. Further classes and closure rules could then be added to model the judgements.

If appropriately constructed, the interpretation and the closure rules would demonstrate that there is a consistent interpretation of the proposed collection of inference rules. Producing a model-theoretic interpretation can help to demonstrate that a formal system is coherent. But, a model of this sort does not necessarily contribute directly to the *understanding* of the framework or the intuitions about the subject matter. Although important, here we view model-theory as playing a secondary, supporting role to the formal framework.

3. Imperative Dilemmas

It is appropriate to discuss some of the dilemmas described in the literature on imperatives, and demonstrate how they can be addressed within this proposed framework.

3.1. Ross's Paradox

By appealing to some seemingly contrary intuitions about the appropriate rules for a logic of imperatives, Ross [31] argued that it is not possible to

formulate a logic for imperatives with inference rules that individually capture both the notions of satisfaction and validity.

The core of Ross's case can be illustrated by considering disjunction. If we take classical logic to be the gold standard of *validity*, then given the proposition p we should be able to infer $(p \vee q)$, where q is any proposition. If this particular notion of validity is carried over directly into a "logic" of imperatives, then if a is commanded, we can infer that $(a \vee b)$ is commanded, where b is any imperative. But, Ross argues, from (47) we probably do not want to derive the command (48) as the satisfaction criteria of the latter would licence the burning of the letter, which presumably the commanding authority may consider undesirable.

(47) *"Post the letter!"*

(48) *"Post the letter or burn the letter!"*

This tension is resolved in the current account by maintaining a clear distinction between judgements concerning *satisfaction* and those concerning what has been *commanded*. Furthermore, the rules governing commands are very weak. This allows the main thrust of Ross's argument to be avoidable: we do not need to assume that notions of validity apply to the content of commands. Classical validity can apply to judgements themselves without necessarily applying directly to commands, or their content. If there is a judgement that supports something closely resembling classical patterns of inferences, it is that of *satisfaction*. Some problems are avoided if we acknowledge that the judgement of satisfaction does not require or presuppose that a command was issued.

3.2. Free Choice

In the case of free-choice imperatives [3, 8, 21, 39] (§1.2), a key issue is that we appear to be "permitted" to comply with either command, but at the same time may only be allowed to comply with one. In the proposed account, the sense in which the free-choice imperative appears to licence both disjuncts is captured by the fact that it is incoherent to command something that contradicts (or whose satisfaction criteria contradicts) either of them. The exclusive interpretation is captured by ruling that the free-choice command is "satisfied" if *and only if* one disjunct is satisfied (26).

3.3. Jørgensen's Dilemma

The essence of Jørgensen's Dilemma [20] is as follow: (a) logical inferences only hold between sentences with truth values; (b) imperatives have no truth

values; therefore, (c) there should be no logical inferences between imperatives. And yet, (d) it still appears compelling to argue that imperatives do support some kind of logical entailment, as in (49). The dilemma is that the conclusion (c) and observation (d) appear to be at odds with one another.

(49) (a) $$\frac{\textit{“Keep your promises”} \quad \textit{“This is a promise”}}{\therefore\ \textit{“Keep this promise”}.}$$

(b) $$\frac{\textit{“Love your neighbour as you love yourself”} \quad \textit{“Love yourself”}}{\therefore\ \textit{“Love your neighbour”}}$$

The dilemma can be resolved if we take inferences involving propositions (50) to be short-hand for inferences over *truth judgements* about propositions (51).

(50) $$\frac{p_1 \quad p_2 \quad \dots \quad p_n}{p}$$

(51) $$\frac{p_1\ \mathsf{True} \quad p_2\ \mathsf{True} \quad \dots \quad p_n\ \mathsf{True}}{p\ \mathsf{True}}$$

The claim (a) can then be generalised, and restated as *“logical inferences only hold between judgements”*. On this view, we *can* then have entailments involving expressions that do not have truth values—such as imperatives—provided that we identify the relevant judgements. For imperatives, the relevant judgements are those of *satisfaction* and *commanding* rather than *truth* [5]. In the current proposal, we seek to avoid one source of confusion by making explicit the intended nature of such judgements.

Even if otherwise satisfied by the current proposal's resolution of Jörgensen's Dilemma, the inquisitive reader may question what the proposal makes of the specific examples in (49). The theory as formalised in §2 does not capture these entailments from general expressions to specific expression. Even so, one can see that the arguments would appear to follow when couched in terms of satisfaction. In the case of (49a) if the imperative is satisfied and the proposition true in the premises, then the conclusion *“Keep this promise”* is satisfied; if it is not, then either the propositional premise is false, or the imperative premise is not satisfied. In the case (49b), if both premises are satisfied, then the conclusion *“Love your neighbour”* is satisfied; if it is not, then at least one of the premises cannot have been satisfied.

From the perspective of what has been *commanded*, the current account would not allow us to infer that the commands in the conclusions of (49) are judged to have been issued, although it would not be incoherent for an authority to highlight the consequences of satisfying a command by issuing the more specific imperatives.

4. Related Work

The "standard approach" to the formal analysis of imperatives [18] is to take imperatives to have some "propositional content" [15, 20, 26, 35]. Some accounts also factor-in the agent, or addressee [29].

The current proposal avoids any direct reduction of imperatives to propositions. Instead, it treats imperatives as first class entities. Judgements about their satisfaction criteria are taken to have the same status as judgements of truth in the case of propositions. This notion of "satisfaction" corresponds to "fulfilment" criteria [5, 16, 24] or "outcomes" [12].

Some accounts include a specific notion of an action which is intimately related to a proposition [37, 25, 30, 34]. For example, the proposition may be the *post-condition* of the action. The imperative is then a request to perform this action in order for the desired post-condition to become true. But it should be noted that actions, however formulated, need to take account of intent, not just post-conditions. A person who hangs a piece of bread in the water on a hook can only be described as engaging in the act of fishing if that is what she intends to do, regardless of whether or not she catches fish [14], or exactly how she goes about it.

The proposed framework abstracts away from any particular notion of satisfaction, such as an action-based analysis. This allows core aspects of the inferential behaviour of imperatives to be considered while avoiding questions about actions, causality, events, intentions, the frame problem [27] and the relationship between actions and events [4]. The framework can be enriched with actions and events if that is thought appropriate.

It is common to adopt a *model-theoretic* methodology for semantic analysis. With such an approach, the primary task would be to provide an interpretation of imperatives in a model [25, 34]. Any representation language would then have only a secondary role. This can be contrasted with the current proposal, which seeks to provide a framework in which intuitions about inference behaviour are formulated more directly. An argument in favour of this approach is that it makes it easier for us to work at an appropriate level of abstraction. We can focus on the intuitions, rather than working around the technical difficulties that can arise when formulating a theory primarily as an "encoding" in some pre-existing model. The approach taken here also seems to make it easier to maintain a classical notion of inference, and avoid the need to adopt some form of defeasible entailment [3].

There are alternative formalisations that model imperatives in terms of "commitments" or "to do" lists [28, 29]. There is a sense in which these can be seen to be capturing the notion of satisfaction, and treating what has been

commanded as something that need not be subject directly to any substantive rules of entailment.

There appear to be no other existing proposals that combine: (a) an explicit and unambiguous distinction between commanding and satisfying; (b) the avoidance of logical dilemmas in the face of incoherent commands; (c) consideration of conditional and pseudo imperatives; (d) a treatment of the permissive aspects of free-choice imperatives which does not resort to defeasible inference.

5. Conclusions and Future Work

The primary role of this contribution is to present a framework for formalising intuitions about the basic patterns of behaviour of judgements concerning imperatives. Some sample rules are proposed. The account could be extended to include quantification, discourse phenomena [25], pragmatic issues, and the relationship with deontic logic [13]. It may also be appropriate to find some way of unifying, or relating, those patterns of behaviour that are common to both *truth* and *satisfaction*.

It might be argued that the current formalisation provides a mere *description* of the patterns of behaviour of imperatives, and that only those accounts that seek to integrate an analysis of imperatives within some pre-existing model can properly claim to count as a fully-fledged explanatory *theory*. Such a claim may be seen to be reinforced if the appropriate patterns of behaviour are obtained as a 'natural' consequence of some definitional reduction of imperatives to other independently motivated notions.

A counter-argument is that the identification of appropriate ontological categories and judgements, and the formalisation of patterns of behaviour into precise rules, is an important and necessary step. Such an analysis can be used to determine whether a proposed reduction preserves our intuitions. This approach also allows us to work at an appropriate level of abstraction, and avoids the risk of conflating intuitively distinct ontological categories.

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References

[1] Alchourrón, Carlos E., and Eugenio Bulygin, *Normative Systems*, Springer-Verlag, Wien, 1971.

[2] Anderson, Alan Ross, 'A reduction of deontic logic to alethic modal logic', *Mind*, 67 (1958), 100–103.

[3] Asher, Nicholas, and Daniel Bonevac, 'Free choice permission is strong permission', *Synthese*, 145 (2005), 3, 303–323.

[4] Bach, Kent, 'Actions are not events', *Mind*, 89 (1980), 353, 114–120. New series.

[5] Beardsley, Elizabeth Lane, 'Imperative sentences in relation to indicatives', *Philosophical Review*, 53 (1944), 2, 175–185.

[6] Castañeda, Hector Neri, *Thinking and Doing*, D. Reidel Publishing Co., Dordrecht and Boston, 1975.

[7] Clark, Billy, 'Relevance and "pseudo-imperatives"', *Linguistics and Philosophy*, 16 (1993), 79–121.

[8] Dignum, Frank, John-Jules Ch. Meyer, and Roel Wieringa, 'Free choice and contextually permitted actions', *Studia Logica*, 57 (1996), 1, 193–220.

[9] Fox, Chris, 'Obligations, permissions and transgressions: an alternative approach to deontic reasoning', in *Proceedings of the Tenth Symposium on Logic and Language*, Theoretical Linguistics Program, ELTE, Budapest, Balatonszemes, Hungary, 2009, pp. 81–88.

[10] Franke, Michael, 'How and how not to employ discourse relations to account for pseudo-imperatives', in Paul Dekker, and Michael Franke, (eds.), *Proceedings of the Amsterdam Colloquium*, ILLC/Department of Philosophy, University of Amsterdam, Amsterdam, 2005, pp. 83–88.

[11] Franke, Michael, *Pseudo-Imperatives*, Master's thesis, Institute for Logic, Language and Computation, University of Amsterdam, 2005.

[12] Ginzburg, Jonathan, and Ivan Sag, *Interrogative Investigations*, CSLI, Stanford, 2000.

[13] Hage, Jaap C., *Studies in Legal Logic*, chap. 6: What is a Norm?, Springer, Berlin, 2005, p. 173ff.

[14] Hamblin, Charles L., *Imperatives*, Blackwell, Oxford, 1987.

[15] Hare, Richard Mervyn, 'Imperative sentences', *Mind*, LVIII (1949), 21–39. Also in [17].

[16] Hare, Richard Mervyn, 'Some alleged differences between imperatives and indicatives', *Mind*, LXXVI (1967), 303, 309–326.

[17] Hare, Richard Mervyn, *Practical Inferences*, Macmillan, 1971.

[18] Huntley, Martin, 'The semantics of English imperatives', *Journal of Linguistics and Philosophy*, 7 (1984), 103–133.

[19] Jackson, Frank, 'On the semantics and logic of obligation', *Mind*, 94 (1985), 177–195.

[20] Jørgensen, Jørgen, 'Imperatives and logic', *Erkenntnis*, 7 (1937–38), 288–296.

[21] Kamp, Hans, 'Free choice permission', *Proceedings of the Aristotelian Society*, 74 (1973), 57–74.

[22] Klein, Daniel B., and Brendan O'Flaherty, 'A game-theoretic rendering of

promises and threats', *Journal of Economic Behavior and Organization*, 21 (1993), 295–314.

[23] Krifka, Manfred, 'Semantics below and above speech acts', Talk held at Stanford University, 2004.

[24] Lappin, Shalom, 'On the pragmatics of mood', *Linguistics and Philosophy*, 4 (1982), 559–578.

[25] Lascarides, Alex, and Nicholas Asher, 'Imperatives in dialogue', in Peter Kühnlein, Hans Rieser, and Henk Zeevat, (eds.), *The Semantics and Pragmatics of Dialogue for the New Millenium*, Benjamins, 2004, pp. 1–24.

[26] Lewis, David, 'General semantics', in Donald Davidson, and Gilbert Harman, (eds.), *Semantics of Natural Language*, Reidel-Dordrecht, 1972, pp. 169–218.

[27] McCarthy, John, and Patrick J. Hayes, 'Some philosophical problems from the standpoint of artificial intelligence', in Bernard Meltzer, and Donald Michie, (eds.), *Machine Intelligence*, vol. 4, Edinburgh University Press, 1969, pp. 463–502.

[28] Piwek, Paul, 'Imperatives, commitment and action: Towards a constraint-based model', *LDV Forum: GLDV-Journal for Computational Linguistics and Language Technology, Special Issue on Communicating Agents*, 17 (2000), 1,2. ISSN 0175–1336.

[29] Portner, Paul, 'The semantics of imperatives within a theory of clause types', in Kazuha Watanabe, and Robert B. Young, (eds.), *Proceedings of Semantics and Linguistic Theory 14*, CLC Publications, Ithaca, NY, 2005. Paper presented at SALT 14, 14th–16th March 2004.

[30] Pérez-Ramírez, Miguel, and Chris Fox, 'An axiomatisation of imperatives using Hoare logic', in Harry Bunt, Ielka van der Sluis, and Roser Morante, (eds.), *Proceedings of the Fifth International Workshop on Computational Semantics (IWCS-5)*, Tilburg, Netherlands, 2003, pp. 303–320.

[31] Ross, Alf, 'Imperatives and logic', *Theoria*, 7 (1941), 53–71. Republished as [32].

[32] Ross, Alf, 'Imperatives and logic', *Philosophy of Science*, 11 (1945), 30–46.

[33] Russell, Benjamin, 'Imperatives in conditional conjunction', *Natural Language Semantics*, 15 (2007), 2, 131–166.

[34] Segerberg, Krister, 'Validity and satisfaction in imperative', *Notre Dame Journal of Formal Logic*, 31 (1990), 2, 203–211.

[35] Stenius, Erik, 'Mood and the language game', *Synthese*, 17 (1967), 254–274.

[36] Turner, Raymond, *Computable Models*, Springer, 2009.

[37] van Eijck, Jan, 'Making things happen', *Studia Logica*, 66 (2000), 1, 41–58.

[38] Wyner, Adam Zachary, *Violations and Fulfillments in the Formal Representation of Contracts*, Ph.D. thesis, King's College London, 2008.

[39] Zimmermann, Thomas Ede, 'Free choice disjunction and epistemic possibility', *Natural Language Semantics*, 8 (2000), 255–290.

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