Foundations for an Ontology of Intentions and Plans

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1. *Introduction*

An ontology of intentions and plans is needed to model human cognition, and agency of both human agents and artificial intelligence agents.[[1]](#footnote-1) Existing BFO conformant ontologies that include the term ‘plan’ are the Common Core Ontologies (CCO),[[2]](#footnote-2) and the Industrial Ontologies Foundry (IOF),[[3]](#footnote-3) which give an informational account, and the Ontology for Biomedical Investigations (OBI),[[4]](#footnote-4) which gives a realizable entity account. Non-BFO conformant ontologies that include the term ‘plan’ are the Provenance Ontology (PROV-O),[[5]](#footnote-5) Descriptive Ontology for Linguistic and Cognitive Engineering’s (DOLCE) Descriptions and Situations (DnS) module,[[6]](#footnote-6) and Plan-O.[[7]](#footnote-7)

Remarkably, the existing ontologies do not both model intentions and plans despite most using some cognate of ‘intention’ and related terms like ‘commitment,’ and ‘purpose.’

* Cco:Plan is a “Directive Information Content Entity that prescribes some set of **intended** **Intentional** Acts through which some Agent expects to achieve some Objective.”[[8]](#footnote-8)
* Iof:Plan is a “**intention**-to-perform processes on the part of an agent as prescribed by a plan specification.”[[9]](#footnote-9)
* Obi:Plan: is a “realizable entity that is the inheres in a bearer who is **committed** to realizing it as a planned process.”[[10]](#footnote-10)
* Prov:Plan: is an “entity that represents a set of actions or steps **intended** by one or more agents to achieve some goals.”[[11]](#footnote-11)
* Plano:Plan is a “specification of behavior for some **purpose**.”[[12]](#footnote-12)
  + Plano:Purpose is an “effect that is **intended** or desired by an agent.”[[13]](#footnote-13)

Perhaps more remarkably, one of the ontologies does not define plans in terms of ‘intention,’ or any related terms, at all.

* Dns:Plan is a description of a situation[[14]](#footnote-14)

Toyoshima, Barton, and Grenier give a dispositional account of intentions (and no account of plans),[[15]](#footnote-15) but, as will be shown, it falls short in important ways that a representational account does not. This paper ultimately gives a representational account of intentions and plans. It does so by using previous works on representations, namely, the Cognitive Process Ontology (CPO)[[16]](#footnote-16) and John Searle’s work on representations.[[17]](#footnote-17) This paper also uses Searle’s work on intentions,[[18]](#footnote-18) and Michael Bratman’s work on intentions and plans.[[19]](#footnote-19) After presenting the representational ontology of intentions and plans, this paper provides a brief formalization of the ontology, and discusses how the ontology relates to other works on intentions and plans.

This paper uses a driving example which is called (CODER). (CODER) features Jim who is a software engineer. When the workday begins, Jim intends to (1) write code; and (2) produce software. To produce software, Jim must make a plan, in part: (1) a plan for him to produce the software, which describes his intentions for himself; and (2) a plan for the computer, which describes his intentions for the computer.

* In this paper, italicized terms denote instances of the named class whereas non-italicized terms denote the named class itself. (**still must enact this plan**)

1. *Method: A Representational Approach*

To describe the mechanisms in (CODER), this paper uses the tools provided by BFO, and the BFO conformant suite of midlevel ontologies CCO. Along with this work, this paper uses prior ontological work on representations, which is implemented in the Cognitive Process Ontology (CPO): a BFO and CCO conformant ontology. This section will also discuss John Searle’s work on representations.

This paper uses the Common Core Ontologies’ model of information, which uses three classes: information content entity, information bearing entity, and information quality entity.[[20]](#footnote-20) Information content entities are generically dependent continuants that are about some entity. As generically dependent continuants, information content entities generically depend on one or more independent continuant for their existence. For example, the information content entity that is Tolstoy’s *War and Peace*, which originally depended on the first completed manuscript of *War and Peace* but which now depends on every copy of *War and Peace* that exists. In particular, information content entities depend on some information bearing entity, which is an independent continuant that carries it. For example, the ink in this copy of *War and Peace*. Information content can only be carried by an independent continuant that bears some information quality entity, which is a quality that concretizes some information content entity. For example, the pattern of the ink in this copy of *War and Peace*.

This paper uses a version of CPO’s model of representations which is modified out of necessity. CPO defines a representation as “a quality that concretizes, or is intended to concretize, some information content entity.”[[21]](#footnote-21) The clause ‘or is intended to concretize’ is problematic for a project modelling intention because it seems to smuggle in some understanding of intention. While it is true that it must smuggle in some understanding of intention, the disjunctive nature of the clause does not strictly pose a problem for this project. However, since it is a defined class, it does indicate that there are two kinds of representations, and only one of them can be the basis for an ontology of intentions and plans. The first kind is just an information quality entity. The second is an intended representation, which causally depends on an intended act: an act prescribed by, and itself caused by, some intention. Clearly intended representations presuppose the existence of an intention and thus cannot be the ontological basis for intentions. I will now discuss representations generally, but will have in mind information quality entities that are not intended representations and thus omit the problematic clause. Later in the paper, after the representational model of intentions is presented, I will say more about intended representations.

A representation is a quality, a type of specifically dependent continuant, that concretizes some information content entity. For example (again), the pattern of the ink that concretizes this copy of *War and Peace*. As specifically dependent continuants, representations specifically depend on exactly one independent continuant for their existence. For example, this copy of *War and Peace* is borne by the ink on the page such that if the ink ceases to exist so does the pattern of the ink and thus this copy of *War and Peace*. As qualities, representations are realized at all times they exist, and require no extra process to be realized in contrast to realizable entities.

When representations concretize information content entities, they are derivatively about whatever the concretized information content entity is about.[[22]](#footnote-22)

* Say more about what it is for X to be derivatively about Y.
* Concretization v.s. derivative concretization

For example, this representation on the television screen is derivatively about World War Two because it concretizes some World War Two documentary, which is an information content entity about World War Two. This copy of *The History of the Peloponnesian War* is derivatively about the Peloponnesian War because it concretizes *The History of the Peloponnesian War*, which is an information content entity about the Peloponnesian War.

An addition to representations in books and on television screens, there are mental representations, which are the entities that humans (and other organisms) think with. CPO models mental representations using ‘cognitive system,’ and ‘mental quality.’ A cognitive system is a “system which realizes cognitive dispositions, all of whose parts are also parts of a single organism.”[[23]](#footnote-23) A mental quality is a “quality which specifically depends on an anatomical structure in the cognitive system of an organism.”[[24]](#footnote-24) A mental representation is a “mental quality that is a representation.”[[25]](#footnote-25)

Not all mental qualities are mental representations. For example, there are mental qualities that affect the occurrence of our feelings, like pain, which are not derivatively about anything. However, the mental qualities of interest in this paper are mental representations. For example, my thought that concretizes some information content entity about pizza, and so which is derivatively about pizza.

Following Searle, both mental representations and non-mental representations, like maps, succeed or fail in matching reality.[[26]](#footnote-26) For example, my belief that it is snowing outside matches reality if and only if it is snowing outside, and fails to match reality if and only if it is not snowing outside. A map of New York City matches reality if and only if it is New York City pictured on the map. To account for this, Searle argues, we need two notions: success condition and direction of fit.[[27]](#footnote-27) The success condition is the way the world needs to be for the representation to match reality. The success condition in the given example is that it is snowing outside. The direction of fit of a representation specifies the direction of the matching relationship between the world and the representation.[[28]](#footnote-28) For example, beliefs have a representation-to-world direction of fit. That is to say that the success conditions of a belief can be satisfied only if it matches the way the world is. My belief that it is snowing, for example, is a successful belief if and only if it is snowing.

Following CPO, mental representations that have a mind-to-world direction of fit are *cognitive representations*.[[29]](#footnote-29) Cognitive representations always concretize some descriptive information content entity, which is an information content entity that describes some entity.[[30]](#footnote-30) So, in the given example, the belief that it is snowing requires that some part of my cognitive system concretizes some information content entity which describes the outside as snowing.

*Conative representations*, on the other hand, are what CPO calls a mental representation with a world-to-mind direction of fit.[[31]](#footnote-31) Examples include desires and, as will be shown, intentions.[[32]](#footnote-32) If I desire to eat pizza, my desire is satisfied if and only if I do eat pizza. Thus, the world must change to match my desire. Some conative representations concretize some descriptive information content entity that describes, for example, what one wants. These are plausibly desires.[[33]](#footnote-33) For example, some mental representation that concretizes some information content entity that describes that I want pizza can be satisfied if and only if I eat pizza. I can also want it to be snowing outside, and that representation’s success conditions is satisfied if and only if it does snow outside. In the first example, my representation must cause that success conditions (my eating pizza). In the second example, my representation cannot cause the satisfaction of the success conditions (this snowing outside).

1. *An Ontological Account of Intentions and Plans*

The argument this section of the paper forwards is that intentions and plans are representations because, like representations, (i) intentions and plans are derivatively about things; (ii) we think with intentions and plans; and (iii) we can have delusional intentions and plans.

* 1. *Intentions*

Following Toyoshima, Barton, and Grenier, this paper uses the word ‘intention’ rather than ‘intent.’[[34]](#footnote-34)

* + 1. *Bratman and Searle on Intentions*

In addition to the above, this paper uses both Bratman on intentions and plans, and Searle on intentions. First, following Bratman, intentions are “conduct-controlling pro-attitudes.”[[35]](#footnote-35) Intentions are pro-attitudes because they guide conduct including mental conduct like reasoning. Intentions are conduct controlling because they direct conduct, resist reconsideration, and are stable (Bratman calls this “inertia”).[[36]](#footnote-36) In other words, intentions are pro-attitudes to which an agent commits. An agent can commit to attitudes that are not pro-attitudes, like moral beliefs, for example. While they may indirectly guide conduct, they do so as inputs in a deliberation process that outputs intentions.

An intention can guide actions in two general ways. The first way is by guiding an agent toward some objective, or goal, or end. Doing so guides reasoning and conduct such that it is consistent with that end, as when I commit to eating lunch at noon today. The second way is by guiding actions themselves, as when I commit to eating pizza at noon today.

There are also compound intentions that both guide an agent’s actions and guide that agent toward some end. Following Searle, there are two ways to relate objective intentions and action intentions together. First is committing to some objective *by way of* some action, as when I commit to eating lunch at noon today by way of eating pizza at noon today. My eating pizza at noon today just is my eating lunch at noon today. My intended action is sufficient for my intended end. Second is committing to some objective *by means of* some action, as when I intend to eat lunch at noon today by means of going to the pizzeria. My going to the pizzeria at noon today is a just a means to the end of my eating lunch at noon today.

Clearly, intentions have a world-to-mind direction of fit, and thus are conative representations.

* + 1. *An Ontology of Intentions*

When Jim, the software engineer in (CODER), arrives at work, he must pick an objective for the day. Notice that Jim need not set a reasonable objective. He may well and truly think that he can write the code for the next version of Microsoft Word in just a day. Suppose he commits to doing so. This is all it takes for Jim to have the intention to produce the next version of MS Word in a single day. The intention derivatively prescribes the endstate of having a particular deliverable, namely, the next version of MS Word. Furthermore, the intention will be an input into Jim’s reasoning about how specifically to achieve his prescribed objective. The output of this reasoning will be intentions derivatively about actions, which need not be reasonable either. For these reasons, intentions seem like representations.

Instead, suppose Jim commits to the more reasonable objective to produce some simple computer program. Call intentions that are derivatively about objectives *objective-intentions*. To account for objective-intentions, this paper uses a necessarily modified version of ‘objective specification’ from CPO. According to CPO an *objective specification* is a “directive information content entity that prescribes an intended process endstate.”[[37]](#footnote-37) But this definition, as with CPO’s definition of ‘representation,’ relies on some understanding of the word ‘intended.’ So, this paper will omit the word ‘intended’ for now, and later discuss intended objective specifications.

As an input to his reasoning, Jim’s objective-intention guides further reasoning to forming intentions about actions that will lead to that objective. Suppose Jim forms the intention to write one-hundred lines of code. Call intentions that are derivatively about actions *action-intentions*. To account for action-intentions, this paper uses ‘action specification’ from CPO. According to CPO, an *action specification* is a “directive information content entity that prescribes some action.”[[38]](#footnote-38)

Since Jim can attempt to make the world fit the content of his intentions, by writing one-hundred lines of code and by producing the simple program, his intentions are conative representations. What distinguishes intentions from other conative representations, like desires, is that intentions involve commitment. In order to model this, this paper imports the object property ‘is\_fused\_with’ from CPO (citing Husserl citing Stumpf),[[39]](#footnote-39) and introduces a new term ‘commitment value.’ ‘is fused with’ is a primitive relation that relates two quality instances “so closely related that a new quality instance seems to emerge from them.”[[40]](#footnote-40) An example is the quality of green of a television screen that seems to emerge from yellow and blue pixels. A commitment value is a mental quality that, when fused with a conative representation CR, determines the extent to which a cognitive system operates as if CR is controlling. Further, a positive commitment value is commitment value that when fused with a conative representation CR results in the bearing cognitive system treating CR, to some extent, as if it were controlling.[[41]](#footnote-41) When a particular kind of conative representation is fused with a positive commitment value, an intention seems to emerge.

* Intention: A conative representation that either (i) concretizes some action specification or some objective specification; or (ii) concretizes some action specification and some objective specification; and (iii) is fused with some positive commitment value.
  + Simple intention: A conative representation that (i) concretizes either some action specification or some objective specification; and (ii) is fused with some positive commitment value.
    - Action Intention: An intention that concretizes some action specification.
    - Objective Intention: An intention that concretizes some objective specification.

On this account, it is possible to have an intention that does not relate to another intention. For example, the intention I have right now to raise my arm (I just raised my arm). Usually, however, both an action intention and objective intention will be involved in a compound intention. For example, Jim’s writing one-hundred lines of code will lead to Jim’s producing some simple software.

Following Searle, there are two ways for an action intention and objective intention to relate. The first way is such that the agent commits to achieve the prescribed objective *by means of* the prescribed action. For example, one may intend to turn on the light by means of flipping the light switch. The second way is such that the agent commits to achieve the prescribed objective *by way of* the prescribed action. For example, one may intend to vote on an issue by way of raising their hand. In this case, the hand raise just is what it is to vote. This is importantly different because turning the light on is not just flipping the switch: electricity needs to flow to the light for it to turn on, for example.[[42]](#footnote-42) Therefore, the ‘by way of’ relation is constitutive, and the ‘by means of’ relation is causal. To account for these, respectively, this paper uses ‘is process part of’ and ‘causes.’

* Compound intention: A conative representation that either (i) concretizes some DICE that prescribes some action causes some objective; or (ii) concretizes some DICE that prescribes that some action is process part of (and not some proper process part of) some objective; and (iii) is fused with a positive commitment value.
  + Constitutive compound intention: A conative representation that (i) concretizes some DICE that some action is process part of (and not some proper process part of) some objective; and (ii) is fused with a positive commitment value.
  + Causal compound intention: A conative representation that either (i) concretizes some DICE that prescribes some action causes some objective; and (ii) is fused with a positive commitment value.

For example, Jim intends to produce some program that is caused by writing one-hundred lines of code. It is not just the one-hundred lines of code that are the program. Jim also needs to save the program in the correct format. Writing one-hundred lines of code and saving it in the correct format just is producing the program.

Suppose Jim works from home and has a young child that likes to help Jim with his work. Jim can intend that his child is the one that clicks the save button for him. Thus, Jim can intend that his child does some action, namely, click the save button.

Of course, the commitment one has to their intentions is defeasible. Suppose that there is a fire at Jim’s office that would put him in danger if he did not evacuate. Jim is permitted to abandon his intentions for the day without saying that Jim was never committed to accomplishing his objective of producing some program by writing some lines of code. Intentions are also defeasible in relation to other intentions. This is where commitment values do extra work in the model. If there are two conflicting intentions, say Jim both intended to relax all day and produce some software, the intention with the higher commitment value wins out. In this case, let us say that Jim is more committed to producing software on the day in question. Jim therefore abandons his intention to relax all day.

But, as will be shown, a more detailed model of Jim’s day at work will require modeling plans.

* 1. *Kinds of intentions*

Before proceeding to plans, it is necessary to say something about kinds of intentions found in philosophy and cognitive science literature. What is said will be important to what is later said about plans.

A prominent view of intentions in cognitive science, the Dynamic Hierarchical Model, says there are three kinds of intentions: motor intentions, proximal intentions, and distal intentions.[[43]](#footnote-43)

* Motor intention: An intention

Proximal intentions are what some philosophers, like Searle, call an “intention-in-action,”[[44]](#footnote-44) and, like Bratman, call a “present-directed intention.”[[45]](#footnote-45)

* Proximal intention: An intention

A distal intention is what some philosophers, like Searle, call a “prior intention,”[[46]](#footnote-46) and like Bratman, call a “future-directed intention.”[[47]](#footnote-47)

* Distal intention: An intention

Cognitive scientists observe that collections of intentions can have a hierarchical structure in two senses.[[48]](#footnote-48) First, executing distal intentions requires executing proximal intentions, and executing proximal intentions requires executing motor intentions. Second, collections of each kind of intention can also be organized hierarchically.

* 1. *Plans*
     1. *Bratman on Plans*

According to Bratman, plans have some of the same characteristics as intentions: they control behavior, they resist reconsideration, and they play roles as input in practical reasoning.[[49]](#footnote-49) This is because all intentions are plan-states.[[50]](#footnote-50) Put another way: at least some plans are temporally extended chains of *distal* intentions. At least some plans have the characteristics of intentions plus whatever characteristics come from the temporal extension of distal intentions.

According to Bratman, unlike intentions: (i) there are partial plans that can be filled in; and (ii) plans typically have a hierarchical structure.[[51]](#footnote-51) The partiality is a consequence of a plan’s temporal extension because it would not be rational to settle on all steps of a plan in advance due to likely changes in circumstance. The hierarchical structure is also a consequence of the temporal extension of intentions because the further in the future the intentions extend, the more steps, substeps, and subplans will be required to successfully execute the plan. The rational way to organize these, of course, is hierarchically. A hierarchy is an arrangement of entities such that some are represented as above or below other entities. In the case of plans, arrangements represent entities in terms of order of completion (if order of completion matters).

Bratman focuses on what is called a nested hierarchy. A common way to begin thinking about nested hierarchies is to think about Russian matryoshka dolls which have a nested hierarchy structure. The largest doll contains a smaller one, and the smaller one contains an even smaller one, and so on. Plans are similar. For example, some plan might contain some objective, which requires some subobjective to be achieved before it can be achieved. That subobjective will require some actions to be performed before it can be achieved. For example, the completion of an essay (objective) requires the completion of an outline (objective) which requires doing research (action). This plan is partial because it is not only these things that are required for the completion of an essay, and as time goes on the plan will be filled in with more detailed objectives and actions.

Plans can also have subplans. For example, you may plan to go see the newest Marvel movie when you have the free time. You may also have a plan for today, which initially contains no free time. But suppose an appointment is cancelled and you have the time to see the new Marvel movie. Adding the plan to see the marvel movie to your daily plan creates a plan nested plan. This occurs in more subtle ways whenever two representations are merged such that one is nested in the other.

Linear hierarchies are also of interest in this paper. Linear hierarchies are represented as a list of steps without and nested items (i.e., sub-actions, sub-objectives, or sub-plans).

There are good reasons to think that not all plans are temporally extended chains of intentions. First, though all intentions involve commitment, the same is not true of plans. A person can have a plan in mind without committing to it. Alfred Mele and Paul Moser give the following example, which I have slightly modified to use terminology consistent with the present paper. “Suppose that you once encountered a plan for making a dollhouse in *Childlife Magazine*. You committed it to memory and are now mentally reviewing it, purely as a mnemonic exercise. The plan in . . . your memory now [has no component of commitment]. You are not the least bit [committed] now to execute the plan or to make a doll house. This scenario is quite coherent. Having a plan does not entail [commitment to] executing the plan.” [[52]](#footnote-52) Second, though all intentions are mental representations, the same is not true of plans. Blueprints, for example, are plans, but are printed on a kind of paper called vellum. The plans that artificial intelligence agents have are represented in a computer rather than some organism’s cognitive system. Another interesting difference between plans for humans and plans for computers is that the former are typically partial, even in execution, whereas the latter are never partial in execution.

This paper accounts for Bratman’s differences between plans and intentions plus the objections in terms of plans as complex representations of intentions.

* + 1. *An Ontology of Plans*

Begin with reasons to think that plans are representations. First, plans are derivatively about things. Namely, they are about intentions and the processes those intentions prescribe. Just as a photograph of a map represents the map and the geographical region that the map represents, a plan represents both the intentions it describes and the processes that the intention prescribes. Just as one can use a photograph of a map to navigate a geographical region, one can use a plan to perform the processes that the intentions prescribe. For example, blueprints are about the structure that will be built, and the intentions of the planner. Ultimately, the blueprints, like a photograph of a map, can be followed. Second, following Bratman, we think with plans. They are both inputs and outputs of reasoning. As an input to reasoning, blueprints will restrict what materials can be purchased to achieve the goal of building the structure. As an output, a plan will prescribe some purchasing of some material. Third, we can have delusional plans. A student can plan to attend Harvard despite lacking all the required dispositions.

Return to Jim. When Jim’s workday began, he had the intention to produce a program by means of writing code. He also intended to have his son click the save button at the end of the day. But to achieve his objective via his intended actions, he must make a plan. That is, he must represent his intentions in a connected way, and in a way that can be edited and added to. In order to account for the representations of his intentions, this paper introduces two terms.

* Plan Component Specification: An information content entity that represents some intention.
* Plan Component: A representation that concretizes some plan component specification.
* Plan: A representational complex that has parts only some plan components.

In order to account for the connections, which are typically hierarchical and between plan components, this paper introduces the term *hierarchy value*.

* Hierarchy Value: A quality that, when fused with a plan component, results in some agent treating it is above or below another plan component.
* Hierarchical Plan Component: A plan component that is fused with some hierarchy value.
* Hierarchical Plan: a plan that has parts only some hierarchical plan components.

Jim’s plan begins as a straight forward linear hierarchy that can be represented as follows.

1. Produce program by means of writing code.
2. Have son click the save button.

In Bratman’s terms, this is a partial plan, since there are more plan components that must be added in order to be used to accomplish the objective.

1.0.- Produce program by means of writing code.

1.1.- Create plan for computer

1.2.- Express plan for computer in commands

1.2.1.- Write code module 1

1.2.2.- Write code module 2

1.2.3.- Write code module 3

1.2.4.- Write code module 4

1.2.5.- Write code module 5

2.0.- Have son click the save button.

2.1.- Summon son

2.2.- Show son how to click save button

1. *Formal Ontological Foundations of Intentions and Plans*

A turtle file with the above presented terms can be found on the repo for the Foundations for an Ontology of Intentions and Plans (FOIP).

<https://github.com/avsculley/intention-plan-ontology-foundation>

1. *Discussion*

This discussion is in two parts. First is considering views in the literature that are contrary to the views just presented. Second is showing how this ontology can further account for important entities in the literature. Much of what follows deserves its own paper, but, for the sake of this paper, is limited to showing how it relates to the just presented view of plans.

* 1. *Intentions: Dispositions or Representations?*

In this subsection, I will provide the best reason to think that intentions are dispositions, and then show how my representational account accounts for that reason.

* + 1. *Intentions as dispositions*
* Intentions seem (i) internally grounded and (ii) realizable in actions.
  1. *Plans: Dispositions, Information, or Representations?*

In this subsection, I will provide the best reason to think that plans are dispositions and information content, and then, in turn, show how my representational account accounts for each reason.

* + 1. *Plans as realizable entities*
* Plans seem realizable in actions.
  + 1. *Plans as information*
* Plans seem like they can exist in more than one place at one: they generically depend.
  1. *What are mental representations? What is a mental state?*

The dominant view in the philosophy of mind (pom) is that mental representations are mental objects.[[53]](#footnote-53) In FOIP terms pom:mentalRepresentation is a material entity that bears some cpo:mentalRepresentation.

Mental states are relations between some cognitive system and some mental representation.[[54]](#footnote-54) In FOIP terms, pom:mentalState is a relational quality that is borne in both some pom:mentalRepresentation and the cognitive system that it is part of.

* 1. *How do intentions relate to beliefs and desires?*
* My view is neutral between the reductive view and non-reductive view
  + Reductive view: Davidson
  + Non-reductive view: Bratman
* My view is neutral about whether intentions are the output of a decision process, since it seems plausible that there are non-deliberative intentions.
  + TBG: intentions are the output of a decision process (though they recognize that there are non-deliberative intentions)
  1. *How do plans relate to intentions?*

Despite the facts that: (1) the nature of intentions and plans are closely related; and (2) ‘plan if and only if intention’ is false, most treatments merely stipulate the relation and do not elucidate their stipulation. There is not room to do this complicated issue justice here, so the aim is just to explain what the views seem to be and how they relate to the view argued for in the above. Ultimately, my view accounts for all the entities involved in each view, though, of course, we disagree on which entity is rightfully called a plan.

The first view is that plans are the contents of intentions.[[55]](#footnote-55) This view can be found in the work of Alfred R. Mele. What exactly does it mean for plans to be the contents of intentions? Mele writes: “In the limiting case… one’s action plan is a representation of one’s performing a basic action of a certain type. In other cases, one’s plan is a representation of one’s prospective A-ing and the route to A-ing that one intends to take.”[[56]](#footnote-56)

* In FOIP terms, a mele:Plan either is a foip:Intention or the information content entity that some foip:Intention concretizes.

The second view is that plans are the object of intentions. This view can be found in the work of Scott Shapiro. What exactly does it mean for plans to be the objects of intentions?

* “By “plan,” I am not referring to the mental state of “having a plan.” Intentions are not plans, but rather take plans as their objects. For my purposes, plans are abstract propositional entities that require, permit, or authorize agents to act, or not act, in certain ways under certain conditions.”[[57]](#footnote-57)
* “Plans are norms created to be norms.”[[58]](#footnote-58)
* “To conclude, a plan is a special kind of norm. First, it has a typical structure, namely, it is partial, composite, and nested. Second, it is created by a certain kind of process, namely, one that is incremental, is purposive, and disposes subjects to comply with the norms created. Third, it is supposed to settle, and purports to settle, questions about what is to be done.”[[59]](#footnote-59)
* In FOIP terms a shapiro:Plan is an Directive Information Content Entity that is the output of some process intended to create that Directive Information Content Entity.

The third and fourth view are both attributable to Michael Bratman. The third view, which is attributable to early Bratman, is that plans are complex intentions.[[60]](#footnote-60)

* “Plans, as I shall understand them, are mental states involving an appropriate sort of commitment to action . . . Plans, so understood, are intentions writ large . . . But because of their increased complexity (as compared with relatively simple intentions) plans reveal other properties…”[[61]](#footnote-61)

The fourth view, which is attributable to later Bratman, is that plans are temporally extended chains of intentions (Bratman puts it in terms of intentions being plan-states).[[62]](#footnote-62)

* 1. *Intention and Action*
     1. *Intending and Having an Intention*
     2. *Intentions and Affordances*
* Intention Bearer: A material entity that bears some intention.
  + Action Intention Bearer: An intention bearer that bears some action intention.
  + Objective Intention Bearer: An intention bearer that bears some objective intention.
* Intended Disposition: A disposition that has material basis some intention bearer.
  + Intended Action Disposition: An intended disposition that has material basis some action intention bearer.
  + Intended Objective Disposition: An intended disposition that has material basis some objective intention bearer.
* Humans use intentions to coordinate intra- and inter-personally.[[63]](#footnote-63) In this capacity, intentions and plans can pick out dispositions which are necessary for coordination. For example, kicking a soccer ball takes foot-eye coordination. Forming the intention to kick a soccer ball picks out the necessary dispositions of one’s eye and one’s foot (and leg, and so on). This allows the realization of the pre-existing dispositions in a new way, and thus the player gains the new disposition to kick a soccer ball.
* Act of Intending: An Act that has output some intention.
* Having an Intention: An act that has participant at all times some intention.
  1. *Intended Act and Intentional Act*
     1. *Intended representation*
* There are two kinds of intended representation: ones that do concretize some information content entity, and ones that do not concretize some information content entity. The former are a kind of information quality entity whereas the latter are not.
  + 1. *Intended Objective Specification*
* *Intended objective specification*: An objective specification that is output of some intended act.
  1. *Plans and Action*
     1. *Planning and Two Ways to Have a Plan*
     2. *Plans and Affordances*
     3. *Planned Act*
* Plan Bearer: A material entity that bears some plan.
* Planned Realizable: A realizable entity that has material basis some plan bearer.
  + Planned Role: A planned realizable that is some role.
  + Planned Disposition: A planned realizable that is some disposition.
    1. *Successful and Unsuccessful Plans*
  1. *Software*
  2. Intentions and Plans as Dispositions
* As will be shown, dispositions are needed to connect intentions and plans to actions, but such dispositions are unnecessary for some intention or plan to exist.
  + In the case of intentions, one can have delusional intentions, which pose a problem for a dispositional account of intentions. For example, some person might have the intention to attend Harvard University, but simply not have the necessary grades and test scores. As such, they could not form the disposition to attend Harvard. But it is clear that it is possible to form such an intention. So, intentions cannot be dispositions.
  + A representational ontology of intentions accounts for this case. A person can have the intention to do any number of delusional or impossible things, insofar as they are legitimately committed to doing those things. We can explain why it is impossible for those intentions to be satisfied by pointing to the lack of necessary dispositions, but maintain that the intentions still exist as representations.

1. Conclusion and Future Work
   1. Conclusion
   2. Future work on Intentions and Plans
   3. Future Work on Metarepresentations

* Knowledge Representations
* Ontologies

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1. [↑](#footnote-ref-1)
2. (CUBRC, Inc. [2017] 2022) [↑](#footnote-ref-2)
3. (Drobnjakovic et al. 2022) [↑](#footnote-ref-3)
4. (“Ontology for Biomedical Investigations” [2017] 2023) [↑](#footnote-ref-4)
5. https://www.w3.org/TR/prov-o/ [↑](#footnote-ref-5)
6. [↑](#footnote-ref-6)
7. (Tate, n.d.) [↑](#footnote-ref-7)
8. (CUBRC, Inc. [2017] 2022) [↑](#footnote-ref-8)
9. (Smith et al., n.d.), 10. [↑](#footnote-ref-9)
10. (“Ontology for Biomedical Investigations” [2017] 2023) [↑](#footnote-ref-10)
11. https://www.w3.org/TR/prov-o/#Plan [↑](#footnote-ref-11)
12. (Tate, n.d.), 13. [↑](#footnote-ref-12)
13. (Tate, n.d.), 13. [↑](#footnote-ref-13)
14. [↑](#footnote-ref-14)
15. (Toyoshima, Barton, and Grenier 2020) [↑](#footnote-ref-15)
16. [↑](#footnote-ref-16)
17. (Searle 2009; 1983; 2001) [↑](#footnote-ref-17)
18. (Searle 2009; 1983; 2001) [↑](#footnote-ref-18)
19. (Bratman 1999a; 1999b) [↑](#footnote-ref-19)
20. (Donohue 2017; CUBRC, Inc. [2017] 2022) [↑](#footnote-ref-20)
21. Limbaugh [↑](#footnote-ref-21)
22. CPO [↑](#footnote-ref-22)
23. [↑](#footnote-ref-23)
24. [↑](#footnote-ref-24)
25. [↑](#footnote-ref-25)
26. (Searle 2001, 36) [↑](#footnote-ref-26)
27. (Searle 2001, 37) [↑](#footnote-ref-27)
28. Searle says direction of fit is a primitive because it cannot be analyzed in terms of simpler entities. [↑](#footnote-ref-28)
29. CPO, Limbaugh et al. [↑](#footnote-ref-29)
30. Limbaugh et al [↑](#footnote-ref-30)
31. CPO, Limbaugh et al. [↑](#footnote-ref-31)
32. Searle 2001 [↑](#footnote-ref-32)
33. TBG [↑](#footnote-ref-33)
34. TBG [↑](#footnote-ref-34)
35. (Bratman 1987, 20, 22) [↑](#footnote-ref-35)
36. (22) [↑](#footnote-ref-36)
37. [↑](#footnote-ref-37)
38. [↑](#footnote-ref-38)
39. [↑](#footnote-ref-39)
40. CPO, Limbaugh [↑](#footnote-ref-40)
41. This is a modified version of the definition of cpo:confidenceValue [↑](#footnote-ref-41)
42. Searle [↑](#footnote-ref-42)
43. [↑](#footnote-ref-43)
44. [↑](#footnote-ref-44)
45. [↑](#footnote-ref-45)
46. [↑](#footnote-ref-46)
47. [↑](#footnote-ref-47)
48. [↑](#footnote-ref-48)
49. (29) [↑](#footnote-ref-49)
50. (Bratman 2022) [↑](#footnote-ref-50)
51. (29-30) [↑](#footnote-ref-51)
52. Mele and Moser (<http://www.jstor.org/stable/2215919>), 43, citing (Mele 1992, 144) [↑](#footnote-ref-52)
53. (Pitt 2022), 1. [↑](#footnote-ref-53)
54. (Pitt 2022), 3. [↑](#footnote-ref-54)
55. Shepard [↑](#footnote-ref-55)
56. (Mele 1992), p. 218. [↑](#footnote-ref-56)
57. 127 [↑](#footnote-ref-57)
58. 128 [↑](#footnote-ref-58)
59. 129 [↑](#footnote-ref-59)
60. [↑](#footnote-ref-60)
61. 29 [↑](#footnote-ref-61)
62. [↑](#footnote-ref-62)
63. [↑](#footnote-ref-63)