

Complex procedures instantiated by their proper parts

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Abstract

This paper discusses two accounts of the relationship between complex procedures and their parts. First, one may argue that the parts of a complex action always differ numerically from that action. Second, it seems that every instance of a step that is involved in a procedure, while it is executed, is also an instance of the whole procedure itself. It turns out that in order to deal with actions and processes in general, one must be able to express the contrast between perfective aspect (something has happened) and imperfective aspect (something was happening).

1 How to make omelettes

How many actions does it take to make an omelette? Philosophers have offered two simple answers to this question. The first is “as many as you like”, the second “only one”. Common sense tells us that it takes about six:

In order to make an omelette, you beat two or three eggs together with salt and pepper (1). Then you heat a little butter in a frying pan over medium heat until foaming (2). After the eggs are added into the middle of the pan (3) you stir them with a fork held flat, prongs parallel to the bottom of the pan (4). When most of the eggs are set but still slightly liquid, the omelette is ready. At this stage, it may be folded (5), inverted (6) and served immediately.

1.1 The first philosophical answer

It is easy to see how to obtain the first philosophical answer. According to common sense, the first step in making an omelette is to beat two or three eggs together with salt and pepper. In order to do that, you have to break at least two eggs (actions no. 7 and 8), then add salt (9) and pepper (10). In order to break an egg, you grab one (11), knock it against a suitable edge (12), and so on. There will be no end for this series, since every continuous movement could be split into segments: in order to move your hand from *A* to *C*, you first have to move it from *A* to *B* and then to *C*.

Alvin Goldman has suggested such an answer. He writes:

... two action-tokens are identical if and only if they involve the same agent, the same property, and the same time (1970:10).

This is a bit roundabout in expression. Goldman claims that action tokens are instances of properties. When he says that they “involve” a property, he does not want to say that they have this property, but that they *instantiate* it. Thus he claims that an action token can instantiate only one action-property or action type (p. 12).¹

But this view has all sorts of grotesque consequences. Applied to ordinary objects, it would imply that one object could never exhibit more than one property. According to such a theory, objects could only be round or red, but not round *and* red. Of course, this might simply mean that action tokens are very much unlike ordinary objects. Hence, the problem with Goldman’s answer is that it introduces a kind of thing with very unusual features, and that it leads to the claim that in order to make omelettes, one has to realize innumerable many such things.

1.2 The second philosophical answer

The second philosophical answer is also obtained straightforwardly enough.²

Suppose I make an omelette. At some stage I will be stirring the eggs in the pan, with the fork held flat. I will do this *in order* to make the omelette. Conversely, I will make the omelette *by* stirring the eggs, and I will stir the eggs *by* moving the fork. Suppose now that someone asks me, in these

¹Similarly, Landesman 1969 claims that agents instantiate actions. This is mistaken. Action types are instantiated by action tokens, and one token can instantiate more than one such type.

²It is not only a *philosophical* answer. For instance, in the biomedical terminology SNOMED CT®, removing a needle is classified as a *kind of* acupuncture. But whereas acupuncture is a *kind of* therapeutic procedure and electric stimulation of an acupuncture needle is a *kind of* stimulation, properly speaking removing needles is not a kind of acupuncture. Rather, inserting, stimulating and removing acupuncture needles are proper *parts* into which acupuncture procedures can be decomposed. Hence, the designers of SNOMED seem to admit that acupuncture procedures can coincide with their proper parts.

circumstances, how many things I am doing. The correct answer will be “only one”. Although I am presently holding the fork flat, stirring the eggs, and making the omelette, I am not doing three different things at once.

However, if I am asked the same question only a little later, while folding the omelette, I will still be making the same omelette, that is, continuing the same action. In this sense, I am performing only one action by performing six movements consecutively. Conversely, I am doing six things in order to do one.

This kind of answer has been suggested by Elisabeth Anscombe. Here is a famous passage from her *Intention*:

In short, the only distinct action in question is this one, A. For moving his arm up and down with his fingers round the pump handle *is*, in these circumstances, operating the pump (1957:46).

Anscombe uses a different example, but the problem is the same. She claims that moving one’s arm *is*, in certain circumstances, operating a pump. When I break an egg in order to make an omelette, then the breaking of the egg is a *proper part of* making the omelette, but according to Anscombe it is also an *instance of* making the omelette.

The second philosophical answer also has its obvious drawbacks. For when I am stirring the eggs and later folding the omelette, I will then be performing two different instances of omelette making that are *identical*. For I am still making the same omelette. But how can two identical items both be different proper parts and at the same time instances of a third item? Again, actions seem to be very special objects.

1.3 A classification of occurrents

Let me now introduce some terminology.

Processes. A *happening* is whatever can be said to happen at or during a time. A *processes* is a telic happening, that is, it has an endpoint that it need not necessarily reach, but which would constitute its completion.³ When I read a book or cross a street, I may be interrupted. Then it will be the case that I have started but not finished reading the book or crossing the street. Book readings and street crossings are thus telic. On the other hand, the falling of a stone or a dust storm are not telic: they can stop, but they cannot be interrupted before they are finished. They are finished whenever they stop.

³There is no established technical use of the term *process*. Mourelatos uses ‘process’ for homogeneous or non-telic occurrents like “push a cart” or “walk” (1978). He withdraws this definition later (1993). Stout (1997) identifies processes with kinds or patterns of events, which are persistent entities. The Gene Ontology consortium reserves the title ‘process’ for what I call ‘procedures’: *complex* processes. It calls simple processes ‘activities’ or ‘functions’. Etymology would suggest that processes involve a change, are countable, and have a typical outcome. What I define as ‘process’ is roughly equivalent with what Aristotle calls *kinesis* and what has been called ‘achievement’ (Ryle), ‘performance’ (Kenny), ‘accomplishment’ (Vendler), ‘development’ (Mourelatos 1978) or ‘change of state’ (Dowty).

In general, processes cannot be divided into proper parts of the same type.⁴ Winning a football match involves a lot of kickings, but no further winnings of football matches. By dividing a process into proper parts, one will, as a rule, get two happenings of a different kind. By the same token, combining two processes of the same kind will yield a process of another kind. In this respect, processes behave like the things denoted by count terms.

In order to be able to count happenings, they must have a point where they stop. Processes can easily be counted by counting their completions. Hence, one can count how many eggs have been broken or how many times the butter was heated until foaming. Non-telic happenings can be counted by counting the times they actually stop or by applying an external measure. For instance, the eggs may be stirred three times or for five minutes.

Procedures. Processes are either simple or complex. A complex process is called a *procedure*. One way to distinguish procedures from simple processes is the following. Before a procedure token *p* is completed, it makes sense to ask how much of it has already been completed and how much is yet to be done, where this question is understood to be about the relative completion of the procedure, not about objectively measured amounts of time. Procedures consist in a certain number of steps. We can say how much of a procedure is completed by telling how many of these steps are completed. Making an omelette is certainly a procedure: if I am now stirring three eggs with a little salt and pepper, then it is clear what is still to be done.

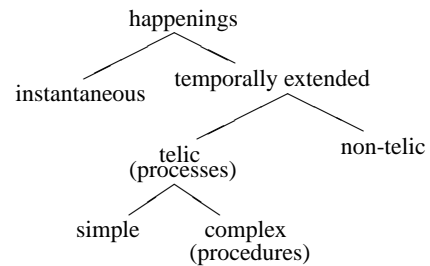


Figure 1: A classification of happenings

You can always discern whether a process is completed or not. As for procedures, you can always say more or less clearly how much of them has been completed. In order to know this, you have to consider the *type* of the process or procedure in question. ‘Making an omelette’ is a procedure type, whereas ‘my making an omelette yesterday’ is a procedure token.

Recipes. Procedures divide into steps. Every procedure type can be specified by a *recipe* that lists these steps. Recipes specify *types* of procedures. What they say need not be true

⁴This does not always hold true. Reading a book may involve reading a book where one book is part of another book. But these are special cases.

of every instance of such a procedure type. There can be unusual or abnormal instances of a procedure that are nonetheless instances of it. There are unexpected courses of scarlet fever and unorthodox omelette makings, which do not exhibit all the features described by the corresponding recipe. They are nonetheless instances of the respective types, although not perfect ones. Hence, whereas a recipe may describe how to make omelettes, it need not apply to every particular omelette making. In other words, a recipe specifies how *an* omelette is made, but not necessarily how *this* omelette was made.

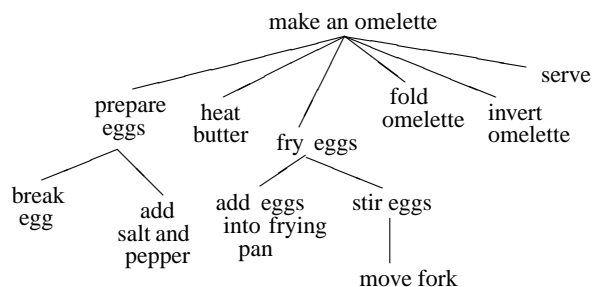


Figure 2: How to make an omelette

Recipes can be visualized by using tree diagrams.⁵ The root node of a tree diagram will be occupied by a general description that will in most cases specify the overall goal of the procedure. The child nodes stand for the steps involved in the parent procedures. These steps can consist in further procedures that involve further steps. Leaf nodes represent *basic* steps.

A basic step is any process whose description “itself implies an answer to the ‘how’-question” (Baier 1972:284). The basic steps in which making an omelette consists relate to the whole step in the same way in which the ingredients of the omelette relate to the omelette. Ingredients are things that one can buy in an ordinary shop; basic steps are what an ordinary cook can do. It does not make more sense to divide the breaking of an egg into further sub-steps than it does to enlarge the list of ingredients by distinguishing infinitely many different parts of eggs. For finite procedures, there will always be a finite number of basic steps. Otherwise, it seems, it would be impossible to execute them.

Completion. When shall we call a procedure token incomplete? Intuitively, we would say that a procedure token is incomplete if a part of it is still missing. However, since recipes only specify procedure types and not their instances, we do not yet have a parthood relation for procedure tokens. We only know what the parts of a procedure *type* are. I suggest calling a procedure token complete when all the steps belonging to its type have been instantiated by this token. A

⁵Goldman (1970) would draw the trees in the exact opposite way, starting with a particular action as a root node and then adding different possible things that can be achieved by executing this action as child nodes. Goldman style trees do not specify recipes for types of actions. Rather, they relate different possible descriptions of the same happening to each other.

procedure token is incomplete as long as a part of its type is not instantiated.

But we still lack a criterion for the completeness of *simple* processes that do not have further processes as their parts. One might say that a simple process is complete if its goal state is reached. This, however, is only a necessary criterion. A process is only completed when its goal state is reached *via* the process. There being an omelette does not imply that I have made it.⁶ In the present context, however, I will be content with this necessary condition for the completeness of simple processes.

None of the features hitherto discussed, like being temporally extended, telic or complex, belongs exclusively to intentional actions. Many procedures are non-intentional, such as digestion and glycolysis. The arguments presented in this paper apply to any kind of complex procedure involving telic happenings. Instead of asking how many actions it takes to make an omelette, one may as well ask how many steps are involved in glycolysis.⁷

2 Discussion

This paper is interested in the following general kind of question: for a procedure p , how many steps s_i are involved in p ?

2.1 Eliminating the first philosophical answer

We should not want to divide a procedure into an infinite number of further processes. But anyway, there is only one way in which this could be done: by introducing pseudo-goals like “completing half of s_i ”. One could divide every hand movement into two telic happenings, these again into two further happenings and so on. But at some point, there will be no qualitatively new answers to the question “how does s_i happen?” or “by which means is s_i achieved?” When such a point is reached, we have identified a basic step. We can, but we should not further decompose basic steps. For instance, when I know how to move my hand two centimeters to the left, I necessarily also know how to move it one centimeter to the left, except in very special circumstances. And when I know how it comes about that a tree grows five inches, then I will also know how it grows two inches.

Let us then ask how many *basic* steps are involved in making an omelette. We still have to decide between the second philosophical answer, that there is only one action, and the common sense answer, that there are about six. The two accounts need not disagree about the number of branches in the according tree diagram. Assume that there are three leaf

⁶Compare the discussion in Davidson 1980:110f.

⁷The Gene Ontology consortium has made questions like this fundamental ones, since they define processes as complex activities and functions as simple activities. The Gene Ontology, however, uses different ‘ontologies’ for processes and functions. For instance, glycolysis is found in the *biological process* ontology, whereas adenosine-tetraphosphatase activity is listed in the *molecular function* ontology. Hence, in order to classify a happening in the Gene Ontology, one first has to determine whether it is complex or simple.

nodes, labeled s_1 – s_3 . These will be the basic processes involved in p . The disagreement is not about the number of basic actions, but about the relation between basic steps and their parent complex procedure. These are, again, the two remaining positions under discussion.

- (1) While p is going on, there is always only one of s_1 – s_3 happening. But while one of them is happening, it is true that p as a whole is happening. For instance, while I am breaking the egg, it is true that I am making the omelette. Therefore, each of s_1 – s_3 is an instance of p and hence, p is the only distinct happening.
- (2) But obviously, to do s_1 is not to do s_2 . For instance, to break an egg is not to fry it. Therefore, p consists of three different processes that are realized consecutively.

Since answer (2) seems *prima facie* preferable, the main problem appears to be how we should account for the apparent plausibility of (1).

2.2 Breaking an egg is making an omelette

Is it not true that while I am breaking an egg, I am also making an omelette? Consider the following example:

... suppose I encounter John in the street. I ask him what he is doing and he replies that he is walking home. Suppose now that shortly afterwards, before he reaches his house, John is run over by a car and badly injured. An ambulance is summoned, and John is rushed to hospital. It is now false that John walked home on that occasion; was it therefore false that he was walking home when I questioned him? Should John in fact have said something like ‘As far as I know, I am walking home’ or even ‘Ask me again in ten minutes time what I was doing now and then I’ll be able to tell you’? (Galton 1984:86–7)

It must be true that I am already making an omelette while I am breaking an egg because I do not only know what I am doing after I have done it. If there were no stage when I was making the omelette before I have already made it, then there would have been no time when the omelette was made at all. For as soon as the omelette is served, I do *no longer* make it. I have then made it. But before that point, I have *not yet* made it. If I am making the omelette at all, then I must be making it while I have not yet made it.

If it can be truly said that by breaking the egg now I perform the whole omelette making, then a complex procedure will already “exist” before it is complete. Put differently, it will already be instantiated by an incomplete token of its kind.

However, if complex procedures are already instantiated before they are completed, then a procedure will also be instantiated by a token that *remains incomplete*, that is, by a failed attempt to perform it. If I was already making the omelette while breaking the first egg then I will have been making the omelette even if the first egg remains the only one. Then I was making the omelette without having made

it. This has been called the “imperfective paradox” (Dowty 1991:133).

Is only completing the omelette making it? That I may have been making the omelette without having made it might not appear to be intuitively correct. When the omelette was not made, one might argue, there was no omelette making but only a failed attempt to make one.

Should we say instead, then, that I am making the omelette only when I am carrying out the very last step of the procedure? But then I will not be making it any ‘more’ than before, since making an omelette involves breaking an egg — and I am not doing that now. I am only inverting the omelette, which is not even the most important step. Now if inverting the omelette can, in these circumstances, be an instance of making it, why can’t breaking the egg be an instance of making the omelette? The correct answer is that no part of making an omelette is the only one in which the making consists. One makes an omelette only by doing everything that is mentioned in the recipe: first breaking three eggs, then stirring them and so on.⁸

Is it only about language? When Anscombe suggested the second philosophical answer to our question, she formulated it in the present progressive: “moving his arm up and down with his fingers round the pump handle is, in these circumstances, operating the pump”. In English, the progressive is a means to express what linguists call the imperfective *aspect*. Whereas tense locates an event in the past, present or future, aspect concerns the internal temporal constituency of an event.⁹ Events can be referred to as ongoing or as completed. The first is done by using a verb phrase in *imperfective aspect*: an event “was happening”. For the second, *perfective aspect* is used: something “has happened”.¹⁰

The disagreement on how many actions are involved in making an omelette can now be brought down to a difference in verb aspect.

- (i) While I *was breaking* the egg, I *was already making* the omelette.
- (ii) When I *have broken* the egg, I *have not yet made* the omelette.

But aspect is a linguistic phenomenon. Hence, the following counter argument would seem to be valid:

We allow ourselves to say that someone is doing p although she has not yet done p . But this is only a manner of speech. What we should really say is that the person in question has already done something else with the intention of doing p or that she has done something else that would typically lead to p .

⁸ Compare McDermott 1982:143.

⁹ See Comrie 1976, Galton 1984 and Rödl 2005.

¹⁰ The aspect contrast can only be demonstrated in the past tense since there are no verb phrases in present tense, perfective aspect. When we say that “something happens”, we do not refer to a completed, but to a regular or generic event.

Thus it seems that breaking an egg is only called ‘making an omelette’ because it is done *with the intention* to make an omelette. But we can leave intentions aside. Although our example is an action, the argument does not only apply to intentional movements. We can also say that trapping glucose in a cell is an instance of glycolysis, since while the glucose is being trapped, glycolysis is already happening. And glycolysis can be interrupted, such that it was happening but then did not happen.

This move does not solve the problem. One could still argue that when an omelette is being made, there is really only something that has hitherto happened *that would typically lead to* a completed omelette making.

But if we decided to replace every sentence of the form “*p* is happening” with another one of the form “*p*’ has happened, which would typically lead to *p*”, then the following argument would apply. Call it the *recursive elimination argument*.

Assume that I am involved in a procedure that would typically result in an omelette. Now I am breaking an egg. But am I really doing that? No, I am actually only doing something that would typically result in a broken egg. I am only knowcking an egg against a suitable edge. But according to the argument, I would not even be doing that. I would only have done something that would typically lead to having hit an egg on an edge. And so on.

It would follow that I am now only doing an infinitely ‘small’ action. I am not even moving my hand; probably I am doing something short of ‘firing a neuron’, which does not even seem to be something that I myself do. Again, we are left with a rather strange concept of human action.

The conclusion should be that when we want to deal with processes, we cannot do without imperfective aspect. We *must* allow ourselves to say that something is happening although it has not yet happened. For processes and procedures, the imperfective paradox will always be possible: it may always turn out that I am doing something that I will not have done. One could even define processes by that criterion: a process is anything that may have been happening without having happened.¹¹ A stone cannot be falling without having fallen. But while I am breaking the egg, I am making an omelette, but when I am interrupted shortly after that, I may not have made the omelette in the end. Likewise, glycolysis can be happening without having happened.

2.3 Instantiation and parthood combined

The recursive elimination argument has shown that it would be wrong to replace every occurrence of “*A* is doing *p*” by “*A* has done something that would typically result in *p*”. We should not attempt to replace every formulation in imperfective aspect by another one in perfective aspect. But it remains true that verb phrases in imperfective aspect refer to *what would typically result*. That someone is doing *p* (imperfective aspect) simply means that she is realizing an instance of

¹¹ Aristotle classifies *kineseis* (processes) as happenings that do not include their completion. Cf. *Physics* VI,1, 231b30–232a1.

a specific type. When a person tells us that she is making an omelette, although it may turn out later that she fails to do so, then she is referring to the type of procedure that she has executed. She is referring to the recipe that specifies how to make an omelette. This recipe includes the serving, although the actual token need not.

Hence the imperfective aspect refers to types and recipes: that this instance of breaking an egg is an instance of making an omelette means that egg breakings are *typical* parts of omelette makings, as specified in the cookbook. Happenings that do not figure in the recipe for making an omelette are not instances of omelette makings. Recipes specify what *one* does, not what some particular cook happens to do.

Using the distinction between types and instances of procedures, we can now postulate the following rule that reconciles the two remaining answers to our question about the makings of omelettes.

For two process types *P* and *Q* and an instance *p* of *P*:
p is also an *instance of Q* if
p is currently happening and *P* is a *part of Q*.

By this rule, breaking an egg may be both an instance and a part of making an omelette. This particular egg breaking is an instance of making an omelette, and egg breakings in general belong to making an omelette as one of its proper parts.

3 Conclusions

It follows that procedures are unlike ordinary objects. In general, we attribute parts to types of things on the basis that the instances of the type have these parts. For instance, the type ‘human heart’ can be called a part of the type ‘human’ if all normal humans have human hearts. But the types themselves do not really have parts. What we really mean is that the instances of these types have parts.

For procedures, I have suggested moving in the opposite direction. While a token of omelette making is occurring, the parts of making an omelette are not simultaneously present. An omelette making is at one time exclusively and completely instantiated by breaking an egg, and then exclusively instantiated by frying them. No procedure token has all the steps as its parts that are described in the recipe. The only entity that can be said to have all these parts is the recipe or the respective type. Hence, we attribute parts to procedure tokens only by analogy. Particular procedure token do not really have parts; only the types do so.

In this sense, procedures may be said to be instantiated by their proper parts. On the type level, breaking an egg is a proper part of making an omelette; on the token level, it instantiates making an omelette. Consequently, two different process tokens may constitute the very same token procedure (at different times). Breaking an egg may be an instance of the same procedure as frying two eggs. Again, this does not hold for ordinary objects: one may point to the wall surrounding the Vatican and say, correctly, that this is the Vatican. However, the Vatican is an instance of the type ‘state’. The wall surrounding the Vatican clearly is a part of this instance, but never and nowhere is it an instance of the type ‘state’.

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