William Godwin: An Early Practitioner of Backward Induction

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Abstract. In commenting on the method employed when he composed his 1794 novel, *Caleb Williams*, William Godwin said that he developed the plot and prepared outlines of its three volumes in reverse order. It is argued that this method of composition anticipates some of the main features of the backward induction procedure used in decision theory and game theory to solve sequential decision problems.

Keywords. Backward Induction; History of Decision Theory; William Godwin; *Caleb Williams*

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1. Introduction

William Godwin (1756–1836) was a renowned philosopher, novelist, journalist, historian, and publisher.[1] His *An Enquiry Concerning Political Justice* (Godwin, 1793) is a seminal treatise on political philosophy. Godwin's immediate family included some of the leading literary and intellectual figures of his time: his wife, Mary Wollstonecraft; his daughter, Mary Shelley; and his son-in-law, Percy Bysshe Shelley.

In the "Preface to the Present Edition" (Godwin, 1832, pp. v–xiv) to the 1832 edition of his novel, *Fleetwood*, Godwin describes the method he employed when he composed his first and best-known novel, *Caleb Williams* (Godwin, 1794), which was published in three volumes in 1794.[2] According to this account, Godwin developed the plot of his novel in reverse order; first the third volume, then the second, and finally the first. Furthermore, he prepared outlines of the three volumes in the same reverse order before turning to the composition of his novel in the conventional order.

Although stated informally, as I shall show, Godwin has described some of the main features of the backward induction procedure used in decision theory and game theory to solve sequential decision problems. It is not claimed that the backward form of reasoning that Godwin described fully captures what is now understood as backward induction because Godwin's account of his compositional procedure is silent about some of the details that a complete backward induction analysis would provide. Nevertheless, his methodology provides a clear precursor to the backward induction procedure now used to solve sequential decision problems.

Decision theory is concerned with individual choice, whereas game theory is concerned with decision-making when there is strategic interaction among a number of individual decision makers. In both cases, these theories employ a rational choice methodology. According to this methodology, individuals are considered to be rational to the extent that their behavior can be explained in terms of maximizing consistent preferences over the possible actions that are feasible given the beliefs that they hold about factors outside their own

[1] For an overview of Godwin's life and philosophy, see Butler and Philp (1992) and Philp (2021).

[2] For a modern variorum edition of *Caleb Williams*, see Clemit (1992). Further commentary by Godwin on the composition of *Caleb Williams* may be found in the autobiographical material collected in Philp (1992) and in Godwin (1795). For corrections to the titles and dating of the autobiographical fragments in Philp (1992), see Clemit (2005).

control. The extent to which backward induction and related dynamic decision criteria satisfy norms of rationality is the subject of ongoing debate by philosophers.[3]

When choices are made over time, in order to best pursue their interests, a rational decision-maker anticipates what future choices they will make in each of the possible future choice situations that might arise. The formal modeling of sequential decision-making builds on the pioneering work in the early 1950s of Harold Kuhn and Leonard Savage (Kuhn, 1953; Savage, 1954). *Backward induction* is the reasoning procedure in which an optimal sequence of decisions is determined by iteratively reasoning backward in time. Backward induction is also used in game theory to identify subgame perfect Nash equilibria when individuals interact over time.

Planning every decision in advance is a complex problem. Savage (1954, pp. 16–17) recognizes that this kind of forward planning is not cognitively feasible unless the problem can be considered in isolation and does not make undue demands on the decision maker's cognitive skills, what he calls a *small-world problem*. In planning the plot of *Caleb Williams*, Godwin was faced with a small-world problem. Consequently, rational choice theory can offer genuine insight into the choices that he made.

Godwin's compositional method is particularly important for the writing of detective fiction as there is a need to construct an intricate plot that ultimately leads to the solution of a crime. This objective is facilitated by the use of backward reasoning in plot construction. Murch (1958, p. 32) credits Godwin for inventing this way of constructing a plot and for creating in *Caleb Williams* "two central characters foreshadowing the amateur detective and the official police agent."[4]

Other forms of backward reasoning are *back chaining* and *retrograde analysis*. Back chaining teaches a skill beginning at a predetermined desired outcome and working back to the beginning. With back chaining, in order to eventually have subjects make choices in the natural order, they are first taught how to make them in the reverse order. In contrast, with backward induction, the order in which decisions are implemented is the reverse of how the decision-making procedure identifies optimal choices. According to Edelman (1995, p. 54), "[t]he concept of retrograde analysis ... relies on

[3]See Thoma (2019, Sec. 7).

[4]For further discussion of the influence of *Caleb Williams* on detective fiction, see Graham (1990, pp. 59–70).

identifying small clues in the present to help reconstruct the past—and ultimately to piece together and understand the present." Retrograde analysis was developed to analyze sequences of plays in chess. While backward induction is concerned with identifying an optimal outcome and determining how best to reach it, retrograde analysis is concerned with inferring how an observed outcome was obtained.

Examples of backward induction reasoning in Hebrew religious writings have been identified by Brams (2012) and in Indian folk tales by Wiese (2012). These narratives were composed over two millennia ago. However, their use of backward induction reasoning is only implicit; it took modern scholars like Brams and Wiese to show how the sequence of decisions made in these texts could be elucidated using backward induction. In contrast, Godwin explicitly describes the logic of the decision-making procedure that he used to plot his novel.

Godwin may well have been the first person to explicitly *articulate* a version of backward induction. The first documented use of backward induction in a formal individual decision problem is by the mathematician Arthur Cayley in 1875 (Cayley, 1875), almost half a century after the appearance of Godwin's 1832 Preface. Cayley considered an individual who sequentially draws tickets and receives the amount written on the last one drawn. Knowing the number of tickets, their values, and the number of draws that are allowed, the question is: When to stop drawing? Cayley's problem is an example of an optimal stopping problem—deciding when to stop sampling a random process in order to maximize some payoff.[5] It was not until the 1940s that backward induction as a procedure for solving individual sequential decision problems came into its own, reaching its apogee with Richard Bellman's work on dynamic programming (Bellman, 1959).[6] The first explicit use of backward induction in game theory was by von Neumann and Morgenstern (1944, Chap. III, Sec. 15).[7]

In order to give some context for my discussion of Godwin's compositional method, in Section 2, I consider some of the ways in which rational choice

[5]Ferguson (1989) discusses some of the early contributions to this problem. Hill (2009) provides a clear exposition of how backward induction can be used to solve an optimal stopping problem when there is full information about the possible values.

[6]See Rust (2008) for a brief overview of the use of backward induction in the 1940s and 1950s.

[7]Schwable and Walker (2001) convincingly demonstrate that claims of earlier uses of backward induction in formal game theory models are incorrect.

theory has been used in literary analyses and how its use has been justified. In Section 3, I provide an introduction to the formal modeling of an individual sequential decision problem and to backward induction as a procedure for identifying an optimal solution. In this section, I also introduce a simplified form of backward induction that I contend is the one used by Godwin. In Section 4, I reproduce what Godwin said about his compositional method. In Section 5, I argue that this method anticipates the reasoning procedure used by backward induction, at least in the simplified form described in Section 3. Finally, In Section 6, I offer some concluding remarks.

2. Rational Choice Theory and Literature

In her analysis of how decision-making features in *An Enquiry Concerning Political Justice* and in *Caleb Williams*, Fielding (2009, p. 381) has remarked that "[f]or much of its course, the history of the novel has been a history of people taking decisions. ... [I]t is the need for characters to take decisions that, at least until the twentieth century, propels the novelistic narrative forward." To the extent that rational choice theory accurately reflects the reasoning and behavior of individuals, one should expect that the choices in literary and religious texts would exemplify its approach to decision-making.[8] Elster (2009, p. 5) goes so far as to contend that "[r]ational choice explanation plays a critical role in the interpretation of both texts and social behavior. The interpretation of fiction benefits from the use of this type of explanation." Livingston (1991, p. 52, emphasis in the original) argues "that there are *no* literary phenomena that can be adequately understood or explained without relying, at least implicitly, on a rationality heuristic."[9]

One way that rational choice theory is used in literary studies is to interpret and critique narratives, thereby offering a nontraditional methodology for literary criticism. As has already been noted, this approach is exemplified by Brams (2012) and Wiese (2012). Further examples of this approach are provided by the analyses of novels and short stories by Jane Austen and Edith Wharton carried out by Chwe (2013) and Weymark (2024), respec-

[8]Chwe (2013, pp. 30–34) provides an overview of some of the research on the use of rational choice theory in literary studies.

[9]Livingston does not make the stronger claim that it is the conception of rationality employed in rational choice theory that has this feature; rather, his claim is about theories of rational agency in general.

tively.[10] In addition, literary works have been a rich source of material for illustrating rational choice theory's concepts and methods of analysis. An early example in which both of these features of the relationship between rational choice theory and literature are present is provided by von Neumann and Morgenstern's analysis of the pursuit of Sherlock Holmes by Professor Moriarty in "The Adventure of the Final Problem" (Conan Doyle, 1893) in terms of a mixed strategy Nash equilibrium (von Neumann and Morgenstern, 1944, pp. 176–178).[11]

Behavioral economists have identified cognitive reasons for why decision-makers do not always conform to the rationality principles employed by rational choice theory. Morson and Schapiro (2017) suggest that literature provides resources for making models of decision-making more realistic. Nevertheless, rational choice theory may be illuminating even when some of the characters do not conform to the rationality principles employed by the theory. Indeed, a character's departure from standard principles of rationality may be an essential feature of a story that rational choice theory may shed light on. For example, this is the case with folktales that feature tricksters who take advantage of the lack of strategic sophistication of their adversaries.[12] As Fielding (2009) notes, Godwin himself recognized that not all choices are based on rational calculations—they may instead be made impulsively or be attributed to fate. She also notes that Godwin recognized that the difficulty of reaching a decision may be so formidable that indecision results.[13]

Here, it is not the choices made by the characters in a narrative that is of concern. Rather, it is the choices Godwin made as an author structuring a plot. As I shall argue, Godwin's authorial choices conformed with the rationality principle underlying backward induction.[14]

[10] According to Chwe (2013, p. 1), "Austen's novels do not only provide 'case material' for the game theorist to analyze, but are themselves an ambitious theoretical project, with insights not yet superseded by modern social science."

[11] Read (2020, p. 370) regards Conan Doyle's story and Edgar Allan Poe's "The Purloined Letter" (Poe, 1845b) as being the two "central texts used to discuss how literature and game theory can mutually support one another."

[12] See Chwe (2013, Chap. 3) and Wiese (2012).

[13] For an illuminating discussion of indecisiveness in fiction, see Garcha (2019).

[14] As part of the creative process, authors take account of the likely responses of their audiences to what they read. Readers, in turn, may form expectations about what effects the author was intending to create. Game theory has been used by Hutchinson (1983) and Livingston (1991, pp. 69–75) to provide insight into the strategic aspects of the reading

3. Sequential Decision-Making and Backward Induction

Planning the plot of *Caleb Williams* is an example of an *individual sequential decision problem*. Such problems are formally modeled using decision trees.[15] A *decision tree* consists of a set of nodes, branches, and payoffs. This terminology reflects the fact that the sequence of possible situations in which a choice must be made and the options available to choose from resembles a tree in branching structure. Here, attention is restricted to decision trees in which each possible sequence of decisions terminates after a finite number of choices have been made, there is no uncertainty, and the decision-maker is always cognizant of all past decisions. These are all features of the decisions described in Godwin's 1832 Preface.

There are two kinds of nodes. A *decision node* designates a stage in the problem at which the decision-maker makes a choice. A *terminal node* indicates that there are no further decisions to be made. The problem begins with a decision node called the *initial node*. Associated with each terminal node is the *payoff* to the decision-maker if this node is reached. A payoff indicates the value to the decision-maker of the outcomes obtained with their sequence of choices. Each decision node has one or more *branches* that connect this node to exactly one other node, its *successor*. These branches represent the possible choices available to the decision-maker at this stage of the problem. A decision tree contains no cycles. Consequently, for each node distinct from the initial node there is a unique path from the initial node to it.

These definitions are illustrated in Figure 1. The first decision takes place at the open circle at the bottom of the figure. There are two alternatives to choose from represented by the branches labelled L and R. Should R be chosen, the decision-maker must then make a further choice from the alternatives c, d, and e, after which there are no further decisions to be made. Similarly, if L is initially chosen, there is then a choice between a and b. If b is chosen, the decision-making ends, but if a is chosen, there is a final choice from the alternatives α and β. The number at the end of the last branch chosen indicates the payoff received from the sequence of choices that have been made. For example, a payoff of 3 is obtained by following the

and writing of literary texts.

[15] For a good introduction to sequential decision problems and their solutions, see Wiese (2021).

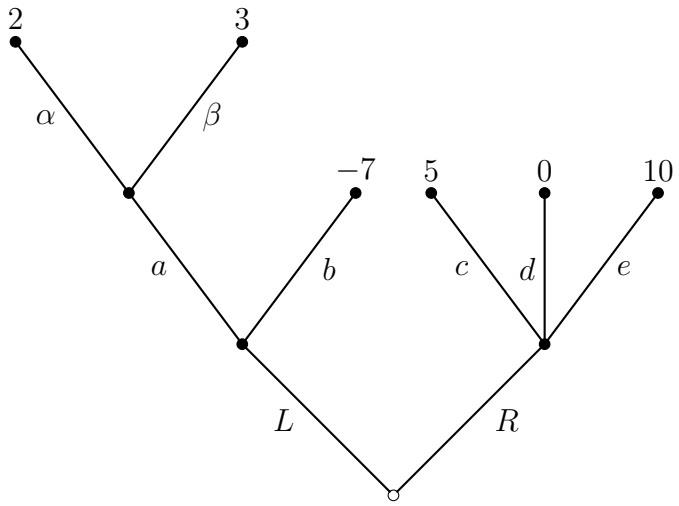


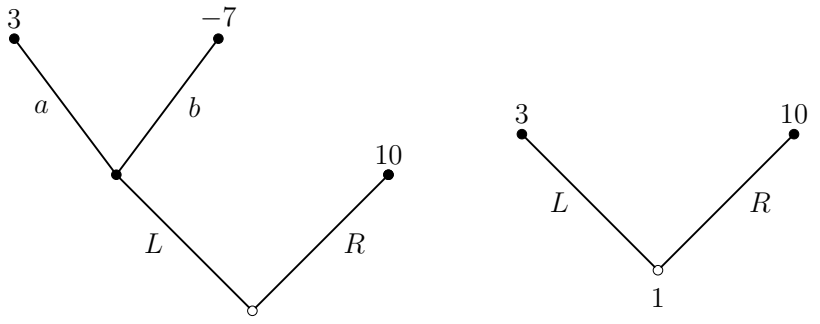
Figure 1: A decision tree.

path characterized by the sequence of choices L, a, and β.

A *strategy* specifies what the decision-maker chooses at every place in the decision tree where a choice is to be made. In Figure 1, there are four places where the tree branches, so a strategy consists of the choice of four branches. For example, one strategy is the choice of L, b, d, and α. The decision-maker knows the whole structure of the decision tree, so they can choose a strategy before actually implementing any of their choices. In other words, a strategy serves as a set of instructions specified in advance saying what to do in every possible contingency. By choosing a strategy in this way, the decision-maker engages in forward-looking contingent decision-making.

In order to determine which strategy maximizes the decision-maker's payoff, forward-looking planning is essential as the best choice at each decision node depends on what the decision-maker anticipates that they will choose at each of the subsequent decision nodes. This is a complex problem, one that *backward induction* provides a way of solving.

Backward induction is based on the observation that no forward planning is needed at any decision node that immediately precedes a terminal node because, at such a node, the decision-maker only needs to determine which branch yields the highest payoff, not what is possible in some other part of the decision tree. In Figure 1, there are two decision nodes where the tree



(a) Step 1. (b) Step 2.

Figure 2: The backward induction solution in Figure 1.

branches for a final time. At them, the choices β and e, with payoffs of 3 and 10, respectively, are better than the other available options.

When the choice is between a and b, the decision-maker can now anticipate that β with a payoff of 3 will be obtained if a is chosen. Similarly, they can anticipate that e will be chosen with a payoff of 10 when the choice is between d, e, and f. Consequently, the parts of the decision tree that follow branches a and e can be replaced by these payoffs, as shown in panel (a) of Figure 2. Once this is done, in the resulting decision tree, there are no further decisions once a choice has been made between a and b. The choice of a rather than b results in a higher payoff, namely 3, so this part of the decision tree can be replaced by this value, as shown in panel (b) of Figure 2. At this stage, the problem has been reduced to one in which there is only a single decision. In it, choosing R is optimal resulting in a payoff of 10. The strategy identified in this way thus consists of the contingent choices R, a, e, and β. When this strategy is implemented, only the choice of R and e are observed. However, the optimal decisions on the paths that are not observed (the forgone possibilities) are used to determine that this path that has been identified is, in fact, the one that is payoff maximizing.

A strategy determined in this iterative way is the backward induction solution to the decision problem being considered. No other strategy can result in a larger payoff when viewed from the perspective of the beginning of the decision tree. Thus, backward induction provides a systematic way of optimally deciding in advance what to do in every contingency. Informally, the decision-maker is forward looking but reasons backward.

When backward induction is used to solve a sequential decision problem, a complete strategy is identified. In the decision tree depicted in Figure 1, this requires making a choice at each of the four nodes at which the tree branches. However, while employing backward induction ensures that the largest payoff is achieved, it is not in fact necessary to determine a complete strategy in order to obtain this outcome; rather, it is only necessary to determine what particular sequence of decisions results in the largest payoff. For example, in Figure 1, inspection of the tree reveals that the largest payoff is 10 and that there is only one sequence of choices that results in it.

Thus, if it is possible to identify the largest payoff, one only needs to work backward from a terminal node with that payoff to determine what path in the tree to follow to reach it. In Figure 1, the payoff of 10 is obtained if e is chosen at the decision node in which c and d are the only other options. To reach this decision node, it is necessary to choose R at the initial decision node. This iterative procedure, what I shall call *simplified backward induction*, uses backward reasoning but it does not, and need not, specify a choice at every decision node in the decision tree. While this procedure is not strictly speaking backward induction, it exemplifies the main features of backward induction reasoning. This is the form of backward reasoning that I argue Godwin employed.

At first glance, simplified backward induction may seem to be more like retrograde analysis than backward induction. However, with retrograde analysis, one knows from the outset where one wants to end up. In contrast, with simplified backward induction, determining what terminal node one wants to end up at is an essential part of the procedure.

4. Godwin's 1832 Preface

Caleb Williams is one of the classics of English literature. Five editions were published in Godwin's lifetime and it has been in print ever since. As noted earlier, in his Preface to the 1832 edition of *Fleetwood*, Godwin set out how he composed his earlier novel. In order to substantiate my claim that Godwin employed a rudimentary from of backward induction to plan the sequence of events in *Caleb Williams*, it is useful to quote in full what Godwin said about his compositional method (Godwin, 1832, pp. vii–ix).

> I formed a conception of a book of fictitious adventure, that should in some way be distinguished by a very powerful interest.

Pursuing this idea, I invented first the third volume of my tale, then the second, and last of all the first. I bent myself to the conception of a series of adventures of flight and pursuit; the fugitive in perpetual apprehension of being overwhelmed with the worst calamities, and the pursuer, by his ingenuity and resources, keeping his victim in a state of the most fearful alarm. This was the project of my third volume.

I was next called upon to conceive a dramatic and impressive situation adequate to account for the impulse that the pursuer should feel, incessantly to alarm and harass his victim, with an inextinguishable resolution never to allow him the least interval of peace and security. This I apprehended could best be effected by a secret murder, to the investigation of which the innocent victim should be impelled by an unconquerable spirit of curiosity. The murderer would thus have a sufficient motive to persecute the unhappy discoverer, that he might deprive him of peace, character and credit, and have him for ever in his power. This constituted the outline of my second volume.

The subject of the first volume was still to be invented. To account for the fearful events of the third, it was necessary that the pursuer should be invested with every advantage of fortune, with a resolution that nothing could defeat or baffle, and with extraordinary resources of intellect. Nor could my purpose of giving an overpowering interest to my tale be answered, without his appearing to have been originally endowed with a mighty store of amiable dispositions and virtues, so that his being driven to the first act of murder should be judged worthy of the deepest regret, and should be seen in some measure to have arisen out of his virtues themselves. It was necessary to make him, so to speak, the tenant of an atmosphere of romance, so that every reader should feel prompted almost to worship him for his high qualities. Here were ample materials for a first volume.

I felt that I had a great advantage in thus carrying back my invention from the ultimate conclusion to the first commencement of the train of adventures upon which I purposed to employ my pen. An entire unity of plot would be the infallible result; and the unity of spirit and interest in a tale truly considered, gives it a powerful hold on the reader, which can scarcely be generated

with equal success in any other way.

I devoted about two or three weeks to the imagining and putting down hints for my story, before I engaged seriously and methodically in its composition. In these hints I began with my third volume, then proceeded to my second, and last of all grappled with the first. I filled two or three sheets of demy writing-paper, folded in octavo, with these memorandums. They were put down with great brevity, yet explicitly enough to secure a perfect recollection of their meaning, within the time necessary for drawing out the story at full, in short paragraphs of two, three, four, five, or six lines each.

I then sat down to write my story from the beginning.[16]

This passage only provides a brief sketch of the plot. The sequence of events in the published version of *Caleb Williams* accords well with the description that Godwin retrospectively provided. In particular, the sequence consisting of the murder, the discovery of who committed it following the investigation by someone (Caleb Williams) curious about its perpetrator (who turns out to be his master, Ferdinando Falkland), and the subsequent tale of "flight and pursuit" of Williams agrees with Godwin's account. Furthermore, the traits of the pursuer and victim are realized in Falkland and Williams, respectively. The former is wealthy and endowed with"amiable dispositions and virtues," whereas the latter is curious and exhibits "perpetual apprehension" during his pursuit. However, the published version moves the murder and the introduction of Williams' "unconquerable spirit of curiosity" to the end of the first volume. The second volume as published focuses on Willams' investigation of the murder and on the beginning of his persecution.

5. Godwin's Use of Backward Reasoning

In any complex sequential decision problem, it is not practical to specify a complete decision tree or a complete strategy. Nevertheless, backward induction can be used to identify an optimal solution in a more tractable version of the problem that the decision-maker faces in which its main features are present. Clearly, Godwin did not consider all of the possible novels that he might have written, nor did he specify in advance all the possible ways

[16]Unfortunately, the memoranda that Godwin refers to have not been located.

that the narrative could unfold even when attention is restricted to the main events in the plot. Nevertheless, I contend that he did use what I have called "simplified backward induction" to decide what he wanted his novel to achieve and to prepare an outline of his plot.

There are many possible fictional instantiations of Godwin's political views that he could have chosen. So, Godwin first had to decide which of them to adopt. That choice corresponds to choosing the terminal node in the decision tree he faced that would provide him with the largest payoff given his preferences. Once Godwin had decided what he wanted to achieve and the form in which he wanted to achieve it (a novel), he reasoned backward to determine the basic incidents in his plot and to determine when key character traits are revealed so as to best to realize this outcome.

That Godwin began with a decision about what he hoped to achieve is apparent from the first sentence of the passage quoted above from the 1832 Preface in which he says that he began by conceiving "a book of fictitious adventure, that should in some way be distinguished by a very powerful interest." No doubt Godwin had something much more specific in mind when he formed his "conception" of *Caleb Williams* but did not think it necessary to go into much detail in a brief account of how he composed his novel.

Further insight into what Godwin hoped to achieve can be obtained from the "Preface" that he wrote for the the first 1794 edition of *Caleb Williams* but delayed publishing for political reasons until the the second 1796 edition (Godwin, 1796, pp. v–vii). In the withdrawn Preface, (Godwin, 1796, pp. vi) states that he

> proposed, in the invention of the following work [i.e., *Caleb Williams*], to comprehend, as far as the progressive nature of a single story would allow, a general review of the modes of domestic and unrecorded despotism by which man becomes the destroyer of man.[17]

Taking account of both prefaces, it seems that Godwin's objective has two components, both of which are reflected in the full title of his novel, *Things as They Are; Or, The Adventures of Caleb Williams*. The first part of the title indicates that Godwin wanted to comment on the current tyrannical

[17]Godwin (1795) also states this purpose in a response to one of the critics of *Caleb Williams*.

situation in Britain following the French Revolution, whereas the second part points to the desire to write an adventure story.[18]

Having chosen where to end up (the best terminal node in decision theory terminology), it remains to show that Godwin used backward reasoning to construct an outline his plot. Godwin's own words confirm that this is what he did. In the first paragraph of the quoted passage, he states that he "invented" the three volumes in reverse order. He later says that he "had a great advantage in thus *carrying back* my invention from the ultimate conclusion to the first commencement of the train of adventures" (my emphasis). He went on to say that when he wrote his outline, he "began with my third volume, then proceeded to my second, and last of all grappled with the first." Moreover, Godwin says that when he turned to what should be in the second volume, he needed "to conceive a dramatic and impressive situation adequate to account for the impulse that the pursuer should feel" in the third volume, namely, "a secret murder." Finally, when Godwin planned the subject of the first volume, he said that he needed to introduce a pursuer with appropriate personal characteristics and financial resources "[t]o account for the fearful events of the third." Thus, in "inventing" both of the first two volumes, Godwin focussed on how to create a path forward to what he planned for the subsequent volumes.

In Godwin's discussion of the subject matter planned for the first volume, he does not explicitly say how what he conceived for it would be used in the second volume. While the 1832 Preface correctly describes the sequence of events and character descriptions in the published version of *Caleb Williams*, as noted above, the assignment of plot elements to volumes does not. For dramatic purposes it makes sense for the murder to take place at the end of the first volume rather than early in the second. What matters for assessing whether Godwin used simplified backward induction when plotting *Caleb Williams* is that he recognized that he had to create the circumstances that would lead to the flight, pursuit, and persecution of the victim after he had decided on the "adventure" that he wanted to write about, which the 1832 Preface shows that he did.

A noteworthy feature of Godwin's account is that he used backward rea-

[18]Drawing on both prefaces, Myers (1972) concludes that in writing *Caleb Williams*, Godwin not only intended to write a gripping adventure story, he also wanted to communicate what he regarded as important insights about moral and political philosophy and psychology to those who do not read philosophical treatises. See Clemit (1993, Chap. 2) for further discussion of this issue.

soning twice. He first used it to sketch the plot in broad strokes. Then, he applied this method a second time in order to work out more of the plot details before beginning to compose his novel in the conventional order. Thus, Godwin's method was applied at two different levels of specificity.

In light of the preceding discussion, it is reasonable to conclude that Godwin's 1832 Preface has described the methodology of backward induction, at least in the simplified form considered here.

6. Concluding Remarks

Whether Godwin's account in the 1832 Preface of how he planned and wrote *Caleb Williams* is an accurate description of what he actually did is complicated by Gilbert Dumas' discovery over a century and half after the novel was published that Godwin substituted a new ending of his novel a couple of weeks before it was published (Dumas, 1966). However, even if Godwin misrepresented how he prepared his outlines, which is doubtful, this has no bearing on whether his 1832 Preface provides an early statement of the kind of backward induction reasoning now used in decision theory.

The novelty of Godwin's compositional method was remarked upon by Charles Dickens in a letter he sent to Edgar Allan Poe in 1842. He wrote:

> Apropos the 'construction' of Caleb Williams. Do you know that Godwin wrote it *backwards*—the last Volume first—and that when he had produced the hunting-down of Caleb, and the Catastrophe, he waited for months, casting about for a means of accounting for what he had done. (Dickens, 1974, pp. 106–108, emphasis in the original, editorial footnotes omitted)

As Hughes (1977) has observed, Dickens mistakenly said that Godwin composed his novel backwards rather than that he planned it that way.[19] Edgar Allan Poe paraphrased this passage from Dickens' letter in his 1845 essay, "A Chapter of Suggestions," (Poe, 1845a, p. 167) and later used the same passage in his influential 1846 essay, "The Philosophy of Composition" (Poe, 1846, p. 164). Thus, even though it was somewhat misrepresented, Godwin's use of backward reasoning had made itself known and was being discussed

[19]The delay Dickens alluded to was actually in the writing of the novel, not in its planning. See Godwin (1832, p. xiii).

in literary circles slightly over a decade after he wrote his 1832 Preface. However, it would have to wait for over forty years from its publication for backward induction to be formalized by Arthur Cayley.

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