



BOOK REVIEW

COMPUTATIONAL INTELLIGENCE IN CONTROL ENGINEERING, Robert E. King, Marcel Dekker Inc., NY, 1999, 295pp.

With the advance of increasingly faster computing hardware and cheaper memory chips, *computational intelligence*, also known as 'soft computation', a relatively new area of research, is becoming more and more important in many engineering and non-engineering disciplines including control engineering. In this information-rich world, the plant to be controlled is becoming more and more complex and control objective is given in a more and more 'high-level' fashion—not just the 'zero steady state error', 'smaller overshoot' or the like requirements. The performance is usually multi-objective. There is another concern about the prior knowledge about the plant and about how to better control the complicated system. In practice, we know that, usually, there does exist some rules or site knowledge from the site-operators about the system and the control. However, these rules, usually linguistic, may contain certain fuzziness. Therefore, new computational tools are needed to effectively design the controller to achieve the multi-objective performance indices with significant uncertainties, nonlinearities, and fuzziness in the description of the model of the plant to be controlled. Computational Intelligence (CI) is a collection of the possible unconventional computational tools to solve the above problems in control engineering. A CI course will be able to equip the students with the essential knowledge and useful resources to solve some of the systems control problems not easily solved using previously learned conventional control methods.

Therefore, 'Computational Intelligence' (CI) is just a label for a set of 'soft computation' (SC) [1] techniques including neural networks (NN), fuzzy logic (FL), and evolutionary computation (EC). Interestingly, compared with the 'artificial

intelligence' (AI), CI seems to be more on 'computation' rather than 'intelligence'. Moreover, in the majority of CI literatures, CI is in fact implicitly regarded as alternatives to conventional optimization/approximation techniques. This observation is also partly verified by References [2,3] where SC is considered as a complement of the conventional computational optimization/approximation techniques, also known as 'hard computation' (HC). Clearly, CI techniques provide opportunities for other subjects to evolve. For example, control engineering, when introduced with AI, evolves into a new subject called 'Intelligent Control'. The book under review by Professor Robert E. King, as the book title shows, is on the CI in control engineering. To our best knowledge, this is the first textbook to systematically introduce CI in control engineering, prefaced by Professor George N. Saridis according to whom, the author '*was one of the first to actually implement Intelligent Control in industry, ... by developing step by step some of the most important Intelligent Computational Algorithms*'.

The author's industrial experience, coupled with a strong academic background, as shown in the above TOC has been channeled into creating the above book that is suitable for both graduate academic education and a manual for the practicing industrial engineer. Again, Professor George N. Saridis wrote in the Preface that '*Such a book fills a major gap in the global literature on Computational Intelligence and could serve as a text for the developing areas of biological, societal and ecological systems.*' which is consistent with our teaching experience. We further comment that, this book is a perfect overview textbook for the course 'Intelligent Control'. In particular, Chapter 2 is dedicated to the 'classical' expert systems (ES) in control. This actually bridges the AI and CI in control engineering. Chapter 3 defines the explicit conditions for the use of intelligent control and its objectives. Chapter 4

summarizes briefly the techniques involved in intelligent control which is a preview of the roles of ES, FL, NN, etc. in intelligent control before detailed presentation in the following chapters. These three chapters give a nice big picture of CI in control engineering as well as the intelligent control in general. In our teaching curriculum of CI, we prefer to use one overview textbook such as the book currently under review or the book [4] in addition to some other dedicated textbooks or reference texts in NN [5, 6], FL [7–9], and EC [10, 11], respectively.

Based on our teaching experience in both fields of Computational Intelligence and Control Engineering, our general observations regarding CI are as follows:

- CI can be an independent advanced course for seniors or the first year graduates. It should be as popular as courses such as ‘Numerical Methods’, ‘Optimization Techniques’, etc.
- CI can also be combined with other specific subjects such as control engineering, electromagnetic, communication, transportation, manufacturing, etc.
- ‘CI in Control Engineering’ is a better substitute of the course ‘Intelligent Control’. ‘Intelligent Control’ seems to be more on general concept while ‘CI in Control Engineering’ is more on the techniques.
- Students are keen on the new, never-heard, fancy terminologies being popped out from the CI literatures. They also keen on knowing more on the frequently heard terms such as NN, FL, EC, etc. They tend to choose the CI course to see what exactly is inside.

An unfortunate factor that hinders the students’ learning in CI is the flooding of publication (see Figure 1 of Reference [3, p. 72]). Although this increasing trend of number of publications is usually used as a positive support of the statement that CI is getting more and more popular and wide-spread use in science and engineering, for beginners, it is very easy to get lost or even ‘drowning’ in face of the literature flood. Without a proper overview type textbook, students can be very easy to get saturated in too many details and get lost the big picture of CI. The current

book under review is the right overview textbook in CI in general and CI in Control Engineering in particular with good industry flavors that the students will be more convinced about CI. In addition to the first four chapters (Chapters 1–4) mainly for overview of CI in Control Engineering, the depth of the subsequent chapters in FL (Chapters 4–10), NN (Chapters 11–14) and EC (Chapters 15–17) has been carefully controlled to a proper level that will not drive away the (engineering) students who hate dense mathematics. This refrained treatment of depth is a clear feature of this book which is perfect for beginners. For advanced readers, however, this book provides a categorized yet again refrained bibliography (Chapter 18) list which comprises of the following categories (the number in the bracket represents number of entries):

- A. Computational Intelligence (3)
- B. Intelligent Systems (13)
- C. Fuzzy Logic and Fuzzy Control (44)
- D. Fuzzy Logic and Neural Networks (5)
- E. Artificial Neural Networks (12)
- F. Neural and Neuro-Fuzzy Control (16)
- G. Computer and Advanced Control (5)
- H. Evolutionary Algorithms (31)
- I. Matlab and its Toolboxes (7)

The four appendices at the end of the book are good for beginners to start to play with the CI algorithms. The codes listed are downloadable from the URL <http://www.lar.ee.upatras.gr/reking/>In conclusion, we feel that this textbook is the spring-board for any one who wishes to dive into the field of computational intelligence. It best fits an overview textbook for a CI course for seniors or first year graduates. When depth in some specific subtopics is more important, additional textbooks or specific reference texts should be used concurrently as we have practiced.

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(DOI: 10.1002/RNC.893)

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