Semantic Web technologies and applications have become increasingly important as new methods for understanding and expressing information are discovered. This work, titled Progressive Concepts for Semantic Web Evolution: Applications and Developments, unites research on essential theories, models, and applications of Semantic Web research. Contributions focus on mobile ontologies and agents, fuzzy databases, and new approaches to retrieval and evaluation in the Semantic Web, among other topics.

Chapter 1, “Evaluating Semantic Web Service Technologies: Criteria, Approaches and Challenges,” by Ulrich Küster, Birgitta König-Ries, and Matthias Klusch presents a criteria model for SWS evaluation and comprehensively analyzes existing approaches towards SWS evaluation. The authors discuss shortcomings in order to identify the fundamental issues of SWS evaluation. Based on this discussion, a research agenda towards agreed upon evaluation methodologies is proposed.

Chapter 2, “Semantic Web Services and Mobile Agents Integration for Efficient Mobile Services,” by Vasileios Baousis, Vassilis Spiliopoulos, Elias Zavitsanos, Stathes Hadjieffthymiades, and Lazaros Merakos proposes the integration of two modern service technologies: Web Services and mobile agents. This integration allows wireless users to access and invoke semantically enriched Web Services without the need for simultaneous, online presence of the service requestor. Moreover, in order to improve the capabilities of Service registries, the authors exploit the advantages offered by the Semantic Web framework. Specifically, they use enhanced registries enriched with semantic information that provide semantic matching to service queries and published service descriptions.

Chapter 3, “Mobile Ontologies: Concept, Development, Usage, and Business Potential,” by Jari Veijalainen discusses ontology and epistemology concepts in general. After that, the author reviews ontologies in the computer science field and introduces mobile ontologies as a special category. It seems reasonable to distinguish between two orthogonal categories, mobile domain ontologies and flowing ontologies. The domain of the former one is in some sense related with mobility, whereas the latter ones are able to flow from computer to computer in the network. This chapter then discusses the creation issues, business aspects, and intellectual property rights (IPR), including patentability of mobile ontologies.

Chapter 4, “Service Provisioning through Real World Objects,” by Massimo Paolucci, Gregor Broll, John Hamard, and Enrico Rukzio discusses the PERCI system, which provides a way to bridge technologies that support the association of digital information with Semantic Web services. This allows the invocation of Web services using the information gathered from the tags, effectively transforming every object in a service proxy.

Chapter 5, “Semantic-Based Bluetooth-RFID Interaction for Advanced Resource Discovery in Pervasive Contexts,” by Tommaso Di Noia, Eugenio Di Sciaccio, Francesco Maria Donini, Michele Ruta, Floriano Scioscia, and Eufemia Tinelli proposes a novel object discovery framework integrating the application layer of Bluetooth and RFID standards. The approach is motivated and illustrated in an innovative u-commerce setting. Given a request, it allows an advanced discovery process, exploiting
semantically annotated descriptions of goods available in the u-marketplace. The RFID data exchange protocol and the Bluetooth Service Discovery Protocol have been modified and enhanced to enable support for such semantic annotation of products. Modifications to the standards have been conceived to be backward compatible, thus allowing the smooth coexistence of the legacy discovery and/or identification features.

Chapter 6, “In Defense of Ambiguity Redux,” by Patrick J. Hayes and Harry Halpin contends that reference is by nature ambiguous in any language. So any attempts by Web architecture to make reference completely unambiguous will fail on the Web. Despite popular belief otherwise, making further ontological distinctions often leads to more ambiguity, not less. Contrary to appeals to Kripke for some sort of eternal and unique identification, reference on the Web uses descriptions and therefore there is no unambiguous resolution of reference. On the Web, what is needed is not just a simple redirection, but a uniform and logically consistent manner of associating descriptions with URIs that can be done in a number of practical ways that should be made consistent.

Chapter 7, “Identity of Resources and Entities on the Web,” by Valentina Presutti and Aldo Gangemi chapter investigates the meaning of the identity of a Web resource, and how the current situation, as well as existing and possible future improvements, can be modeled and implemented on the Web. In particular, the authors propose an ontology, IRE, that provides a formal way to model both the problem and the solution spaces.

Chapter 8, “Ontological Indeterminacy and the Semantic Web,” by Allen Ginsberg argues that the expected utility of the Semantic Web (SW) hinges upon the idea that machines, just like humans, can make and interpret statements about “real world” objects, properties, and relations. A cornerstone of this idea is the notion that Uniform Resource Identifiers (URIs) can be used to refer to entities existing independently of the Web and to convey meanings. This chapter contends that when a URI is used in this manner, it is used declaratively, or that it is an R-URI. The key question is this: when an R-URI is used declaratively on the SW how is an agent, especially a non-human one, supposed to “understand” or “know” what it is intended to refer to or mean?

Chapter 9, “Ontology Driven Document Identification in Semantic Web,” Marek Reformat, Ronald R. Yager, and Zhan Li offers an approach that combines a hierarchy of concepts and ontology for the task of identifying Web documents in the environment of the Semantic Web. A user provides a simple query in the form a hierarchy that only partially “describes” documents (s)he wants to retrieve from the Web. The hierarchy is treated as a “seed” representing user’s initial knowledge about concepts covered by required documents. Ontologies are treated as supplementary knowledge bases. They are used to instantiate the hierarchy with concrete information, as well as to enhance it with new concepts initially unknown to the user. The proposed approach is used to design a prototype system for document identification in the Web environment.

Chapter 10, “A Fuzzy Ontology Generation Framework from Fuzzy Relational Databases,” by Z.M. Ma, Yanhui Lv, and Li Yan proposes a fuzzy ontology generation framework from the fuzzy relational databases, in which the fuzzy ontology consists of fuzzy ontology structure and instances. The authors simultaneously consider the schema and instances of the fuzzy relational databases, and respectively transform them to fuzzy ontology structure and fuzzy RDF data model. This can ensure the integrality of the original structure as well as the completeness and consistency of the original instances in the fuzzy relational databases. The fuzzy RDF data model is used to represent the fuzzy ontology instance.

Chapter 11, “Tightly Coupled Fuzzy Description Logic Programs under the Answer Set Semantics for the Semantic Web,” by Thomas Lukasiewicz and Umberto Straccia presents a novel approach to fuzzy description logic programs (or simply fuzzy dl-programs) under the answer set semantics, which is a tight integration of fuzzy disjunctive logic programs under the answer set semantics with fuzzy description
logics. From a different perspective, it is a generalization of tightly coupled disjunctive dl-programs by fuzzy vagueness in both the description logic and the logic program component. The authors show that the new formalism faithfully extends both fuzzy disjunctive logic programs and fuzzy description logics, and that under suitable assumptions, reasoning in the new formalism is decidable. The authors present a polynomial reduction of certain fuzzy dl-programs to tightly coupled disjunctive dl-programs, and analyze the complexity of consistency checking and query processing for certain fuzzy dl-programs.

Chapter 12, “Evolutionary Conceptual Clustering Based on Induced Pseudo-Metrics,” by Nicola Fanizzi, Claudia d’Amato, and Floriana Esposito presents a method based on clustering techniques to detect possible/probable novel concepts or concept drift in a knowledge base expressed in Description Logics. The method exploits an effective and language-independent semi-distance measure defined for the space of individuals, that is based on a finite number of dimensions corresponding to a committee of discriminating features (represented by concept descriptions). A maximally discriminating group of features can be obtained with the randomized optimization methods described in the chapter. In the algorithm, the possible clusterings are represented as strings of central elements (medoids, w.r.t. the given metric) of variable length. Hence, the number of clusters is not required as a parameter since the method is able to find an optimal choice by means of the evolutionary operators and of a proper fitness function. An experimentation with a number of ontologies proves the feasibility of this method and its effectiveness in terms of clustering validity indices.

Chapter 13, “Nested Optional Join for Efficient Evaluation of SPARQL Nested Optional Graph Patterns,” by Artem Chebotko and Shiyong Lu studies how RDF queries with the so called well-designed graph patterns and nested optional patterns can be efficiently evaluated in an RDBMS. The authors propose to extend relational algebra with a novel relational operator, nested optional join (NOJ), that is more efficient than left outer join in processing nested optional patterns of well-designed graph patterns. They design three efficient algorithms to implement the new operator in relational databases: (1) nested-loops NOJ algorithm, NL-NOJ, (2) sort-merge NOJ algorithm, SM-NOJ, and (3) simple hash NOJ algorithm, SH-NOJ. Using a real life RDF dataset, the authors demonstrate the efficiency of their algorithms by comparing them with the corresponding left outer join implementations and explore the effect of join selectivity on the performance of these algorithms.

Chapter 14, “An Associative and Adaptive Network Model for Information Retrieval in the Semantic Web,” by Peter Scheir, Peter Prettenhofer, Stefanie N. Lindstaedt, and Chiara Ghidini investigates how to improve retrieval performance in settings where resources are sparsely annotated with semantic information. Techniques from soft computing are employed to find relevant material that was not originally annotated with the concepts used in a query. The authors present an associative retrieval model for the Semantic Web and evaluate if and to which extent the use of associative retrieval techniques increases retrieval performance.

Progressive Concepts for Semantic Web Evolution: Applications and Developments provides focused coverage on research and applications in the Semantic Web discipline, investigating key considerations, frameworks, models, and methodologies that continue to inform and redefine information retrieval, services, and technologies in the Semantic Web.