Chapter 2
How Does DICOM Work?

“Everything in life is important, important things are simple, simple things are never easy.”

Murphy’s Law

To introduce order into the complex medical environment, DICOM uses its own lingo, based on its model of the real world (DICOM information model). Here is that model in a nutshell.

All real-world data – patients, studies, medical devices, and so on – are viewed by DICOM as objects with respective properties or attributes. The definitions of these objects and attributes are standardized according to DICOM Information Object Definitions (IODs). Think about IODs as collections of attributes, describing each particular data object. A patient IOD, for example, can be described by name, medical record number (ID), sex, age, weight, smoking status, and so on – as many attributes as needed to capture all clinically relevant patient information. In a broader sense, a patient (just like any other DICOM object) is the set of attributes of which he consists, as you can see on Fig. 2.

DICOM maintains a list of all standard attributes (more than 2000 of them), known as the DICOM data dictionary, to ensure consistency in attribute naming and processing. For example, our patient attributes – name, date of birth, sex, and so on – are also included in the DICOM Data Dictionary. All DICOM attributes are formatted according to 27 value representation (VR) types, corresponding to dates, times, names, and so on.

As soon as the data is captured as DICOM data attributes, it can be transmitted and processed between various DICOM devices and software (Application Entities (AEs), as they are known in DICOM). DICOM represents this processing with a service-rendering model: DICOM applications provide services to each other. Because each service usually involves some data exchange (typically performed over a computer network), it becomes natural to associate particular service types with the data (IODs) that they process. DICOM calls these associations Service-Object Pairs (SOPs), and groups them into SOP Classes. For example, storing a CT image from a digital CT scanner to a digital

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3 If you have an IT background, you will certainly recognize object-oriented design.
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PACS archive corresponds to the CT Storage SOP, as shown on Fig. 3. In this particular example, the CT image represents the DICOM IOD (DICOM data object).

The CT scanner requests the storage service from the archive, and the archive provides the storage service to the scanner. To differentiate between service requestors and service providers, DICOM calls the former Service Class Users (SCUs) and the latter Service Class Providers (SCPs). In the same CT example, the CT scanner acts as the CT Storage SCU, and the digital archive as the CT Storage SCP.

Each DICOM network data exchange between SCU and SCP peers is called association. Consequently, each network transfer begins with an Association
Establishment–DICOM handshake, when the two connecting applications exchange information about each other. This information is called the Presentation Context; if the two applications can match their contexts, they can connect and start SCU-SCP processing.

Because hundreds of DICOM devices and applications are produced by hundreds of DICOM manufacturers, each DICOM unit will be accompanied by its own DICOM Conformance Statement from the manufacturer. This statement explains which SOPs (services) the unit supports, and to what extent (SCU, SCP, or both). The DICOM Conformance Statement is your most essential roadmap for any DICOM-related project. Obtain it from the manufacturer ahead of time and read it carefully. For example, if you buy a digital archive that supports only CT Storage SCU (does not support CT Storage SCP) you won't be able to store CT images in it. The archive won't be able to provide the CT storage service.

This brief summary reflects the core DICOM functionality, and as you can see, it is quite straightforward. In fact, understanding the theory of DICOM is easy; dealing with DICOM in real life is often the challenge. Most of this book is committed to helping you to meet that challenge.