

3.6 Summary

- **Data quality** is defined in terms of *accuracy*, *completeness*, *consistency*, *timeliness*, *believability*, and *interpretability*. These qualities are assessed based on the intended use of the data.
- **Data cleaning** routines attempt to fill in missing values, smooth out noise while identifying outliers, and correct inconsistencies in the data. Data cleaning is usually performed as an iterative two-step process consisting of discrepancy detection and data transformation.
- **Data integration** combines data from multiple sources to form a coherent data store. The resolution of semantic heterogeneity, metadata, correlation analysis, tuple duplication detection, and data conflict detection contribute to smooth data integration.
- **Data reduction** techniques obtain a reduced representation of the data while minimizing the loss of information content. These include methods of *dimensionality reduction*, *numerosity reduction*, and *data compression*. **Dimensionality reduction** reduces the number of random variables or attributes under consideration. Methods include *wavelet transforms*, *principal components analysis*, *attribute subset selection*, and *attribute creation*. **Numerosity reduction** methods use parametric or nonparametric models to obtain smaller representations of the original data. Parametric models store only the model parameters instead of the actual data. Examples include regression and log-linear models. Nonparametric methods include histograms, clustering, sampling, and data cube aggregation. **Data compression** methods apply transformations to obtain a reduced or “compressed” representation of the original data. The data reduction is *lossless* if the original data can be reconstructed from the compressed data without any loss of information; otherwise, it is *lossy*.
- **Data transformation** routines convert the data into appropriate forms for mining. For example, in **normalization**, attribute data are scaled so as to fall within a small range such as 0.0 to 1.0. Other examples are **data discretization** and **concept hierarchy generation**.
- **Data discretization** transforms numeric data by mapping values to interval or concept labels. Such methods can be used to automatically generate *concept hierarchies* for the data, which allows for mining at multiple levels of granularity. Discretization techniques include binning, histogram analysis, cluster analysis, decision tree analysis, and correlation analysis. For nominal data, **concept hierarchies** may be generated based on schema definitions as well as the number of distinct values per attribute.
- Although numerous methods of data preprocessing have been developed, data preprocessing remains an active area of research, due to the huge amount of inconsistent or dirty data and the complexity of the problem.