

# Index

- \*EXTIND option, 202-203
- ADDPFTRG command. *See CL command*
- Alias
  - CREATE ALIAS for, 62, 64
  - for a column, 22, 349-350
  - for a table, 15-17, 62, 66-67, 291, 293, 343
- ALLOCATE CURSOR, 219, 221
- ALTER TABLE, 42-45, 57, 80, 244, 302-306, 312, 314
- Anomalies. *See Data anomalies*
- AS IDENTITY, 42, 46, 63, 240, 300
- Association table (aka intermediate table), 87, 353
- Auditing
  - columns related to, 43-44, 60
  - using triggers for, 279-282, 296
- Authority, 48, 186, 203, 253-254, 265
  - special, 260, 262-263
- AVG function, 23-24, 230, 308, 310
- BETWEEN keyword, 14, 16, 18, 20, 43
- Boyce-Codd normal form. *See Normal forms*
- Business rules
  - enforcing, 305-311, 322, 329
  - entity relationship diagramming and, 87
  - moving into the database/SQL, 2, 5, 78, 140, 152, 299, 318, 322, 337
  - stored procedures and, 201, 208
  - user-defined function (UDF) and, 178
- CALL statement, 149-151, 178, 180-182, 191, 196-197, 202-203, 218-219, 222, 228, 257, 259, 262-263
- Candidate key, 91, 93
- Cardinality, 83, 87-88
  - crow's foot notation and, 87-88
- CASE structure
  - for business rule validations, 312-313, 315
  - for data transformation, 129, 137
  - for flow control, 144-146, 175
  - in UDF example, 233
  - in UDTF example, 257
  - to make data more user-friendly, 75-78, 82
  - used in ORDER BY clause, 78-79
  - used in querying database catalog, 335-336
- CAST function, 23-24, 32, 247-249
- Catalog. *See Database catalog*
- Check constraint, 304-307, 312-315, 317-319, 322, 329, 337
- Chen's notation, 87
- CHGPF command. *See CL command*
- Child table (aka dependent table), 86-87, 89-90, 106
- CL command, 187, 188, 230
  - ADDPFTRG (Add Physical File Trigger), 268, 280
  - CHGPF (Change Physical File), 42, 80
  - CLRPFM (Clear Physical File Member), 30-31
  - CPYF (Copy File), 27
  - CRTLIB (Create Library), 324
  - DSPFD (Display File Description), 54
  - DSPJOB (Display Job), 187
  - DSPUSRPRF (Display User Profile), 231, 259
  - used with a UDTF, 254-257, 259, 262, 265-266
- Class Definition table, 109-110, 125-128, 134-136, 159-161, 210, 214, 217, 243, 275, 351
  - creating the, 122-124
- Class Enrollment per Year table, 122, 129, 135-136, 210, 214
  - creating the, 125-128
  - used with a common table expression (CTE), 351-352
  - used with a trigger, 279-283
  - used in a UDF, 239, 243-244, 247-249
- Classes table, 7-8, 15-17, 48, 70, 72-73, 75, 84, 86, 90, 104, 113, 116

- joined with Students, 17-18, 49, 75
  - joined with Courses, 49, 68, 75
  - normalizing data in, 93-94
  - split into three tables, 109-110, 122-127
- Classes per Year table, 94, 109-110, 122, 127-130, 134-136, 210, 214, 217, 241, 243, 301, 305
- creating the, 124-125
  - used with a common table expression (CTE), 351-352, 354
  - used with a trigger, 281-283
- CLRPFM command. *See* *CL command*
- Column(s)
- aggregate function, 230
  - in ALTER TABLE statement, 42-45
  - in CASE structure, 75-78, 82
  - in Class Definition table, 123
  - in Class Enrollment per Year table, 128-129, 243
  - in Classes table, 8
  - in common table expressions (CTEs), 348-350, 353, 355
  - constraints (validation of business rules) and, 300-306, 312-314, 316-318
  - in Courses table, 6
  - in database catalog, 325-328, 331, 333-334, 336
  - defined in Visual Paradigm data modeler, 98-101
  - definition, 40, 43, 46
  - dependencies, 91-92
  - finding minimum and maximum values of, 21-22
  - functions, 20-24, 32, 230
  - in Grades table structure, 9
  - in INSERT statement, 25-28, 346
  - as a key, 41-42, 54-55, 68, 85-86, 91, 300-302, 343
  - in linking tables, 75
  - naming convention for, 46, 65
  - in queries, 12, 13, 24
  - in stored procedures, 179, 189, 210
  - in Students table structure, 4-5
  - in Teachers table structure, 7
  - triggers and, 270, 277, 279-282, 284-285, 291-293, 296, 317-318
  - UNIQUE keyword and, 300, 302
  - in UPDATE statement, 29, 33
  - user-friendly names for, 16, 59-64, 255
  - in views, 49-52
- Commitment control, 28, 30, 162, 184, 200, 201, 356
- Common table expression (CTE), 339, 348-355
- Compound statement, in SQL/PSM, 141, 145, 152, 161-162, 165-166, 168, 172, 174-175, 189
- Condition declaration. *See* *SQL/PSM*
- Condition handler. *See* *SQL/PSM*
- Constraint(s), 2, 75, 113, 169, 195, 315, 322
- check, 304-307, 312-315, 317-319, 322, 329, 337
  - and columns, 140, 300-306, 312-314, 316-318
  - and database catalog, 323, 324, 326-329
  - DDL, 299-306, 322, 326, 337
  - foreign key, 302-303, 327-328
  - primary key, 326-327
  - referential, 302-304, 319, 322, 337
  - unique, 169, 171, 300-302, 322, 327, 337
  - violations (GET DIAGNOSTICS), 169-171, 173
- Cooper, Jim, 162
- Correlation name. *See* *Alias*
- COUNT function, 20-23, 32, 68-69
- Courses table, 5-6, 25, 66-67, 71-73, 75, 90, 94, 109, 123, 132, 136, 196-197, 290, 293
- common table expressions (CTEs) and, 353
  - database catalog data for triggers associated with, 329-332
  - enforcing “informal” integrity of, 319-322
  - populating, 121-122
- CREATE FUNCTION, 228-229
- CREATE INDEX, 53-57
- CREATE SCHEMA, 324
- CREATE TABLE, 35, 43, 46, 60, 63, 83, 112, 279-280, 300-302, 326, 340
- fundamentals, 39-41
- CREATE VIEW, 49-51, 67, 131
- Crow’s foot notation, 83, 87-89, 107
- Cursor, 150-151, 169-170, 173
- ALLOCATE CURSOR for, 219, 221
  - in compound statement, 161-162
  - DECLARE CURSOR for, 152-153, 156, 199, 201, 203
  - in dynamic SELECT statement, 152-158
  - in dynamic UPDATE and DELETE statements, 158, 160
  - in stored procedures, 177, 188, 198-208, 210-212, 215-225
  - scrollable, 200
- Cyclic dependency. *See* *Dependency*
- Data anomalies, in a database, 74, 83-84, 89-90, 94
- Data Definition Language (DDL), 1-2, 26, 33, 35, 55-57, 59, 80, 85, 140, 162, 228

- constraints, 299-306, 322, 326, 337
- vs. DDS performance, 53
- Data File Utility (DFU), 25, 28, 269
- Data manipulation language (DML), 1-2, 10, 11, 30, 35, 65, 90, 140, 149, 161, 162, 228, 343, 349
- Data modeling, 83, 95, 111, 114, 133, 137, 239, 243
  - with Visual Paradigm, 95-110
- Database catalog, 323-337
  - CASE structure used in querying, 335-336
  - columns in, 325-328, 331, 333-334, 336
  - constraints and, 323, 324, 326-329
  - data about dependencies in, 331, 334, 337
  - Departments table in, 325-327
  - schema catalog, 324, 329, 336
  - system catalog, 2, 179, 322, 324, 332, 334, 337
- Database Design and SQL for DB2*, 162, 184
- Data-centric programming
  - constraints and, 299, 319
  - introduction to, 140
  - SQL/PSM and, 141-175
  - triggers and, 267, 269
- DATFMT (stored procedure option) 186-187
- DB2 for i, 1-2, 4, 43, 102, 112, 141, 163, 168, 171, 184, 188, 282, 300, 324, 346
- DDS, 4, 38, 40-42, 44, 64, 80, 85, 326
  - vs. DDL performance, 53
- DECLARE CURSOR, 152-153, 156, 199, 201, 203
- DEFAULT keyword, 156, 181, 183
- DELETE, 11, 30-32, 33
  - commitment control and, 201
  - in common table expression (CTE), 349
  - cursor and, 200
  - dynamic, 152, 158, 161, 189
  - in MERGE statement, 341-342
  - soft, 30
  - triggers and, 268-269, 271, 278, 279-280, 282-283, 290
- Departments table, 94, 121, 196-197, 284, 300
  - in database catalog, 325-327
  - populating the, 116
  - triggers and, 284-286, 291-293
- Dependency, 90-94, 319
  - cyclic, 92, 93
  - determinant, 91
  - functional, 90-91
  - multi-valued, 92-93
  - shown in database catalog data, 331, 334, 337
  - transitive, 91, 93, 94
- Determinant. *See Dependency*
- DIGITS function, 22-23
- Domain key normal form (DKNF). *See Normal forms*
- Downloadable source code samples for this book, URL
  - for, 10, 11, 42, 47, 189
- DROP, 35, 42, 43, 52, 64, 131
  - INDEX, 55
  - TABLE, 60, 63, 95, 263-264
  - TRIGGER, 307
  - VIEW, 52, 55
- DSPFD command. *See CL command*
- DuplicateKey condition, 194-195
- Dynamic SQL, 182, 196, 200, 201, 203, 204, 209, 227, 239, 241, 268, 269, 270, 278
- EDTCDE keyword, 40
- Entity relationship diagram (ERD), 83, 87, 111, 209-210, 244, 303, 323
  - creating with Visual Paradigm, 95-97, 102-110, 114, 134, 137
  - notation, 87-89
- Error handling, in SQL/PSM, 141, 162-175, 242, 245-246, 277
  - GET DIAGNOSTICS in, 167-171
- Evolve Your RPG Coding*, 20, 182, 189, 227, 311
- Excel, 25, 42, 254, 340, 341, 343
- Exception join, 14, 72-74, 82, 117
- EXISTS predicate, 70-72, 73-74, 82, 117
- Extended indicator, 199, 202-203
- FETCH, 153-158, 169, 175, 200, 220-221, 223
  - FIRST, 21, 154
  - NEXT, 154
- Fifth normal form. *See Normal forms*
- First normal form. *See Normal forms*
- Flow control, in SQL/PSM, 141, 144-146, 175
  - using CASE, 145-146
  - using IF, 144-145
  - in a UDF, 234-237
- FOR COLUMN, 51-52, 55, 60-61, 63
- FOR loop, 147, 150-152
- Foreign key, 84, 86-87, 106, 111, 169
  - constraints, 302-304, 327-328
  - in database catalog, 327-328
- Fourth normal form. *See Normal forms*
- Full (outer) join, 19-20

Functional dependency. *See Dependency*

#### Function

- aggregate, 230
- AVG, 23-24, 230, 308, 310
- CAST, 23-24, 32, 247-249
- COUNT, 20-23, 32, 68-69
- creating a user-defined, 228-229
- DIGITS, 22-23
- SUM, 22, 32, 230, 247-248, 334
- user-defined (UDF), 186, 227-239, 242-250, 266, 306, 316-317, 324, 331-334, 337. *See also User-defined function (UDF)*
- user-defined table (UDTF), 229-230, 250-254, 257, 259-265, 266. *See also User-defined table function (UDTF)*

Gantner, Susan, 53

GENERATED ALWAYS, 42-43, 46, 60, 63

GET DIAGNOSTICS, 167-175, 277

- condition-related data, 169, 170, 173
- connection-related data and, 169

Grades table, 8-9, 46, 60, 62, 65, 75-76, 86, 109, 122, 129, 279-280

GROUP BY, 33, 68-69, 349-350

- aggregating data with, 24-25

HAVING clause, 21

HOLDABILITY, 199, 201

IBM Access Client Solutions (ACS), 12, 35-36, 55, 57

#### IBM i

- applications, 272, 323
- database, 1-2, 324
- database structure, problems with, 5, 9, 10, 73, 74
- establishing a database connection to, in Visual Paradigm, 103-104
- programmers, 302
- supported languages, 182, 227, 251, 268, 269
- system name, vs. SQL name, in stored procedures, 179
- version 7.2 or later, 159

IBM Rational Developer for i, 12

Identifying relationship, 86, 88, 92, 109

IF statement, 77, 144-145, 149, 168, 195, 207, 249, 281

Implicit join, 14-15

#### IN

- parameter type (in stored procedure), 179
- predicate, 11, 14, 32, 229, 231

#### Index

- CREATE INDEX for, 53-57

- in SQL, 53-57, 65

Indicator, extended. *See Extended indicator*

Inner join, 14-18, 48-51, 67-71, 81, 119-122, 125, 128, 240-241, 342, 353

INSERT, 11, 25, 42, 43, 45, 47, 51, 64, 80, 83, 115, 119, 124-130, 137, 161, 169, 178, 244, 346

- with common table expressions (CTEs), 349

- with constraints, 308, 314, 317-321

- and MERGE, 341-342, 344-345

- “strawberry” type, 27-28

- in triggers, 268-269, 271-274, 278-283, 285, 290, 308

- “vanilla” type, 25-26

Insert anomaly, 89. *See also Data anomalies*

INSTEAD OF trigger, 270-271, 287-292, 295, 296

INTERSECT, 117

ITERATE, 148-149, 175

Java, 1, 83, 95, 151, 165, 205

Join (of tables), 14-20

- exception, 14, 72-74, 82, 117

- full, 19-20

- implicit, 14-15

- inner, 14-18, 48-51, 67-72, 81, 119-122, 125, 128, 240-241, 342, 353

- left, 17-18

- outer, 19, 72, 125

- right, 18

#### Key

- candidate, 91, 93

- for Classes table, 48

- columns, 20

- constraints, 326-328

- duplicate error, 193, 195

- foreign, 84, 86-87, 106, 111, 169, 302-304, 327-328

- for Grades table, 9

- logical file and, 53-56

- multipart, 54

- primary, 43, 60, 62, 68, 80, 84-87, 91-94, 105, 108-109, 206, 300-302, 319, 326-327, 343

- shared by tables, 24

- unique, 9, 26, 41-43, 68, 84-85, 326-327

- view cannot have a, 53

#### Keyword

- BETWEEN, 14, 16, 18, 20, 43

- DEFAULT, 156, 181, 183

- EDTCDE, 40

- NOT, 13-14, 32

- NOT NULL, 40, 300-301, 312-313, 347-348
- ON, 16-19
- RANGE, 11-12
- UNIQUE, 42, 56-57, 300-302
- UPDATING, 281-282, 308-309, 311
- LABEL ON, 40-41, 44, 46, 55, 57, 131
- Left join, 17-18
- Logical file (LF), 48, 52-57, 85
- Long names (of columns, triggers, etc.), in SQL, 51, 64-65, 330
- Looping
  - used for control, 141, 147-152, 175
  - FOR, 147, 150-152
  - REPEAT used in, 147-149, 175
- MERGE statement, 339, 341-345
- Modality, 83, 87-88
- Modeling data. *See Data modeling*
- Modernization, 53, 311
- Multipart key, 54
- Multi-valued dependency. *See Dependency*
- Naming convention, 46, 55, 65, 179, 186, 303, 328
- Non-identifying relationship, 87-88, 107
- Normal forms, 2, 83-84, 89, 90, 92, 108, 110, 118, 123, 125, 136, 177, 319
  - Boyce-Codd, 93
  - domain key (DKNF), 93
  - fifth (5NF),
  - first (1NF), 92-93
  - fourth (4NF), 93
  - second (2NF), 92-93
  - third (3NF), 93-94, 123
- Normalization. *See Normal forms*
- Notation
  - Chen's, 87
  - crow's foot, 83, 87-89, 107
- NOT keyword, 13-14, 32
- NOT NULL keyword, 40, 300-301, 312-313, 347-348
- NULL, 18, 21, 202, 249, 300, 302, 314
- ON keyword, 16-19
- One-to-many relationship, 87-88, 94, 107-109, 111
- One-to-one relationship, 88, 195
- OPEN statement, 153-154, 156-158, 169, 175, 199, 203
- ORDER BY clause, 53, 55, 257, 326
  - using CASE in an, 78-79
- Outer join, 19, 72, 125
- Parent table, 86-87, 89-90
- Paris, Jon, 53
- PDM, 54, 55, 131, 204
- Persons table, 94, 119, 121-122, 126, 130, 135, 274, 340-344, 347, 349
  - creating using Visual Paradigm, 104-107, 109
  - using database catalog to get details on, 327-329
  - populating, 116-118
  - used with a user-defined function (UDF), 234-238
  - using referential constraints on, 302-304, 314, 318, 322
  - using a stored procedure to perform database operations on, 191-193, 197, 206, 209
  - using a trigger with, 289-290, 293
- PREPARE statement, 152-153, 156-158, 203-205
- Primary key, 43, 60, 62, 68, 80, 84-87, 91-94, 105, 108-109, 206, 300-302, 319, 326-327, 343
- Query/400, 11, 13, 74
- RANGE keyword, 11-12
- RANK, 120
- Record identifier, 6, 8, 10
- Referential integrity, 2, 75, 87, 94, 121, 302, 304, 319-321
- Relational database, 84, 86, 324
- Relationship (inter-table)
  - identifying, 86, 88, 92, 109
  - non-identifying, 87-88, 107
  - one-to-many, 87-88, 94, 107-109, 111
  - one-to-one, 88, 195
  - parent table, 86-87, 89-90
- RELATIVE, 154-155
- REPEAT, 147-149, 175
- RESIGNAL, 171, 173-175
- Result set locator, 218-219, 221-222
- Returnability, 201-202
- Right join, 18
- RPG, 1-3, 5, 9, 40-41, 64, 73, 75, 80, 140, 141, 143, 148, 151, 154, 163, 165, 178, 185, 189, 200, 202, 205, 220, 225, 227, 251, 257, 333
  - names, 17
  - SQL triggers and, 268-269, 280
- Run SQL Scripts, 12, 35, 39, 278
- Schema, 12, 13, 111, 189, 306, 336-337
  - and database catalog, 323-325, 329, 332-336
  - SYSIBM, 324
  - in a trigger, 271-273
  - UMADB, 37-38, 40-41, 47, 101, 103, 108, 113-114

- in user-defined function (UDF), 229, 231-232, 234, 237, 241, 247, 250, 254, 260
- Scrollability, 200-201
- Second normal form. *See Normal forms*
- Secondary table, 79-80, 82
- SELECT
  - basics, 11-19, 21-23
  - dynamic SQL and, 152-158, 162, 175, 204
  - in SQL/PSM, 140, 142, 143, 152-158, 162, 175, 178
  - in a stored procedure, 189, 193, 195, 198, 200-217
  - in a sub-query, 68-70
  - in a user-defined function (UDF), 229-230, 235-243, 247-250
  - in a user-defined table function (UDTF), 250, 252-254, 256, 258-260, 264-265
  - used in a common table expression (CTE), 348-355
  - used in creating a table, 340-341
  - used in creating a view, 48-54, 66-67, 130-131
  - used in a MERGE statement, 341-342
  - used to check database consistency, 74-75
  - used to create a sorted list, 81
  - used to retrieve data from database catalog, 325-334
  - used to test database changes, 61, 274, 275
  - used with CASE, 76-79
  - used with DELETE, 30
  - used with EXISTS to omit records, 70-72, 73
  - used with GROUP BY to aggregate data, 24
  - used with INSERT, 27-28, 47, 64, 115-116, 128, 137, 346-347
  - used with INTERSECT, 117
  - used with a trigger, 274-275, 278-280, 287, 291
  - used with UNION, 118
  - used with UPDATE, 28
  - used with validations, 320-321
- Semicolon, 13, 141, 171
- SIGNAL, 171-175, 196, 277, 307, 310
- Slash character (/), 13, 187
- Soft delete, 30
- Sort sequence table, 81, 128-129
- Special registers, 44
- SQL/PSM, 139-175
  - assigning variables in, with SET and INTO, 142-144
  - compound statement in, 141, 145, 152, 161-162, 165-166, 168, 172, 174-175, 189
  - condition declarations in, 164-165
  - condition handlers in, 164, 165-167
  - crash course in, 141-175
  - data-centric programming and, 141-175
  - declaring variables in, 141
  - dynamic SQL in, 152-160
  - error handling in, 141, 162-175, 242, 245-246, 277
  - flow control in, 141, 144-146, 175
  - GET DIAGNOSTICS in, 167-175
  - loop control in, 147-149
  - SELECT in, 140, 142, 143, 152-158, 162, 175, 178
  - stored procedures and, 177-178, 189, 191, 198, 219, 224
  - used in a trigger, 271
  - used in a UDF/UDTF, 227-228, 250-251, 253, 265-266
  - using to call other SQL routines, 149-152
- SQLCODE, 163-164, 170-171, 175
- SQLSTATE, 163-175, 193, 196-197
- Statement string, 153
- Static SQL, 152, 169
- Stored procedure (SP), 2, 140, 177-225
  - business rules and, 201, 208
  - columns in, 179, 189, 210
  - creating a, 189-195
  - cursor in, 177, 188, 198-208, 210-212, 215-225
  - database catalog data for a, 324, 329, 332
  - data-returning, 197-215, 218-224
  - IBM i system name, vs. SQL name, in, 179
  - IN parameter type in, 179
  - RETURN used in, 175
  - SELECT used in a, 189, 193, 195, 198, 200-217
  - SQL/PSM and, 149, 151, 177-178, 189, 191, 198, 219, 224
  - structure of, 178-189
  - used for validations, 311
  - when to use, 177-178
- Students table, 4-5, 15, 18, 21, 42, 62, 85-86, 94, 101, 130, 135
  - constraints and, 315, 327
  - joined with Classes table, 17-18, 49, 75
  - modifications to, 101, 105-106, 109
  - populating, 120-121
  - triggers and, 274, 290
  - using stored procedure to perform database operations on, 191, 206, 215
  - using a UDF to access data in, 234-236
  - validations and, 303
- Sub-queries, using, 68-70
- SUM, 22, 32, 230, 247-248, 334
- SYSIBM schema, 324

- SYSTABLES view, 324-325, 329, 337
- System catalog. *See* Database catalog
- System i Navigator, 35-36, 55, 57
- SYSTRIGDEP view, 331-332, 337
- Table
- association (aka intermediate table), 87, 353
  - child (aka dependent table), 86-87, 89-90, 106
  - Class Definition, 109-110, 122-128, 134-136, 159-161, 210, 214, 217, 243, 275, 351
  - Class Enrollment per Year, 122, 125-129, 135-136, 210, 214, 239, 243-244, 247-249, 279-283, 351-352
  - Classes, 7-8, 15-18, 48-49, 68, 70, 72-73, 75, 84, 86, 90, 93-94, 104, 109-110, 113, 116, 122-127
  - Classes per Year, 94, 109-110, 122, 124-125, 127-130, 134-136, 210, 214, 217, 241, 243, 281-283, 301, 305, 351-352, 354
  - Courses, 5-6, 25, 66-67, 71-73, 75, 90, 94, 109, 121-123, 132, 136, 196-197, 290, 293, 319-322, 329-332, 353
  - Grades, 8-9, 46, 60, 62, 65, 75-76, 86, 109, 122, 129, 279-280
  - Persons. *See* *Persons table*
  - Referential integrity and, 2, 75, 87, 94, 121, 302, 304, 319
  - Relationships, 73, 86-87, 140, 301-302
  - Students. *See* *Students table*
  - Teacher Ranks, 94, 114-115, 119, 123, 129, 132
  - Teachers. *See* *Teachers table*
- Teacher Ranks table, 94, 114-115, 119, 123, 129, 132
- Teachers table, 6-8, 13, 24, 48, 101, 129, 150, 291, 301, 319, 321
- inserting data into, 27-28, 32
  - multi-valued dependency on its column, 92, 94
  - modifications to, 104, 107
  - one-to-many relationships of, 94, 108, 110
  - populating, 119-120
  - relationship with Courses table, 66-67, 75, 132
  - relationship with Persons table, 215
  - relationship with Students table, 101, 104, 117
  - triggers and, 276
  - used to populate Teacher Ranks table, 114
- Third normal form. *See* *Normal forms*
- Timestamp, 44, 46, 230, 232, 233
- Toad, 12
- Transitive dependency. *See* *Dependency*
- Trigger, 267-297
- for data validation, 276-277
  - external vs. SQL, 270
  - INSTEAD OF, 270-271, 287-292, 295, 296
  - mechanics of, 270-272
  - more complex scenarios,
  - simple example of, 272-273
  - testing, 273-275
  - used for auditing, 279-282, 296
  - used to compose and fill columns, 284-287
  - what triggers a, 268
  - why use, 269-270
  - when to use, 177-178
- UDF. *See* User-defined function
- UDTF. *See* User-defined table function
- UMADB sample database, 1, 2, 3-10, 11, 35, 62, 65, 83-84, 101, 137, 225, 234, 306
- converting its physical files to SQL tables, 35-46
  - creating the new version of, 102-110
  - entity relationship diagram (ERD), 114, 209
  - migrating data to the new version of, 114-130
  - problems with, 113
  - referential integrity and, 302-304
  - solving its problems through normalization, 89-95
  - trigger examples, 272-295
- Unified Modeling Language (UML), 95-96
- UNION, 117-118
- Unique key, 9, 26, 41-43, 68, 84-85, 326-327
- UNIQUE keyword, 42, 56-57, 300-302
- UPDATE, 11, 28-30, 32, 33, 142, 151, 152, 161, 168, 178, 341
- dynamic, 158-160
  - in common table expression (CTE), 349
  - in error handling, 168, 172
  - in MERGE statement, 341-345
  - “quick and dirty” alternative to MERGE, 346-348
  - in a stored procedure, 189, 200-203
  - with triggers, 268-269, 271, 273, 276, 278-280, 282-285, 288-290, 292-295, 308, 314, 317-321
- Update anomaly, 90. *See also* *Data anomalies*
- UPDATING keyword, 281-282, 308-309, 311
- User-defined function (UDF), 186, 227-239, 242-250, 266, 306, 316-317, 324, 331-334, 337
- business rules and, 178
  - Calculate\_GPA, 242, 245-250
  - examples of, complex, 239-250
  - examples of, simple, 230-239
  - flow control in, 234-236

- overloading, 236-237
- testing, 237-239
- types of, 229-230
- User-defined table function (UDTF), 229-230, 250-254, 257, 259-265, 266
  - anatomy of a, 250-252
  - examples of, complex, 253-265
  - example of, simple, 250-253
  - more complex, 332
  - using in a SELECT statement, 252-253
  - using its data in another UDTF, 260-265
- User-friendliness
  - implementing in a database, 59-82
  - in naming, 16, 51, 255
  - in results, 23, 76, 78
- Validation. *See Business rules and Constraints*
- “Vanilla” INSERT, 25-26
- View
  - cannot have a key, 53
  - changing a, 55
  - columns in, 49-52
  - Course Information, 66-67, 70, 133
  - creating a, 48, 61, 130-131, 134-136
  - debug, 185-186
  - naming of, 65
  - storing source code of, 54
  - supercharging with INSTEAD OF (trigger), 287-295
  - SYSCST, 327-328
  - SYSTABLES, 324-325, 329, 337
  - SYSTRIGDEP 331-332, 337
  - SYSTRIGGER, 329
  - using SELECT to create a, 48-54, 66-67, 130-131
  - vs. logical file, 52-53, 57
  - vs. UDTF, 250-253
  - why necessary, 48
- Visual Paradigm, 83, 95
- Visual Paradigm Community Edition (VPCE), 95-101, 107, 111, 112
- WHERE clause, 14, 28, 30-31, 50, 70-71, 81, 204-207, 210-217, 249, 253, 257, 337, 344, 347, 349
- WHILE, 147-148, 151, 175
- WinSQL, 12