

ISO/IEC 9075-16:2023-06 (E)

Information technology - Database languages SQL - Part 16: Property Graph Queries (SQL/PGQ)

| Contents | Page |
|--|-----------|
| Foreword..... | viii |
| Introduction..... | x |
| 1 Scope..... | 1 |
| 2 Normative references..... | 2 |
| 3 Terms and definitions..... | 3 |
| 4 Concepts..... | 8 |
| 4.1 Notations and conventions..... | 8 |
| 4.1.1 Notations..... | 8 |
| 4.2 Columns, fields, and attributes..... | 8 |
| 4.3 SQL-statements..... | 8 |
| 4.3.1 SQL-statements classified by function..... | 8 |
| 4.3.1.1 SQL-schema statements..... | 8 |
| 4.4 Basic security model..... | 8 |
| 4.4.1 Privileges..... | 9 |
| 4.5 SQL-property graphs..... | 9 |
| 4.5.1 Introduction to SQL-property graphs..... | 9 |
| 4.5.2 Pure property graph..... | 9 |
| 4.5.3 Tabular property graph..... | 11 |
| 4.6 Operations involving property graphs..... | 12 |
| 4.7 Graph pattern matching..... | 13 |
| 4.7.1 Summary of graph pattern matching..... | 13 |
| 4.7.2 Paths..... | 13 |
| 4.7.3 Path patterns..... | 14 |
| 4.7.4 Graph pattern variables..... | 15 |
| 4.7.5 References to graph pattern variables..... | 16 |
| 4.7.6 Path pattern matching..... | 17 |
| 4.7.7 Path modes..... | 18 |
| 4.7.8 Selective path search prefixes..... | 19 |
| 4.7.9 Match modes..... | 19 |
| 5 Lexical elements..... | 20 |
| 5.1 <SQL terminal character>..... | 20 |
| 5.2 <token> and <separator>..... | 21 |
| 5.3 Names and identifiers..... | 24 |
| 6 Scalar expressions..... | 26 |
| 6.1 <value expression primary>..... | 26 |
| 6.2 <identifier chain>..... | 28 |
| 6.3 <set function specification>..... | 30 |
| 6.4 <case expression>..... | 32 |

| | | |
|-----------|---|------------|
| 6.5 | <property reference>..... | 33 |
| 6.6 | <element_id function>..... | 35 |
| 6.7 | <graphical match number function>..... | 36 |
| 6.8 | <graphical path name function>..... | 37 |
| 6.9 | <graphical element number function>..... | 38 |
| 6.10 | <graphical path length function>..... | 39 |
| 7 | Query expressions..... | 40 |
| 7.1 | <table reference>..... | 40 |
| 7.2 | <query specification>..... | 50 |
| 8 | Predicates..... | 51 |
| 8.1 | <predicate>..... | 51 |
| 8.2 | <directed predicate>..... | 52 |
| 8.3 | <labeled predicate>..... | 53 |
| 8.4 | <source/destination predicate>..... | 54 |
| 8.5 | <all_different predicate>..... | 56 |
| 8.6 | <same predicate>..... | 57 |
| 8.7 | <bound predicate>..... | 58 |
| 8.8 | <property_exists predicate>..... | 60 |
| 9 | Additional common rules..... | 61 |
| 9.1 | Potential sources of non-determinism..... | 61 |
| 9.2 | Contextual inference of a set of labels..... | 62 |
| 9.3 | Expansion of an <all properties reference>..... | 65 |
| 9.4 | Satisfaction of a <label expression> by a defined label set..... | 67 |
| 9.5 | Converting a tabular property graph to a pure property graph..... | 69 |
| 9.6 | Machinery for graph pattern matching..... | 72 |
| 9.7 | Evaluation of a <path pattern expression>..... | 77 |
| 9.8 | Evaluation of a selective <path pattern>..... | 82 |
| 9.9 | Applying bindings to evaluate an expression..... | 86 |
| 9.10 | Applying bindings to evaluate a subexpression of an aggregate..... | 89 |
| 9.11 | Applying bindings to generate a row..... | 91 |
| 9.12 | Creation of an element table descriptor..... | 94 |
| 9.13 | Creation of a vertex table descriptor..... | 98 |
| 9.14 | Creation of an edge table descriptor..... | 99 |
| 9.15 | Consistency check of a tabular property graph descriptor..... | 102 |
| 9.16 | Deriving a pure property graph descriptor from a tabular property graph descriptor..... | 104 |
| 10 | Additional common elements..... | 106 |
| 10.1 | <aggregate function>..... | 106 |
| 10.2 | <sort specification list>..... | 108 |
| 10.3 | <graph reference>..... | 109 |
| 10.4 | <graph pattern>..... | 110 |
| 10.5 | <path pattern prefix>..... | 116 |
| 10.6 | <path pattern expression>..... | 120 |
| 10.7 | <graph pattern quantifier>..... | 129 |
| 10.8 | <label expression>..... | 131 |
| 10.9 | <simplified path pattern expression>..... | 133 |
| 10.10 | <element reference>..... | 138 |

| | | |
|-----------|--|------------|
| 10.11 | <path reference>..... | 140 |
| 11 | Schema definition and manipulation..... | 141 |
| 11.1 | <schema definition>..... | 141 |
| 11.2 | <drop schema statement>..... | 142 |
| 11.3 | <table definition>..... | 143 |
| 11.4 | <drop column definition>..... | 144 |
| 11.5 | <drop table statement>..... | 145 |
| 11.6 | <view definition>..... | 146 |
| 11.7 | <drop view statement>..... | 147 |
| 11.8 | <drop domain statement>..... | 148 |
| 11.9 | <drop character set statement>..... | 149 |
| 11.10 | <drop collation statement>..... | 150 |
| 11.11 | <drop transliteration statement>..... | 151 |
| 11.12 | <drop attribute definition>..... | 152 |
| 11.13 | <drop data type statement>..... | 153 |
| 11.14 | <alter routine statement>..... | 154 |
| 11.15 | <drop routine statement>..... | 155 |
| 11.16 | <drop user-defined cast statement>..... | 156 |
| 11.17 | <drop user-defined ordering statement>..... | 157 |
| 11.18 | <drop sequence generator statement>..... | 158 |
| 11.19 | <property graph definition>..... | 159 |
| 11.20 | <alter property graph statement>..... | 164 |
| 11.21 | <add element table definition>..... | 165 |
| 11.22 | <drop element table definition>..... | 167 |
| 11.23 | <alter element table definition>..... | 170 |
| 11.24 | <add element table label clause>..... | 171 |
| 11.25 | <drop element table label clause>..... | 174 |
| 11.26 | <alter element table label properties>..... | 176 |
| 11.27 | <drop property graph statement>..... | 180 |
| 12 | Access control..... | 182 |
| 12.1 | <grant statement>..... | 182 |
| 12.2 | <privileges>..... | 183 |
| 12.3 | <revoke statement>..... | 184 |
| 13 | SQL-client modules..... | 187 |
| 13.1 | <externally-invoked procedure>..... | 187 |
| 13.2 | <SQL procedure statement>..... | 188 |
| 14 | Diagnostics management..... | 189 |
| 14.1 | <get diagnostics statement>..... | 189 |
| 15 | Information Schema..... | 191 |
| 15.1 | Information Schema digital artifact..... | 191 |
| 15.2 | PG_DEFINED_LABEL_SETS view..... | 191 |
| 15.3 | PG_DEFINED_LABEL_SET_LABELS view..... | 192 |
| 15.4 | PG_EDGE_DEFINED_LABEL_SETS view..... | 193 |
| 15.5 | PG_EDGE_TABLE_COMPONENTS view..... | 194 |
| 15.6 | PG_EDGE_TRIPLETS view..... | 195 |
| 15.7 | PG_ELEMENT_TABLE_KEY_COLUMNS view..... | 196 |

| | | |
|---|--|------------|
| 15.8 | PG_ELEMENT_TABLE_LABELS view. | 197 |
| 15.9 | PG_ELEMENT_TABLE_PROPERTIES view. | 198 |
| 15.10 | PG_ELEMENT_TABLES view. | 199 |
| 15.11 | PG_LABEL_PROPERTIES view. | 200 |
| 15.12 | PG_LABELS view. | 201 |
| 15.13 | PG_PROPERTY_DATA_TYPES view. | 202 |
| 15.14 | PG_PROPERTY_GRAPH_PRIVILEGES view. | 203 |
| 15.15 | PG_VERTEX_DEFINED_LABEL_SETS view. | 204 |
| 15.16 | PROPERTY_GRAPHS view. | 205 |
| 16 | Definition Schema. | 206 |
| 16.1 | Definition Schema digital artifact. | 206 |
| 16.2 | DATA_TYPE_DESCRIPTOR base table. | 206 |
| 16.3 | TABLES base table. | 207 |
| 16.4 | PG_DEFINED_LABEL_SETS base table. | 208 |
| 16.5 | PG_DEFINED_LABEL_SET_LABELS base table. | 209 |
| 16.6 | PG_EDGE_DEFINED_LABEL_SETS base table. | 210 |
| 16.7 | PG_EDGE_TABLE_COMPONENTS base table. | 212 |
| 16.8 | PG_EDGE_TRIPLETS base table. | 214 |
| 16.9 | PG_ELEMENT_TABLE_KEY_COLUMNS base table. | 216 |
| 16.10 | PG_ELEMENT_TABLE_LABELS base table. | 217 |
| 16.11 | PG_ELEMENT_TABLE_PROPERTIES base table. | 218 |
| 16.12 | PG_ELEMENT_TABLES base table. | 219 |
| 16.13 | PG_LABEL_PROPERTIES base table. | 221 |
| 16.14 | PG_LABELS base table. | 222 |
| 16.15 | PG_PROPERTY_DATA_TYPES base table. | 223 |
| 16.16 | PG_PROPERTY_GRAPH_PRIVILEGES base table. | 225 |
| 16.17 | PG_VERTEX_DEFINED_LABEL_SETS base table. | 227 |
| 16.18 | PROPERTY_GRAPHS base table. | 228 |
| 17 | Status codes. | 229 |
| 17.1 | SQLSTATE. | 229 |
| 18 | Conformance. | 230 |
| 18.1 | Claims of conformance to SQL/PgQ. | 230 |
| 18.2 | Additional conformance requirements for SQL/PgQ. | 230 |
| 18.3 | Implied feature relationships of SQL/PgQ. | 230 |
| Annex A (informative) SQL conformance summary. | | 234 |
| Annex B (informative) Implementation-defined elements. | | 249 |
| Annex C (informative) Implementation-dependent elements. | | 251 |
| Annex D (informative) SQL optional feature taxonomy. | | 254 |
| Annex E (informative) Deprecated features. | | 259 |
| Annex F (informative) Incompatibilities with ISO/IEC 9075:2016. | | 260 |
| Annex G (informative) Defect Reports not addressed in this edition of this document. | | 261 |
| Index. | | 262 |

Tables

| Table | Page |
|--|-------------|
| 1 Conversion of simplified syntax delimiters to default edge delimiters. | 135 |
| 2 Data types of <condition information item name>s. | 189 |
| 3 SQL-statement codes. | 190 |
| 4 SQLSTATE class and subclass codes. | 229 |
| 5 Implied feature relationships of SQL/PGQ. | 230 |
| A.1 Feature definitions outside of Conformance Rules. | 234 |
| D.1 Feature taxonomy for optional features. | 254 |