polyDB.org

A Database for Discrete Geometric Objects

polyDB

Database for collections of discrete geometric objects

- aims:
  - unified access to collections of discrete geometric data
  - data with information on authors and references
  - stable references into data
  - no restriction on specific data/format of data
  - access not bound to specific software
  - allow simple experimentation with the data
- project started in June 2013 as extension to *polymake*
- web frontend: polyDB.org

polyDB

- *polyDB* is based on MongoDB
  - NoSQL database
  - JSON/BSON documents in *collections*
  - own MongoDB query language
- drivers/APIs for
  - PHP, Perl, Python, . . .
  - `C/C++`, `Julia`. . .
- license
  - MongoDB: Server Side Public License (based on GPLv3)
  - Official drivers: Apache License v2.0

- *polyDB* vs. databases
  - review/QA via some publication
  - no computations in database
  - only data collection

mongodb.org

polyDB: Access

- web frontend — polyDB.org
- Rest API
  - Base URI: polydb.org/rest/current/<endpoint>
    db.polymake.org/rest/current/id/Matroids.Small/n12r3_27395519
  - Documentation: polydb.org/rest/api/0.2
- *polymake* — polymake.org
  - initial application
- *OSCAR* (using *Polymake.jl*) — docs.oscar-system.org/stable
  github.com/oscar-system/Polymake.jl
- python or sage: *pypolydb* (in progress) — github.com/apaffenholz/pypolydb
- Julia: *PolyDB.jl* (in progress) — github.com/apaffenholz/PolyDB.jl
- anything else with MongoDB driver — mongodb.com/docs/drivers

- Queries in
  - MongoDB query language
  - some convenience functions

polyDB Data Format

- data for each collection has two parts
  - (1) data in form for efficient search
  - (2) format document defining
    - data format for each entry in collection
    - mathematical types of entries
- data in JSON
- format/types as JSON schema
- math/CAS interpretation via namespaces
  - *e.g.* software that can deserialize the format
  - possibly mixing namespaces/reading subsets


```
{
   "_id" : "6_40",
   "_ns" : {
      "polymake" : [
        "https://polymake.org",
        "4.3.2"
      ]
   },
   "_type" : "polytope::Polytope<Rational>",
   "VERTICES" : [
      ["1","0","0","0"],
      ["1","1","0","0"],
      ["1","0","1","0"],
      ["1","0","2","3"],
      ["1","3","-1","-2"]
   ],
   "REFLEXIVE" : false,
   "N_LATTICE_POINTS" : 6,
   "EHRHART_POLYNOMIAL" : [
      {"1":"4/3","0":"1","2":"2","3":"5/3"}
   ],
   "SMOOTH" : false,
   "NORMAL" : false,
   "SIMPLE" : false,
   "VERY_AMPLE" : false,
   "F_VECTOR" : [5,9,6],
   [...]
}
```

polyDB Data Format

- ensure lossless storage/retrieval
  - keep exact mathematical types
    based on implementation in some CAS
  - data documents are not self contained
    - needs both data and schema
  - normalize data
    - → dense/sparse formats
- versioning
  - → handle changes in format/serialization
  - → data maintenance: update format
- allow fast retrieval in a CAS
  - access to deserializer
  - JSON transformation

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   "type" : "object",
   "$schema" : "http://json-schema.org/draft-07/schema#",
   "additionalProperties" : false
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   "properties" : { ... },
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   "properties" : { ... },
   "definitions" : { ... },
}
```

```
"properties" : {
   "_id" : {
      "$ref" : "https://polymake.org/schemas/data.json#/definitions/obj_id"
   },
   "_type" : {
      "const" : "polytope::Polytope<Rational>"
   },
   "_ns" : {
      "additionalProperties" : false,
      "type" : "object",
      "properties" : {
        "polymake" : {
           "items" : [{"const" : "https://polymake.org"},{"const" : "4.3.2"}],
           "additionalItems" : false,
           "type" : "array"
        } } }
  [...]
}
```

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   "properties" : { ... },
   "definitions" : { ... },
}
```

```
"required" : {
   "_ns",
   "_type",
   "VERTICES",
   "SIMPLICIAL",
   "EHRHART_POLYNOMIAL",
   "REFLEXIVE",
   "F_VECTOR",
   [...]
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   "definitions" : { ... },
}
```

```
"properties" : {
  "AFFINE_HULL" : {
     "$ref" : "#/definitions/common-Matrix-Rational-NonSymmetric"
  },
  "REFLEXIVE" : {
     "$ref" : "#/definitions/common-Bool"
  },
  "EHRHART_POLYNOMIAL" : {
     "$ref" : "#/definitions/common-UniPolynomial-Rational-Int"
  },
  "N_LATTICE_POINTS" : {
     "$ref" : "#/definitions/common-Int"
  },
  "F_VECTOR" : {
     "$ref" : "#/definitions/common-Vector-Int"
  }
  [...]
}
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}
```
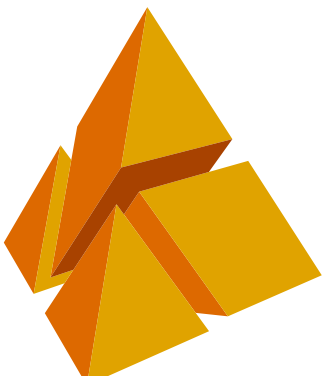

```
"definitions" : {
  "common-Int" : { "type" : "integer" },
  "common-Vector-Rational" : {
    "type" : "array",
    "items" : { "$ref" : "#/definitions/common-Rational" }
  "common-Rational" : {
      "type" : "string",
      "pattern" : "^-?(\\d+(/\\d+)?|inf)$"
  },
  "common-Bool" : { "type" : "boolean" },
  [...]
}
```

Some use cases

- 2024
  - Nill, *Unimodular polytopes and a new Heller-type bound on totally unimodular matrices via Seymour's decomposition theorem*, 2024, arxiv:2405.13431
  - Amendola, Oldekop, *Likelihood Geometry of Reflexive Polytopes*, 2024 arxiv:2311.13572
  - Joswig, Kastner, Lorenz, *Confirmable workflows in Oscar*, 2024, arxiv:2404.06241
- 2023
  - Corey, at al, *Quantum automorphisms of matroids*, 2023, arxiv:2312.13464
  - Berglund et al., *New CalabiYau Manifolds from Genetic Algorithms*, 2023 arxiv:2306.06159
- 2022
  -
  - Fieker, Hofmann, Joswig, *Computing Galois groups of Ehrhart polynomials in OSCAR*, 2022, arxiv:2203.10287
  - Cueto, Markwig, *Combinatorics and real lifts of bitangents to tropical quartic curves*, 2022, arxiv:2004.10891
  - Geiger et al., *Self-dual matroids from canonical curves*, 2022, arxiv:2212.05910
- 2021
  - Geiger, Panizzut, *Computing tropical bitangents to smooth quartic curves in polymake*, 2021, arxiv:2112.04447
- 2020
  - Morrison, Tewari, *Convex lattice polygons with all lattice points visible*, arxiv:2005.04180
- 2019
  - Joswig, Panizzut, Sturmfels, *The Schläfli Fan*, 2019, arxiv:1905.11951



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