Overview

Selected database products overview

Installing Docker

- OS specific instructions at `Install Docker Engine`.
- Windows: Make sure to install Windows Subsystem for Linux version 2 (WSL 2). Install Ubuntu from Microsoft's App store and follow Docker Desktop WSL 2 backend.

Overview

Selected database products overview

➟ Openldap

Why LDAP?

- **Standardized** protocol like HTTP, SMB and others.
- “Glue” connecting an organization's applications and services.
  - Backend data for authentication / SSO, PKI, network FS etc.
  - Meta data repository for users, organisational units, network nodes.

LDAP introduction

- Read the introductory slides at *LDAP* as well.

Overview

Selected database products overview

- Openldap
  - Installation

Running a Docker container

```
docker run --detach (1) \
  --name openldap (2)\
  -p 389:389 \ (3)
  --env LDAP_ORGANISATION="Betrayers heaven" \ (4)
  --env LDAP_TLS=false (5)\
  --env LDAP_DOMAIN="betrayer.com" (6)\
  --env LDAP_ADMIN_PASSWORD="secret" (7)\
  --env LDAP_CONFIG_PASSWORD="secret" (8)\
  --volume ~/OpenLdap/Data:/var/lib/ldap (9)\
  --volume ~/OpenLdap/Config:/etc/ldap/slapd.d (9)\
osixia/openldap:1.4.0 (10)
```

Using docker-compose

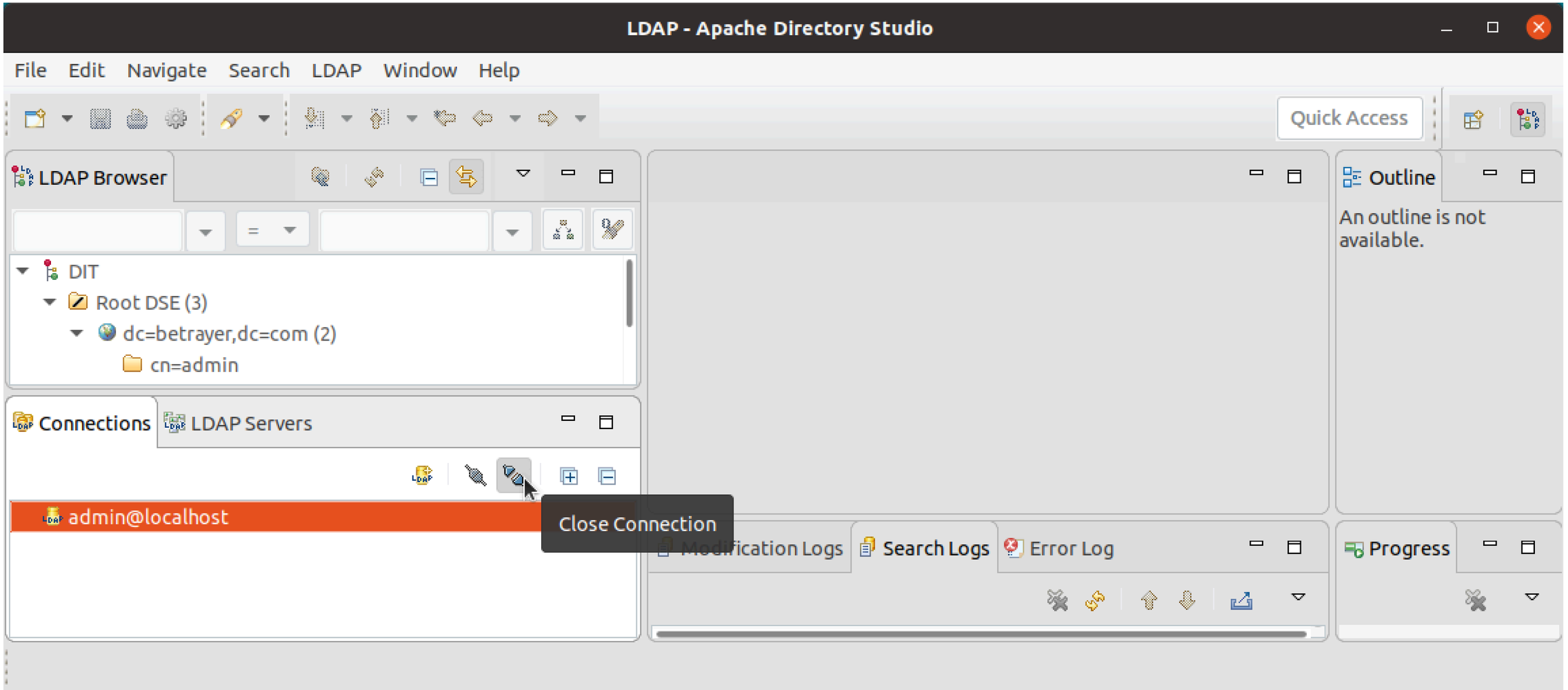
```
version: '3.7'

services:
    openldap:
        image: osixia/openldap:1.4.0
        container_name: openldap
        restart: always
        environment:
            LDAP_ORGANISATION: "Betrayers heaven"
            LDAP_TLS: "false"
            LDAP_DOMAIN: "betrayer.com"
            LDAP_ADMIN_PASSWORD: "secret"
            LDAP_CONFIG_PASSWORD: "secret"
        ports:
            - 389:389
        volumes:
```

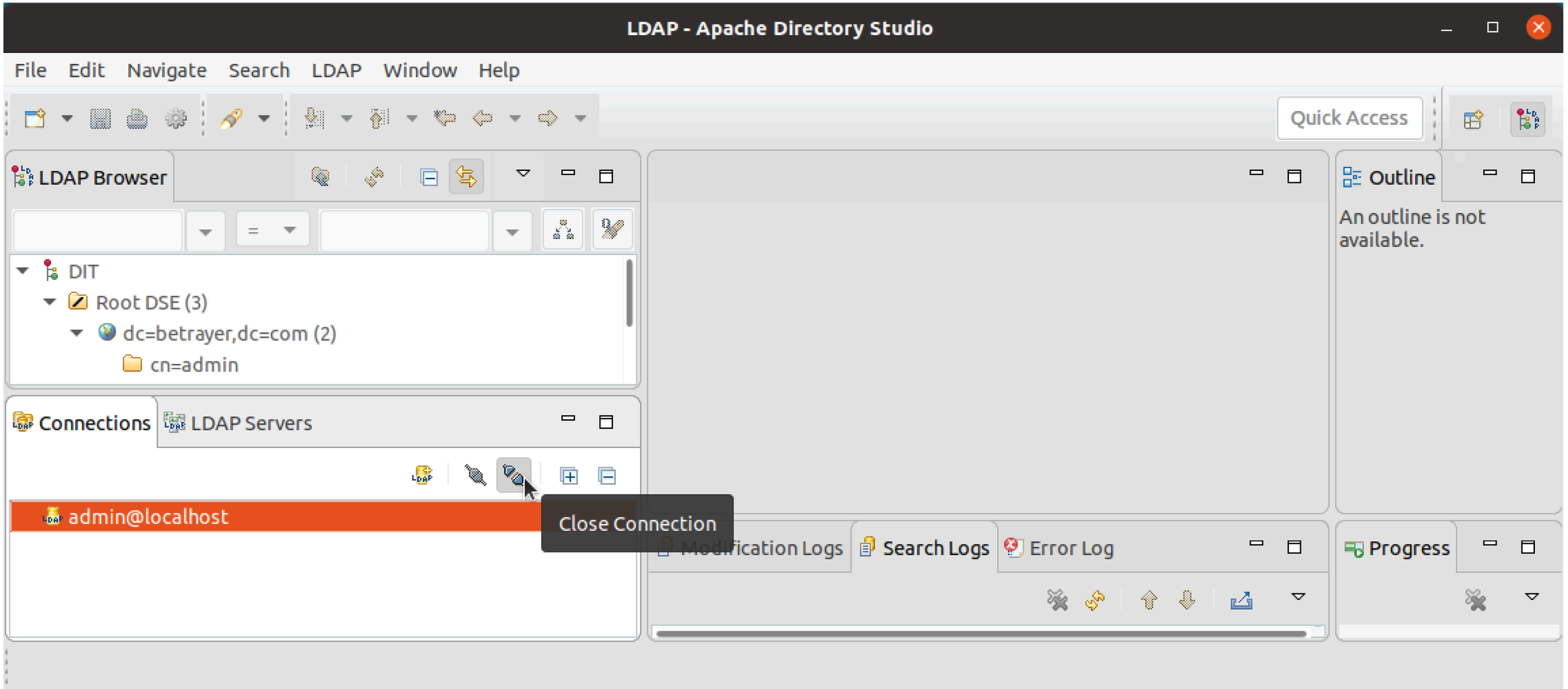
Installing Apache Directory Studio

- Download and install Apache Directory Studio.
- Configure access to your local docker container.

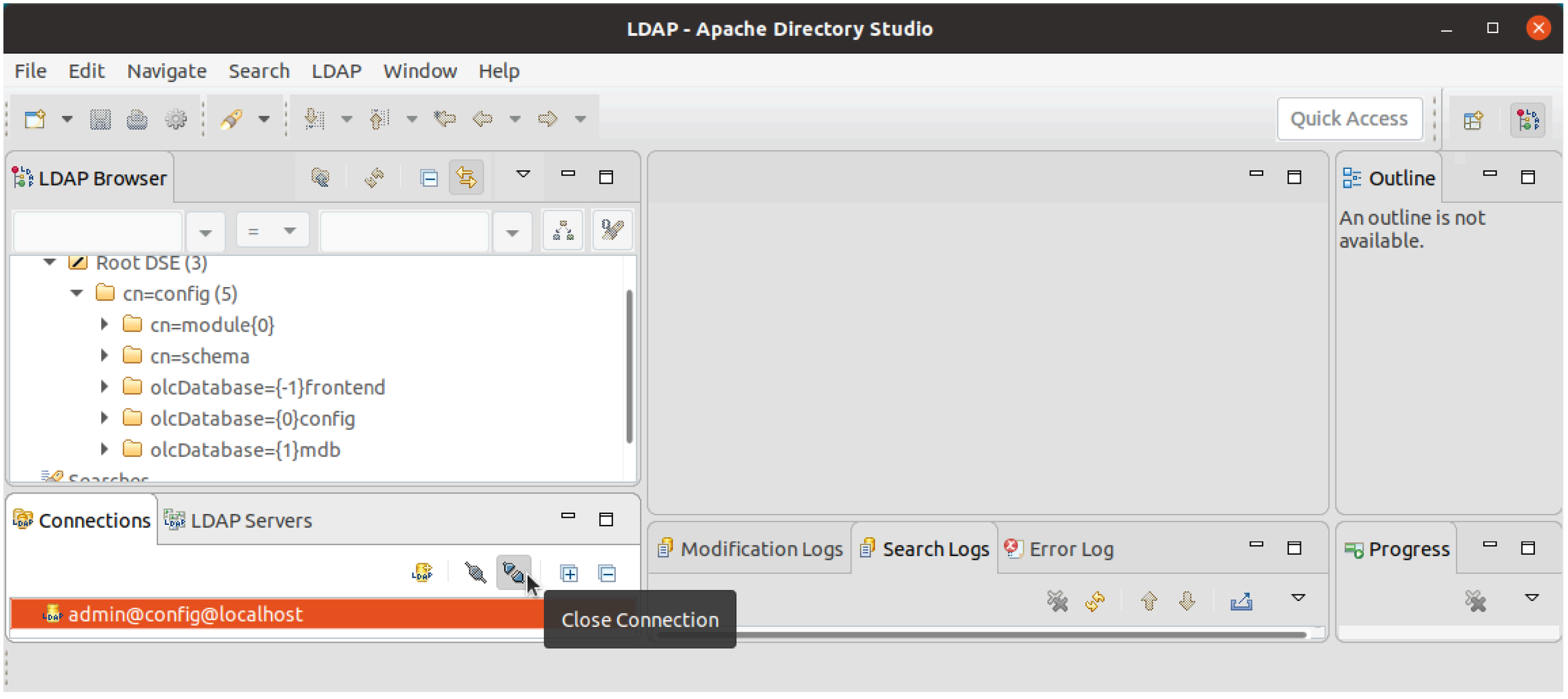
Administrator access to your DIT



Administrator access to your server's data tree



Administrator access to your server's configuration



Overview

Selected database products overview

- Openldap
  - Features

Terminology

- DIT:Document information tree
- DN: An entries distinguished name. Unique identifier.
- RDN: Relative distinguished name. Unique identifier with respect to a given context node.
- Bind operation: Connect to an LDAP service.
    1. anonymous
    2. authenticated

Overview

Selected database products overview

- Openldap
- Features
  - CRUD

Adding an entry

```
dn: uid=smith (1),dc=betrayer,dc=com (2)
changetype: add (3)
objectClass: inetOrgPerson (4)
objectClass: organizationalPerson (4)
objectClass: Person (4)
objectClass: top (4)
uid: smith (5)
cn: Jill Smith (6)
sn: Smith (6)
```

Adding a new attribute

Operation	Result
dn: uid=smith,dc=betrayer,dc=com ❶ changetype: modify ❷ add: **description** ❸ **description**: New employee ❹	dn: uid=smith,dc=betrayer,dc=com objectClass: inetOrgPerson objectClass: organizationalPerson objectClass: person objectClass: top cn: Jill Smith sn: Smith uid: smith **description**: New employee

Replacing an attribute value

Operation	Result
dn: uid=smith,dc=betrayer,dc=com (1) changetype: modify (2) replace: **description** (3) **description**: Long term employee (4)	dn: uid=smith,dc=betrayer,dc=com objectClass: inetOrgPerson objectClass: organizationalPerson objectClass: person objectClass: top cn: Jill Smith sn: Smith uid: smith **description**: Long term employee

Deleting an attribute entirely

Base state	Operation	Result

`dn: uid=smith,dc=betrayer,dc=com`
`...`
`uid: smith`
`commonName: Jill Smith`
`surname: Smith`
`description: Long term employee`
	`dn: uid=smith,dc=...`
	`changetype: modify`
	`delete: description`
		`dn: uid=smith,dc=betrayer,dc=com`
		`...`
		`uid: smith`
		`commonName: Jill Smith`
		`surname: Smith`

Multi valued attributes

Operation	Result

`dn: uid=smith,dc=betrayer,dc=com`
`changetype: modify`
`add: mail` (1)
`mail: smith@company.com` (2)
`mail: jsmith@privateaccount.org` (3)
	`dn: uid=smith,dc=betrayer,dc=com`
	`...`
	`sn: Smith`
	`mail: jsmith@privateaccount.org` (2)
	`mail: smith@company.com` (3)

Set semantics of multivalued attributes

Base state

```
dn: uid=smith,dc=betrayer,dc=com
objectClass: inetOrgPerson
objectClass: organizationalPerso
objectClass: person
objectClass: top
uid: smith
commonName: Jill Smith
surname: Smith
```

Operation

```
dn: uid=smith,dc=betrayer,dc=com
changetype: modify
add: mail (1)
mail: smith@company.com (2)
mail: jsmith@privateaccount.org (3)
mail: smith@company.com (4)

ERR_13207_VALUE_ALREADY_EXISTS (4)
 The value 'smith@company.com' already
 exists in the attribute (mail)
```

Deleting selected attribute values

Base state	Operation	Result
dn: uid=smith,dc=betrayer,dc=com ... cn: Jill Smith mail: jsmith@privateaccount.org mail: **smith@company.com** mail: **anonymous@keeput.org**	dn: uid=smith,dc=... changetype: modify delete: mail mail: **smith@company.com** mail: **anonymous@keeput.org**	**dn**: uid=smith,dc=betrayer,dc=co ... **cn**: Jill Smith **mail**: jsmith@privateaccount.org

Overview

Selected database products overview

- Openldap
  - Features
    - Query

Query scope

- BaseObject
- SingleLevel
- WholeSubtree
- SubordinateSubtree (not yet officially standardized)

Query filter

- Presence: `(cn=*)`
- Equality: `(uid=xy123)`
- Comparison: `(1000 < uidNumber)`
- Substring: `(surname=K*)`
- Approximate Match: `(sn~=gok)`

  (matches `Gack`, `Keck`, `Kubiac`, `Goik`, `Kabbeck`, `Nguyen Quoc`, `Gubic`, `Koc`)

- AND: `(&(5 < uidNumber)(sn=*k*)(gidNumber=1000))`
- OR: `(|(5 < uidNumber)(sn=*k*)(gidNumber=1000))`
- NOT: `(!(5 < uidNumber))`
- Extensible match filters, see Extensible Match Search Filter as well.

Overview

Selected database products overview

- Openldap
  - Features
    - Schema

Schema support

- Objectclass definitions
- Objectclass inheritance. Types:
  - Abstract
  - Structural
  - Auxiliary
- Dynamic instance schema changes
- Single and multivalued attributes
- Attribute data types
- Matching rules (Case sensitive / insensitive, string match, numeric)

Overview

Selected database products overview

- Openldap
  - Features
    - Data access control

Implementations

```
access to attrs=matrikelNr
      by dn="uid=goik,ou=userlist,dc=hdm-stuttgart,dc=de" read
      by dn="uid=kuhn,ou=userlist,dc=hdm-stuttgart,dc=de" read
      by self read
      by * none

access to attrs=userPassword,shadowLastChange,passwordClear
      by dn="uid=Administrator,ou=people,ou=MI,ou=domainlist,dc=hdm-stuttgart,dc=de" read
      by anonymous auth
      by * none
```

Overview

Selected database products overview

- Openldap
  - Features
    - API support

Implementations

- JNDI
- Ldaptive

Overview

- Selected database products overview
  - OpenIdap
    - Exercises

Exercises

1. Work through the exercises the section called “Browse an existing LDAP Server” and the section called “Populating your DIT.” to the section called “Extending an existing entry”.

   > ## Tip
   >
   > When logging in as a non - admin user i.e. using a bind DN like `uid=petra,ou=MIB,ou=MI,dc=betrayer,dc=com` you will not be able to browse your tree. This action requires a permission setting to be changed in `olcDatabase={1}mdb,cn=config of your server's configuration tree`. Follow these steps:
   >
   > 1. Log in to your server's configuration using `cn=admin,cn=config` as in Figure 797, “Administrator access to your server's configuration”.
   > 2. Select your database backend node below `cn=config`.
   > 3. Replace:
   >
   >    ```
   >    to * by dn.exact=gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth manage by * break
   >    ```
   >
   >   By:
   >
   >    ```
   >    to * by dn.exact=gidNumber=0+uidNumber=0,cn=peercred,cn=external,cn=auth manage by * read
   >    ```

Overview

Selected database products overview

➟ Mongodb

Why MongoDB?

- Document oriented (hierarchy support).
- Horizontal scaling (Sharding)
- Large user community
- Major programming languages API support.
- Open Source

Overview

Selected database products overview

- Mongodb
  - Installation

Running a Docker container

```
docker run -d \
  --name localMongoDb (1) \
  -e MONGO_INITDB_ROOT_USERNAME=admin (2) \
  -e MONGO_INITDB_ROOT_PASSWORD=secret (2) \
  -e MONGO_INITDB_DATABASE=admin (3) \
  -v ~/Data/Mongo:/data/db (4) \
  -p 27017:27017 (5) \
  mongo:4.4.1 (6)
```

Using docker-compose

docker-compose.yml

```
version: '3.7'

services:
    mongodb:
        image: mongo:4.4.1
        container_name: mongodb
        restart: always
        environment:
            MONGO_INITDB_ROOT_USERNAME: admin
            MONGO_INITDB_ROOT_PASSWORD: secret
        ports:
            - 27017:27017
        volumes:
            - ./mongo-init.js:/docker-entrypoint-initdb.d/mongo-init.js:ro
```

mongo-init.js

```
db.createUser(
    {
        user: "explorer",
        pwd: "secret",
        roles: [
            {
                role: "readWrite"
                db: "exploredb"
            }
        ],
        passwordDigestor: "server
    }
);
```

```
docker-compose up --build -d
```

Manual user creation (mongo-init.js fail)

```
> mongo -u admin -p secret admin
...
 db.createUser(
...     {
...         user: "explorer",
...         pwd: "secret",
...         roles: [
...             {
...                 role: "readWrite",
...                 db: "exploredb"
...             }
...         ],
...         passwordDigestor: "server"
...     }
... );
Successfully added user: { "user" : "explorer"...
```

Log in as user explorer

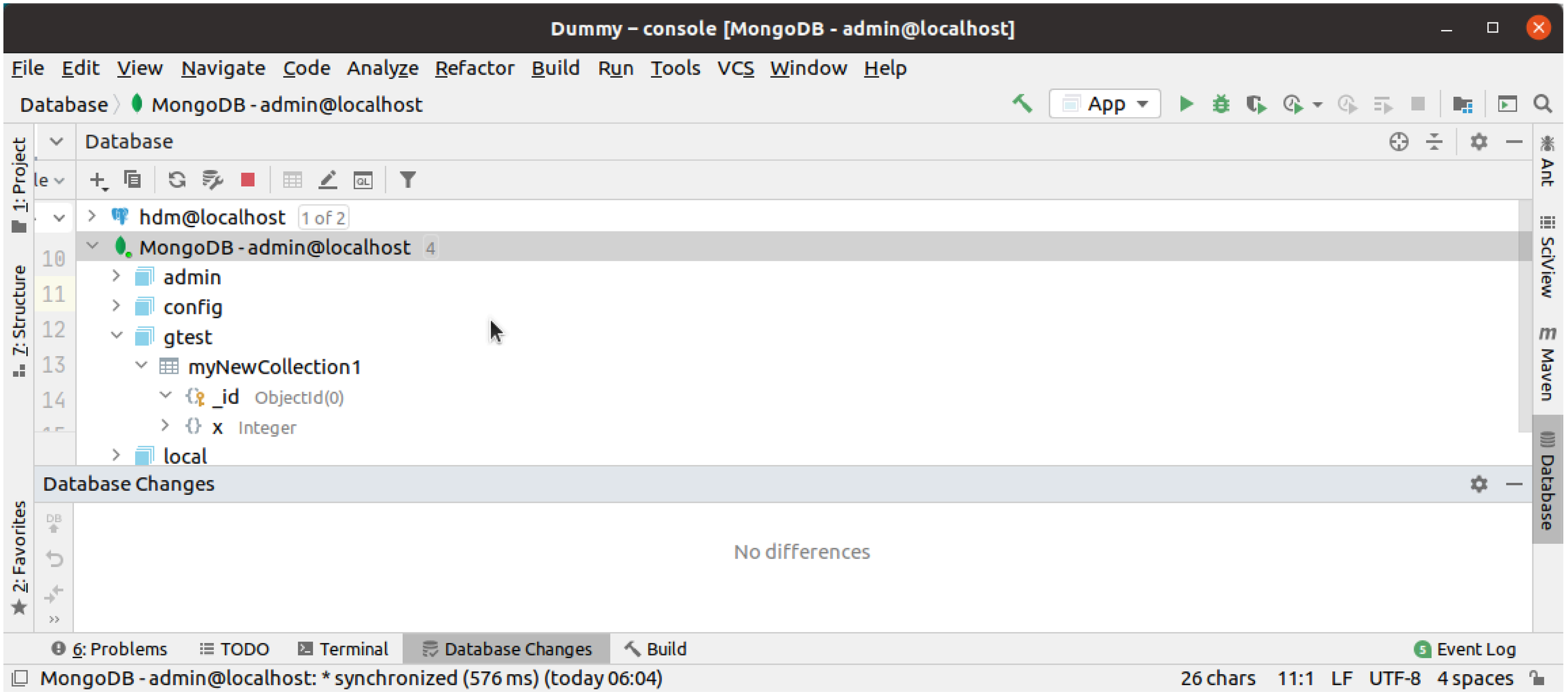
```
> mongo -u explorer -p secret admin
...
> use exploredb
switched to db exploredb

> db.user.insert(
...     { cname: "Eve Gardener",
...         uid: "gardener",
...         email: "gardener@betrayer.com"
...     }
... )
WriteResult({ "nInserted" : 1 })
>
> db.user.find()
{ "_id" : ObjectId("5fa1c79d661a55242658f135"),
  "cname" : "Eve Gardener", "uid" : "gardener", "email" : "gardener@betrayer.com" }
```

Using IntelliJ

- View --> Tool Windows --> Database
- Data Source --> MongoDB

Idea show all databases



Overview

Selected database products overview

- Mongodb
  - Features

Terminology / Hierarchy

- MongoDB Server
  - **Database**
    - **Collection** : Similar to tables in SQL.
      - **Document**: Similar to records in SQL.

```
> mongo -u explorer -p secret admin

> use exploredb

> db.user.insert(
    { cname: "Eve Gardener",
      uid: "gardener",
      email: "gardener@betrayer.com"
    }
 )
```

Overview

Selected database products overview

- Mongodb
- Features
- CRUD

Adding a document

Code	Result

`db.group.insert(`
`  {`
`  cname: "All users",`
`  gid: "users",`
`  }`
`)`
	`db.group.find()`
	
	`[`
	`  {`
	`  "_id": {"$oid": "5fa3035932b87a0c60a6ed1a"},`
	`  "cname": "New users",`
	`  "gid": "users"`
	`  }`
	`]`

Updating attributes

Code	Result

`db.group.update(`
` {_id: ObjectId(`
`  "5fa3035932b87a0c60a6ed1a")},`
` { $set:`
`  {`
`  cname: "New users" (1),`
`  gidNumber: 1000 (2)`
`  }`
` }`
`)`
	`db.group.find()`
	`[`
	`  {`
	`  "_id": {"$oid":`
	`  "5fa3035932b87a0c60a6ed1a"},`
	`  cname: "New users" (1),`
	`  "gid": "users",`
	`  "gidNumber": 1000 (2)`
	`  }`
	`]`

Deleting a document

Code	Result
`db.group.deleteOne( {"_id": ObjectId("5fa3035932b87a0c60a6ed1a")});`	`[ { "acknowledged": true, "deletedCount": 1 } ]`

Deleting multiple documents

Code	Result
`db.group.deleteMany({});`	`[ { "acknowledged": true, "deletedCount": 23 } ]`

Multi valued attributes

Set semantics of multivalued attributes

Deleting selected attribute values

Deleting an attribute

Code

```
db.group.update(
    {_id: ObjectId(
    "5fa3035932b87a0c60a6ed1a")},

    { $unset:
            {
                gidNumber: 42 (1)
            }
    }
)
```

Result

```
db.group.find()

[
  {
    "_id": {"$oid":
     "5fa3035932b87a0c60a6ed1a"},
    "cname": "My users",
    "gid": "users"
  }
]
```

Overview

Selected database products overview

- Mongodb
  - Features
    - Query

Query filter

Overview

Selected database products overview

- Mongodb
  - Features
    - Schema

Schema validation support

```
db.runCommand( {
  collMod: "group",
  validator: { $jsonSchema: {
     bsonType: "object",
     required: [ "cname", "gid" ],
        properties: {
          cname: {
              bsonType: "string",
              description:
              "A group's common name
          },
          gid: {
             bsonType: "string",
             description:
             "A group's short name
          }
        }
     }
  },
  validationLevel: "moderate"
})
```

Violating required field

```
db.group.insert(
 {
   cname: "Extra users"
 }
)
```

```
... Bulk write operation error on server localhost:27017.
Write errors: [BulkWriteError{index=0, code=121,
    message='Document failed validation', details={}}].
```

Schema types

See BSON Types for reference.

Enforcing unique keys

```
db.group.createIndex({
   "cname": 1
  },
  {
      unique: true
})

db.group.insert({cname: "Extra users"
  ...
  }
)
```

```
com.mongodb.MongoBulkWriteException:
Bulk write operation error on server localhost:27017.
Write errors: [BulkWriteError{index=0, code=11000,
message='E11000 duplicate key error collection:
exploredb.group index: cname_1 dup key:
  { cname: "Extra users" }', details={}}].
```

On the downside

- No way to enforce referential integrity rules.

Overview

Selected database products overview

- Mongodb
  - Features
    - Data access control

Implementations

Overview

Selected database products overview

- Mongodb
  - Features
    - API support

Implementations

Overview

Selected database products overview

- Mongodb
  - High performance sharding cluster

Sharding rationale

- Problem: Large datasets / high throughput
- Two alternatives:
  - Vertical scaling: RAM, cpu,...
  - Horizontal scaling: Load distribution by multiple nodes.

Sharding rationale

See sharded-cluster for details.

Overview

Selected database products overview

- Mongodb
  - Exercises

Exercises

1.

2.