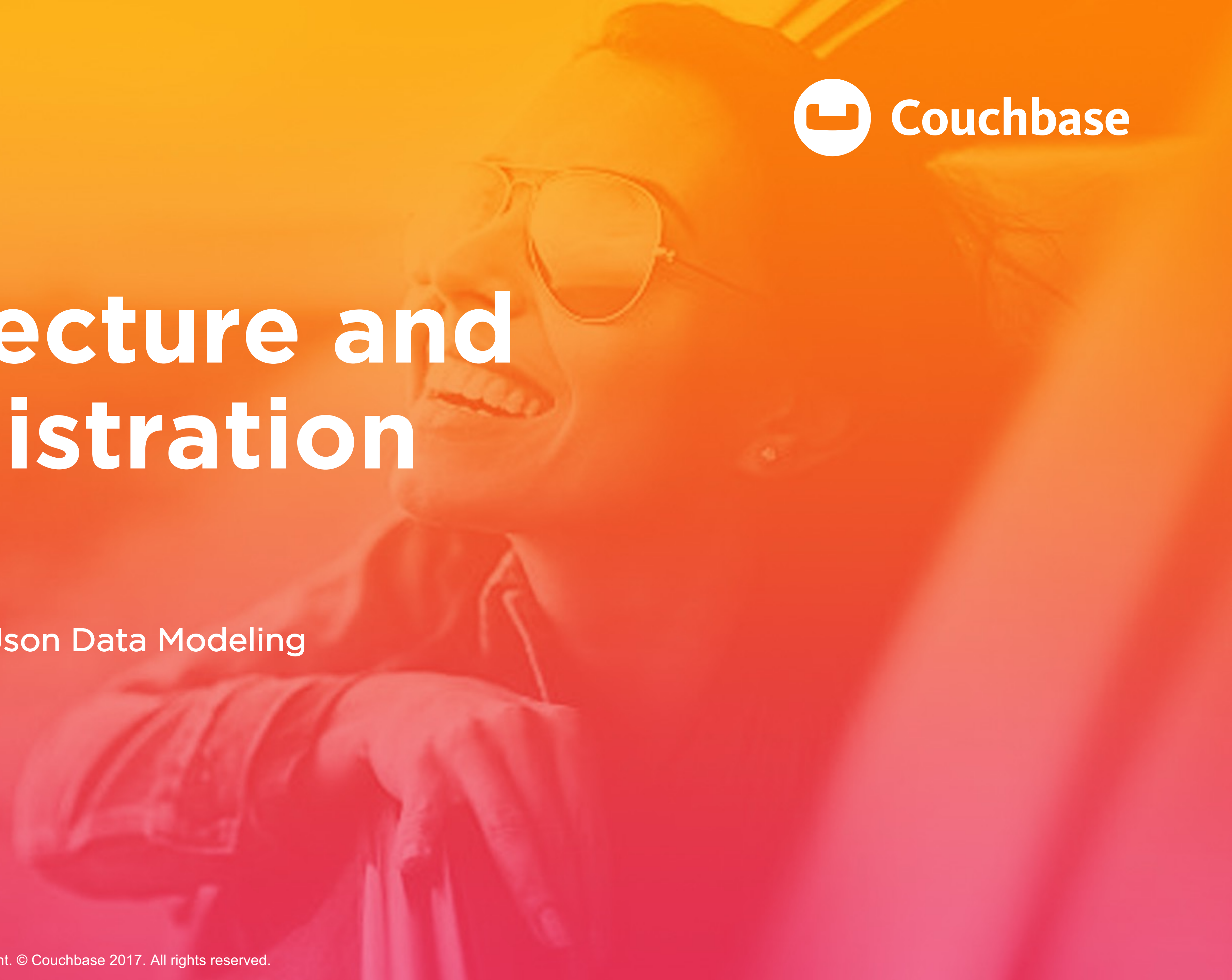
Couchbase



Architecture and Administration Basics

Workshop Day 2 – Json Data Modeling

1 | JSON Document Design

JSON is all the rage these days

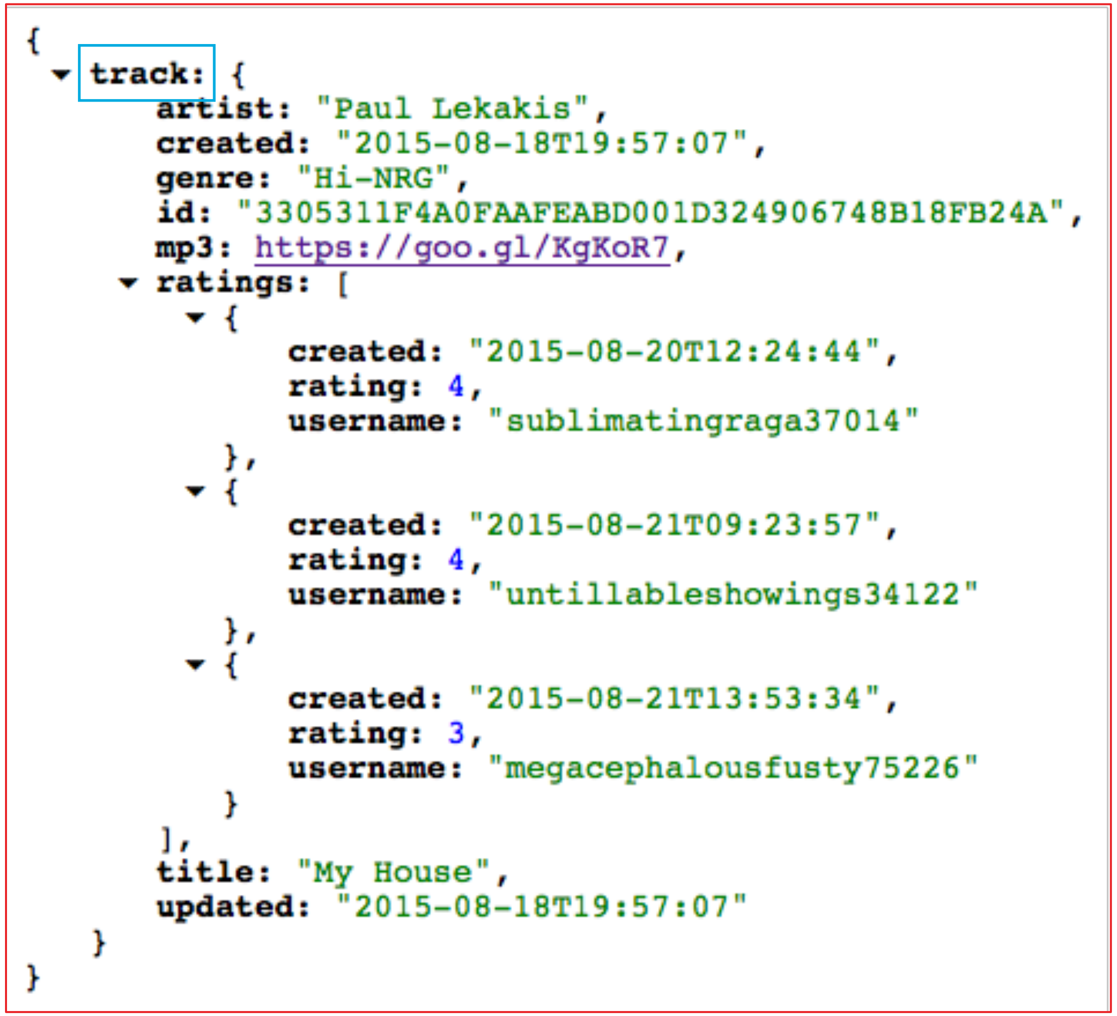
- JSON has (thankfully) replaced XML as the most common format used in APIs
- JSON is particularly useful for JavaScript apps since the data can be easily serialized/deserialized
- JSON has a number of supporting technologies such as JSONPath, JSON Schema and GeoJSON
- JSON does have several worthy competitors including BSON, YAML, Avro, Protocol Buffers and MessagePack
- JSON serialization libraries exist for most popular programming languages

JSON Design Choices

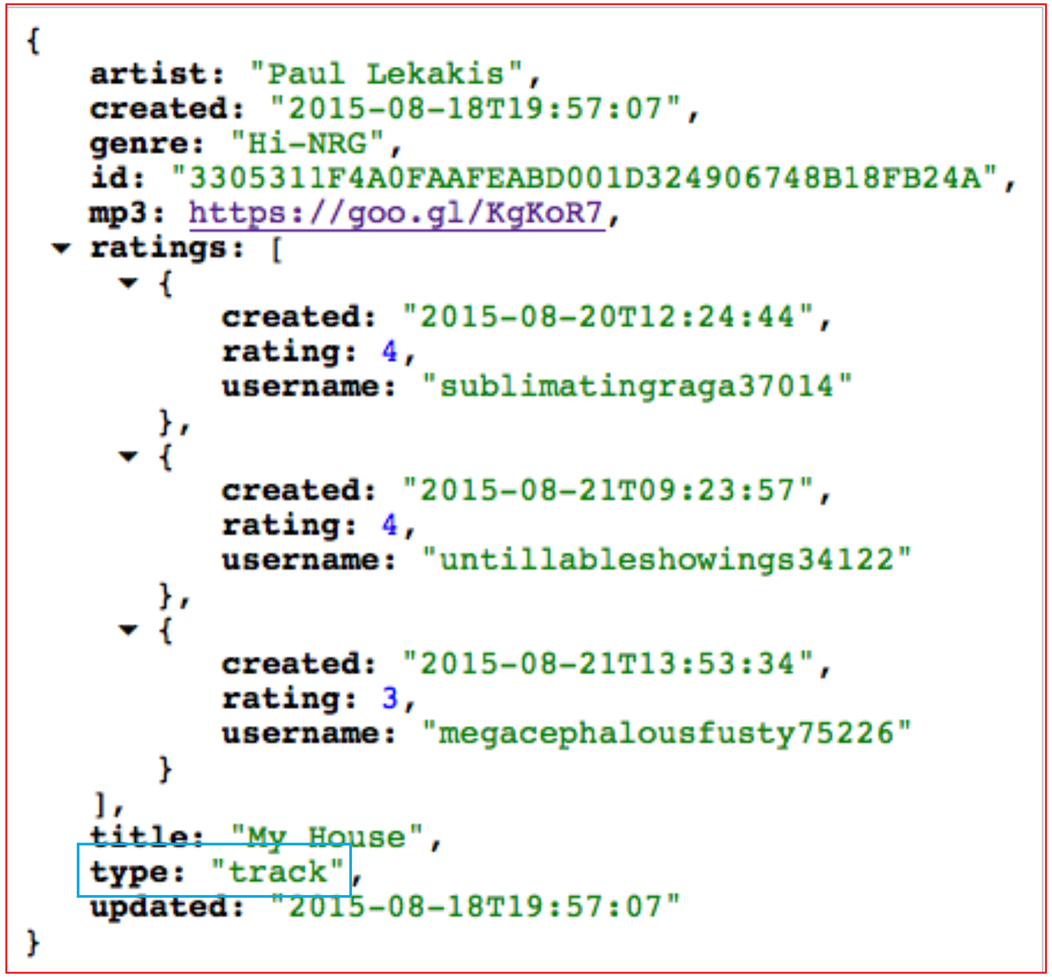
- Single Root Attributes vs. "type"/"class" parameter
- Objects vs. Arrays
- Array Element Types
- Timestamp Formats
- Property Names
- Empty and Null Property Values
- JSON Schema

Single Root Attributes

- A choice between two styles:



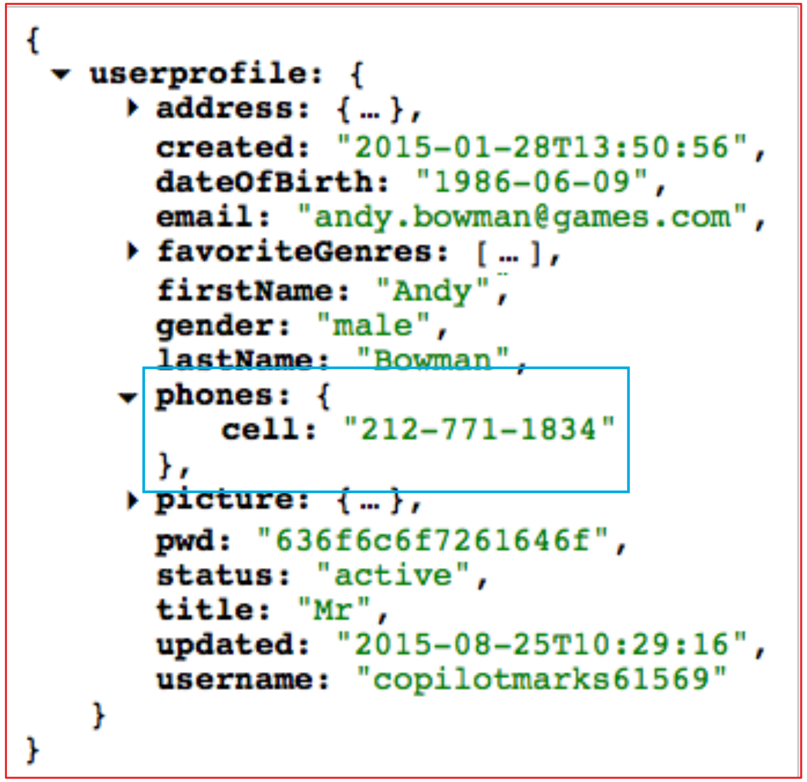
```
{
  track: {
        artist: "Paul Lekakis",
        created: "2015-08-18T19:57:07",
        genre: "Hi-NRG",
        id: "3305311F4A0FAAFEABD001D324906748B18FB24A",
        mp3: https://goo.gl/KgKoR7,
        ratings: [
            {
                created: "2015-08-20T12:24:44",
                rating: 4,
                username: "sublimatingraga37014"
            },
            {
                created: "2015-08-21T09:23:57",
                rating: 4,
                username: "untillableshowings34122"
            },
            {
                created: "2015-08-21T13:53:34",
                rating: 3,
                username: "megacephalousfusty75226"
            }
        ],
        title: "My House",
        updated: "2015-08-18T19:57:07"
    }
}
```



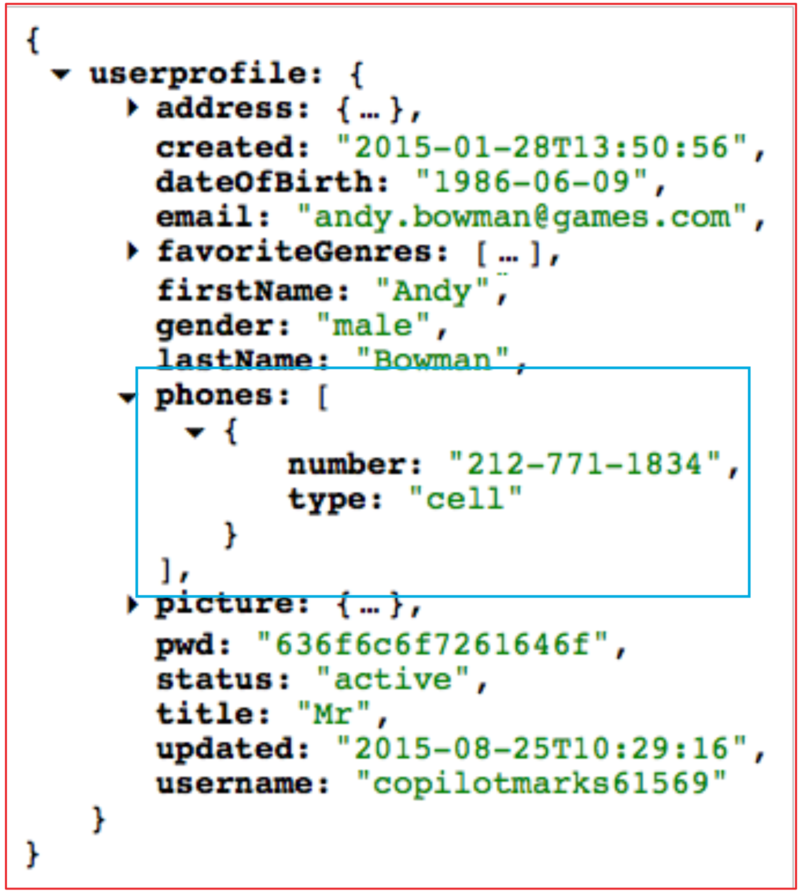
```
{
    artist: "Paul Lekakis",
    created: "2015-08-18T19:57:07",
    genre: "Hi-NRG",
    id: "3305311F4A0FAAFEABD001D324906748B18FB24A",
    mp3: https://goo.gl/KgKoR7,
  ratings: [
      {
            created: "2015-08-20T12:24:44",
            rating: 4,
            username: "sublimatingraga37014"
        },
      {
            created: "2015-08-21T09:23:57",
            rating: 4,
            username: "untillableshowings34122"
        },
      {
            created: "2015-08-21T13:53:34",
            rating: 3,
            username: "megacephalousfusty75226"
        }
    ],
    title: "My House",
    type: "track",
    updated: "2015-08-18T19:57:07"
}
```

Objects vs. Arrays

- Two different ways to represent attributes:



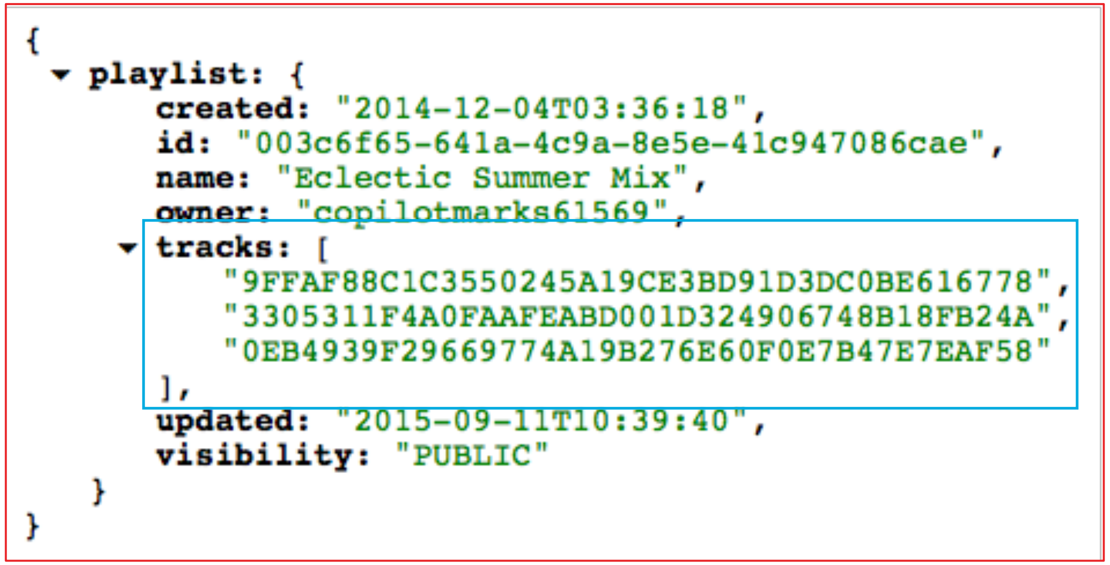
```
{
 ▾ userprofile: {
     ▸ address: {…},
       created: "2015-01-28T13:50:56",
       dateOfBirth: "1986-06-09",
       email: "andy.bowman@games.com",
     ▸ favoriteGenres: [ … ],
       firstName: "Andy",
       gender: "male",
       lastName: "Bowman",
     ▾ phones: {
           cell: "212-771-1834"
       },
     ▸ picture: {…},
       pwd: "636f6c6f7261646f",
       status: "active",
       title: "Mr",
       updated: "2015-08-25T10:29:16",
       username: "copilotmarks61569"
   }
}
```



```
{
 ▾ userprofile: {
     ▸ address: {…},
       created: "2015-01-28T13:50:56",
       dateOfBirth: "1986-06-09",
       email: "andy.bowman@games.com",
     ▸ favoriteGenres: [ … ],
       firstName: "Andy",
       gender: "male",
       lastName: "Bowman",
     ▾ phones: [
         ▾ {
               number: "212-771-1834",
               type: "cell"
           }
       ],
     ▸ picture: {…},
       pwd: "636f6c6f7261646f",
       status: "active",
       title: "Mr",
       updated: "2015-08-25T10:29:16",
       username: "copilotmarks61569"
   }
}
```

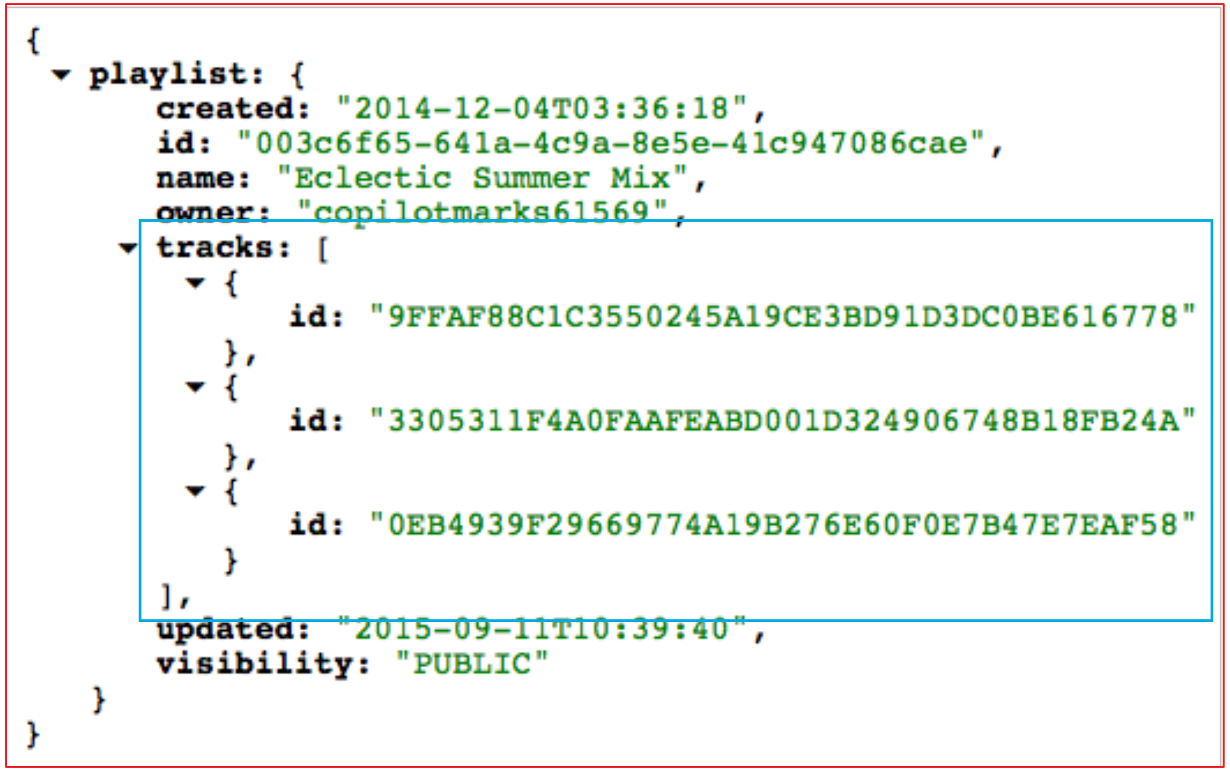
Array Element Types

- Array elements can be simple types, objects or arrays:



```
{
  ▾ playlist: {
        created: "2014-12-04T03:36:18",
        id: "003c6f65-641a-4c9a-8e5e-41c947086cae",
        name: "Eclectic Summer Mix",
        owner: "copilotmarks61569",
      ▾ tracks: [
            "9FFAF88C1C3550245A19CE3BD91D3DC0BE616778",
            "3305311F4A0FAAFEABD001D324906748B18FB24A",
            "0EB4939F29669774A19B276E60F0E7B47E7EAF58"
        ],
        updated: "2015-09-11T10:39:40",
        visibility: "PUBLIC"
    }
}
```

Array of strings

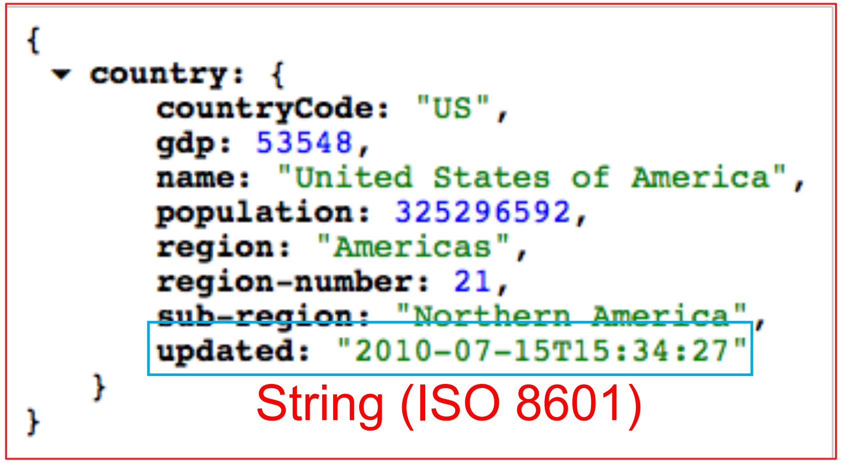


```
{
  ▾ playlist: {
        created: "2014-12-04T03:36:18",
        id: "003c6f65-641a-4c9a-8e5e-41c947086cae",
        name: "Eclectic Summer Mix",
        owner: "copilotmarks61569",
      ▾ tracks: [
          ▾ {
                id: "9FFAF88C1C3550245A19CE3BD91D3DC0BE616778"
            },
          ▾ {
                id: "3305311F4A0FAAFEABD001D324906748B18FB24A"
            },
          ▾ {
                id: "0EB4939F29669774A19B276E60F0E7B47E7EAF58"
            }
        ],
        updated: "2015-09-11T10:39:40",
        visibility: "PUBLIC"
    }
}
```

Array of objects

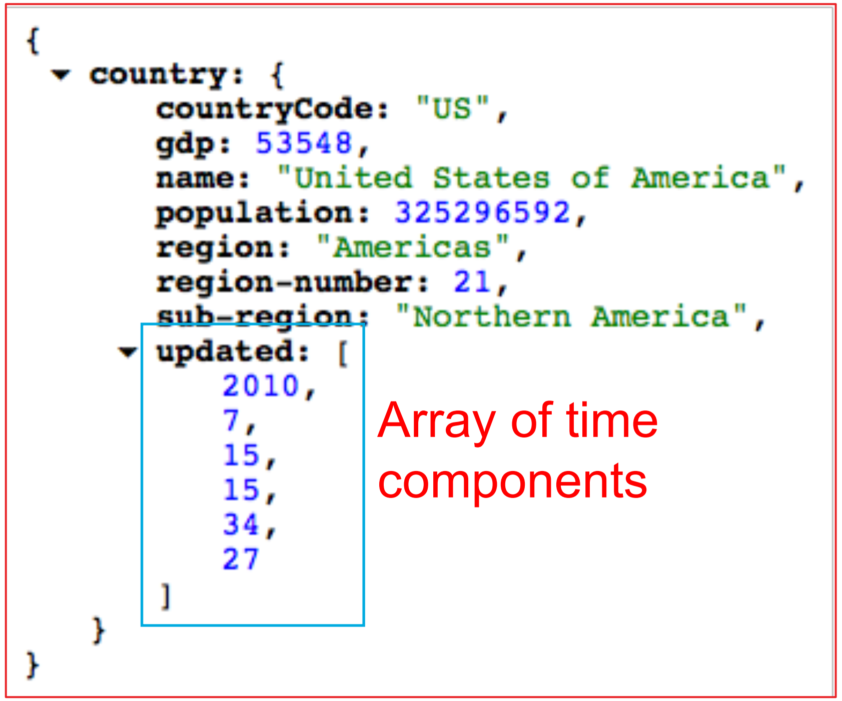
Timestamp Formats

- When storing timestamps, you have at least 3 options:



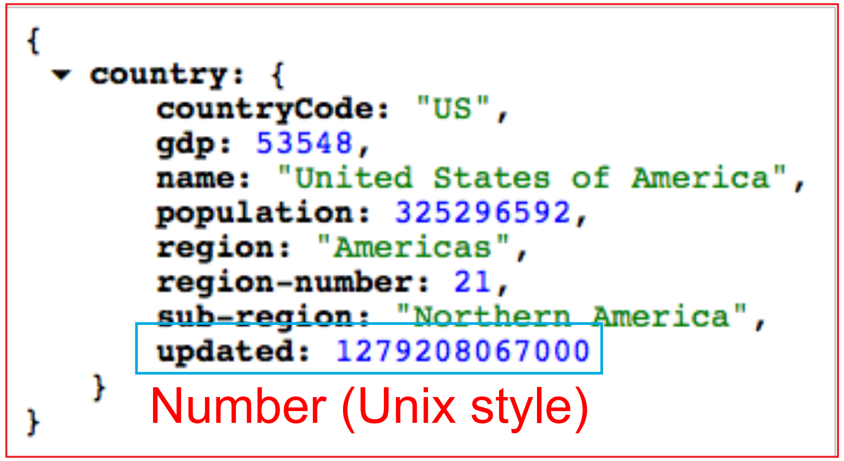
```
{
 ▾ country: {
       countryCode: "US",
       gdp: 53548,
       name: "United States of America",
       population: 325296592,
       region: "Americas",
       region-number: 21,
       sub-region: "Northern America",
       updated: "2010-07-15T15:34:27"
   }
}
```

String (ISO 8601)



```
{
 ▾ country: {
       countryCode: "US",
       gdp: 53548,
       name: "United States of America",
       population: 325296592,
       region: "Americas",
       region-number: 21,
       sub-region: "Northern America",
     ▾ updated: [
           2010,
           7,
           15,
           15,
           34,
           27
       ]
   }
}
```

Array of time components



```
{
 ▾ country: {
       countryCode: "US",
       gdp: 53548,
       name: "United States of America",
       population: 325296592,
       region: "Americas",
       region-number: 21,
       sub-region: "Northern America",
       updated: 1279208067000
   }
}
```

Number (Unix style)

- Make timestamp values relative to UTC

Property Names

- Choose meaningful property names
- Be consistent in naming properties
  - e.g. country_code vs. countryCode (preferred)
- Array types should have plural property names
- All other property names should be singular
- Avoid (if possible) reserved words in your database system and programming language(s)
  - e.g. \`user\` // Reserved word in Couchbase Server
- Avoid (if possible) special characters such as hypens
  - e.g. \`region-number\` // Contains a hyphen

Empty and Null Property Values

- Keep in mind that JSON supports optional properties
- If a property has a null value, consider dropping it from the JSON, unless there's a good reason not to
- N1QL makes it easy to test for missing or null property values

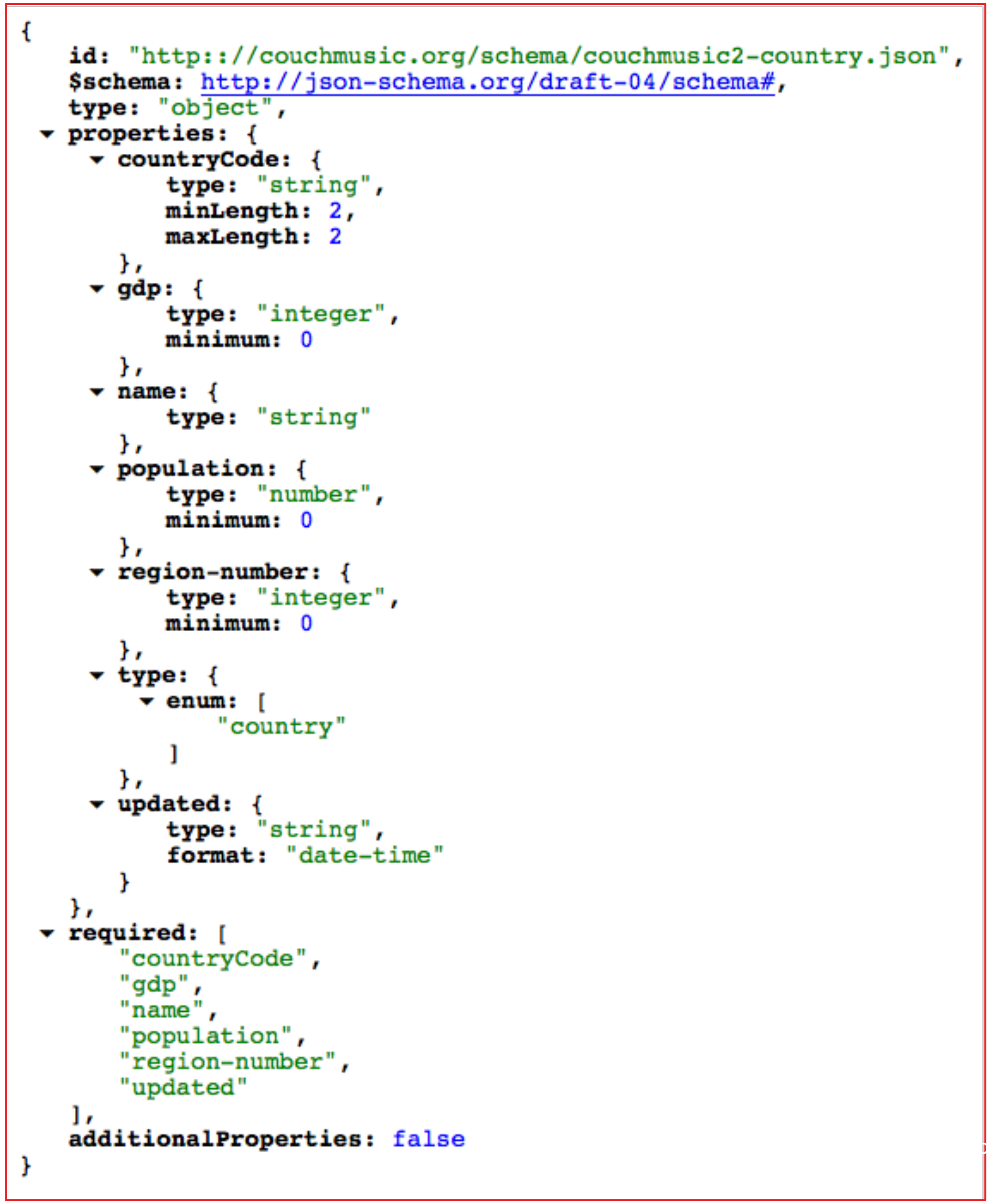
```
SELECT * FROM couchmusic1 WHERE userprofile.address IS NULL;

SELECT * FROM couchmusic1 WHERE userprofile.gender IS MISSING;
```

- Be sure your application code handles the case where a property value is missing

JSON Schema

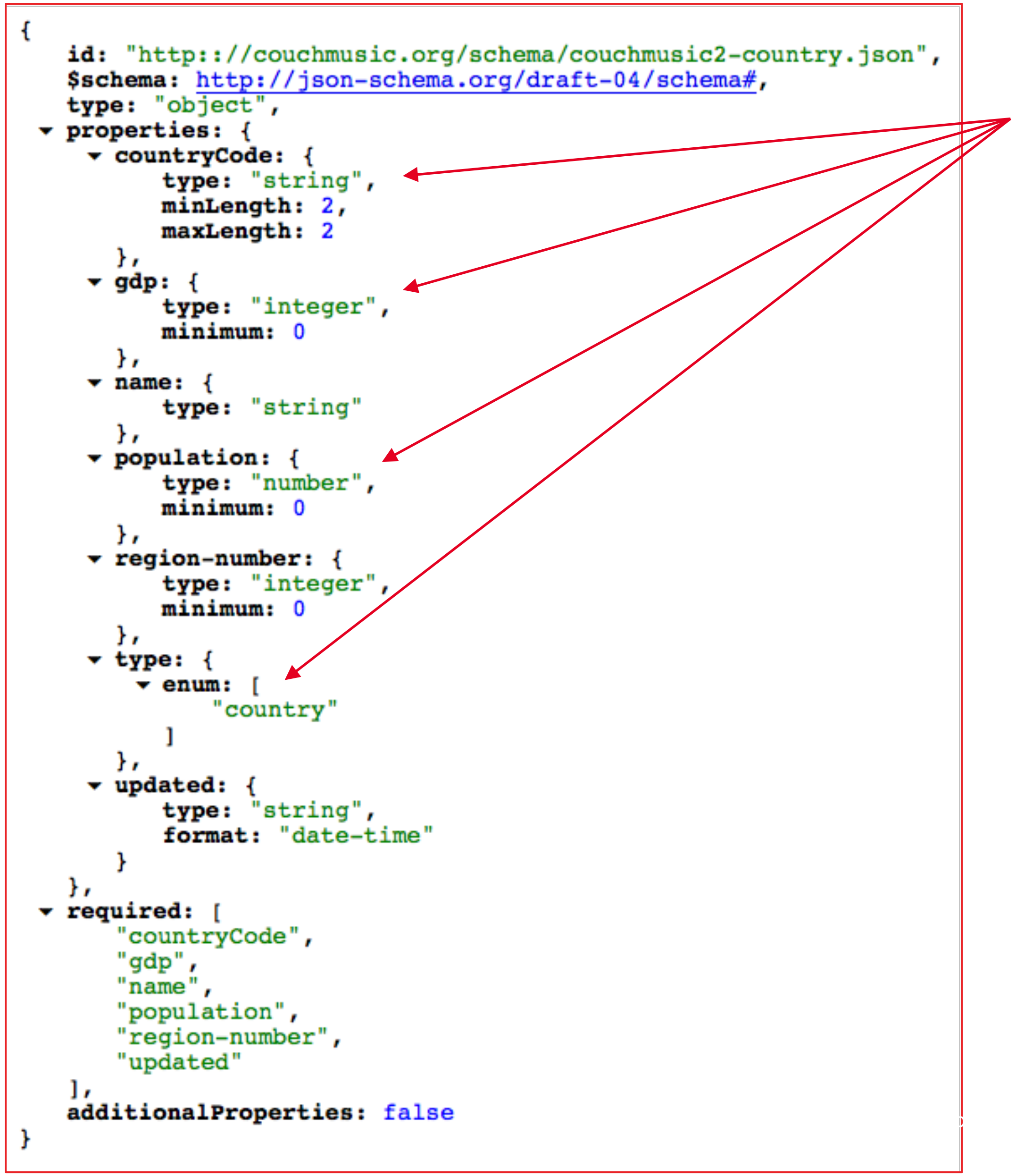
- Couchbase Server pays absolutely no attention to the shape of your JSON documents so long as they are well-formed
- There are times when it is useful to validate that a JSON document conforms to some expected shape
- JSON Schema is a JSON-based format for defining the structure of JSON data
- There are implementations for most popular programming languages
- Learn more here: http://json-schema.org

Example of JSON Schema



```
{
   id: "http://couchmusic.org/schema/couchmusic2-country.json",
   $schema: http://json-schema.org/draft-04/schema#,
   type: "object",
   properties: {
      countryCode: {
         type: "string",
         minLength: 2,
         maxLength: 2
      },
      gdp: {
         type: "integer",
         minimum: 0
      },
      name: {
         type: "string"
      },
      population: {
         type: "number",
         minimum: 0
      },
      region-number: {
         type: "integer",
         minimum: 0
      },
      type: {
         enum: [
            "country"
         ]
      },
      updated: {
         type: "string",
         format: "date-time"
      }
   },
   required: [
      "countryCode",
      "gdp",
      "name",
      "population",
      "region-number",
      "updated"
   ],
   additionalProperties: false
}
```

Example of JSON Schema – Type Specification

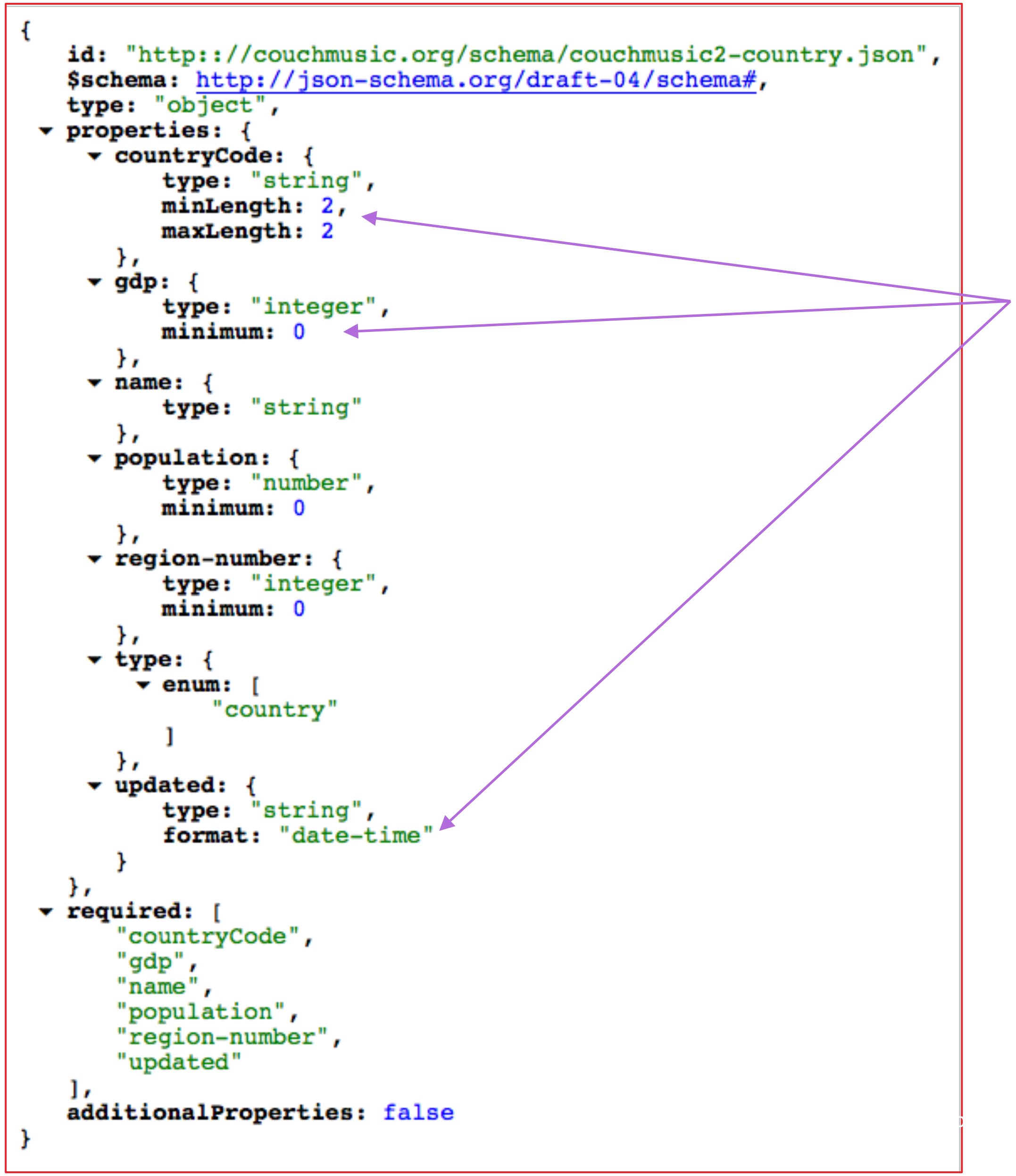


```
{
    id: "http://couchmusic.org/schema/couchmusic2-country.json",
    $schema: http://json-schema.org/draft-04/schema#,
    type: "object",
  ▾ properties: {
      ▾ countryCode: {
            type: "string",
            minLength: 2,
            maxLength: 2
        },
      ▾ gdp: {
            type: "integer",
            minimum: 0
        },
      ▾ name: {
            type: "string"
        },
      ▾ population: {
            type: "number",
            minimum: 0
        },
      ▾ region-number: {
            type: "integer",
            minimum: 0
        },
      ▾ type: {
          ▾ enum: [
                "country"
            ]
        },
      ▾ updated: {
            type: "string",
            format: "date-time"
        }
    },
  ▾ required: [
        "countryCode",
        "gdp",
        "name",
        "population",
        "region-number",
        "updated"
    ],
    additionalProperties: false
}
```

Available type specifications include:

- array
- boolean
- integer
- number
- object
- string
- enum

Example of JSON Schema – Type Specific Validation

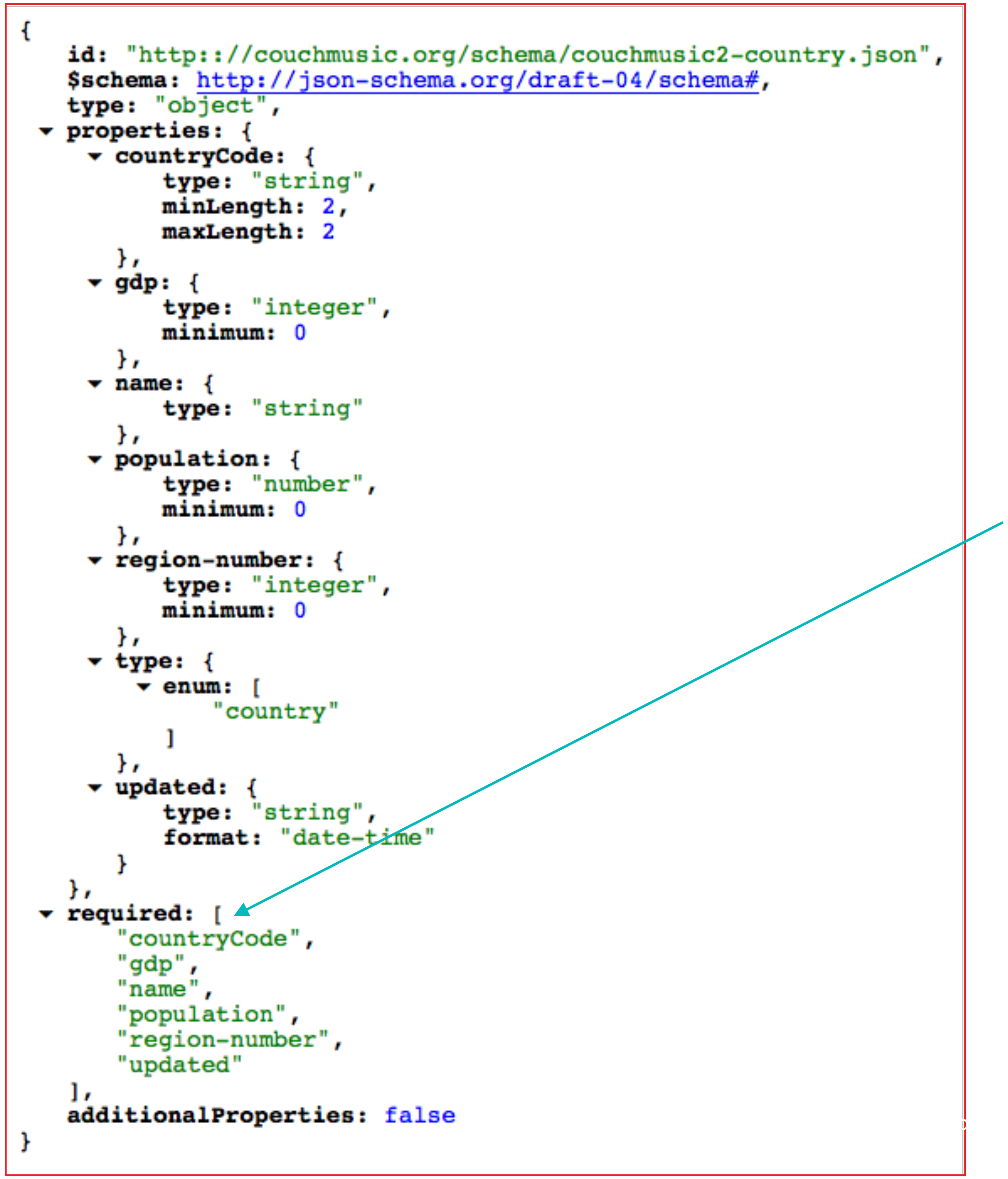


```
{
    id: "http://couchmusic.org/schema/couchmusic2-country.json",
    $schema: http://json-schema.org/draft-04/schema#,
    type: "object",
  ▾ properties: {
      ▾ countryCode: {
            type: "string",
            minLength: 2,
            maxLength: 2
        },
      ▾ gdp: {
            type: "integer",
            minimum: 0
        },
      ▾ name: {
            type: "string"
        },
      ▾ population: {
            type: "number",
            minimum: 0
        },
      ▾ region-number: {
            type: "integer",
            minimum: 0
        },
      ▾ type: {
          ▾ enum: [
                "country"
            ]
        },
      ▾ updated: {
            type: "string",
            format: "date-time"
        }
    },
  ▾ required: [
        "countryCode",
        "gdp",
        "name",
        "population",
        "region-number",
        "updated"
    ],
    additionalProperties: false
}
```

Type specific validations include:

- minimum
- maximum
- minLength
- maxLength
- format
- pattern

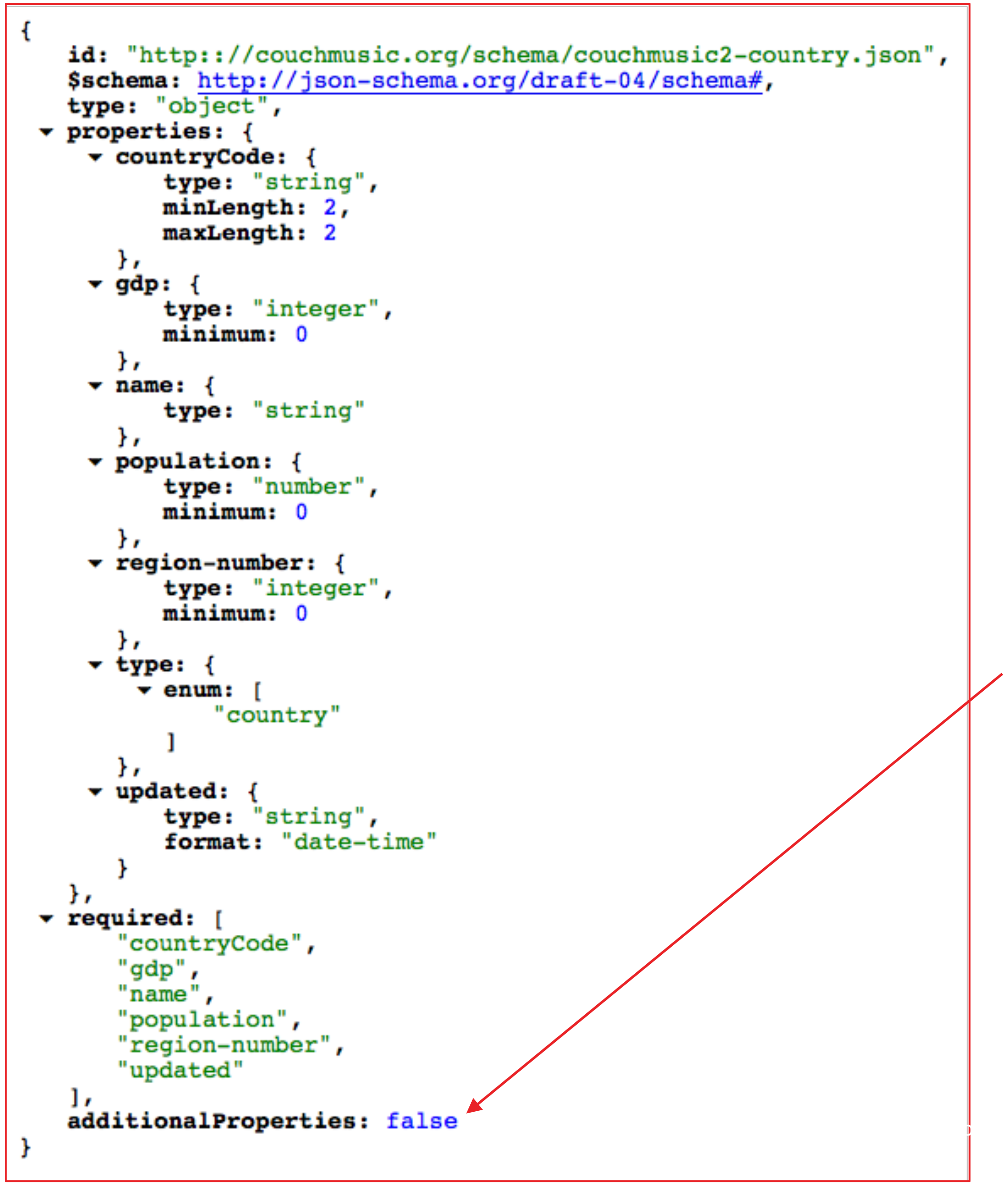
Example of JSON Schema – Required Properties



```
{
   id: "http://couchmusic.org/schema/couchmusic2-country.json",
   $schema: http://json-schema.org/draft-04/schema#,
   type: "object",
   properties: {
       countryCode: {
           type: "string",
           minLength: 2,
           maxLength: 2
       },
       gdp: {
           type: "integer",
           minimum: 0
       },
       name: {
           type: "string"
       },
       population: {
           type: "number",
           minimum: 0
       },
       region-number: {
           type: "integer",
           minimum: 0
       },
       type: {
           enum: [
               "country"
           ]
       },
       updated: {
           type: "string",
           format: "date-time"
       }
   },
   required: [
       "countryCode",
       "gdp",
       "name",
       "population",
       "region-number",
       "updated"
   ],
   additionalProperties: false
}
```

Required properties can be specified for each object

Example of JSON Schema – Additional Properties



```
{
   id: "http://couchmusic.org/schema/couchmusic2-country.json",
   $schema: http://json-schema.org/draft-04/schema#,
   type: "object",
   properties: {
     countryCode: {
         type: "string",
         minLength: 2,
         maxLength: 2
     },
     gdp: {
         type: "integer",
         minimum: 0
     },
     name: {
         type: "string"
     },
     population: {
         type: "number",
         minimum: 0
     },
     region-number: {
         type: "integer",
         minimum: 0
     },
     type: {
       enum: [
           "country"
         ]
     },
     updated: {
         type: "string",
         format: "date-time"
     }
   },
   required: [
     "countryCode",
     "gdp",
     "name",
     "population",
     "region-number",
     "updated"
   ],
   additionalProperties: false
}
```

Additional properties can be disabled

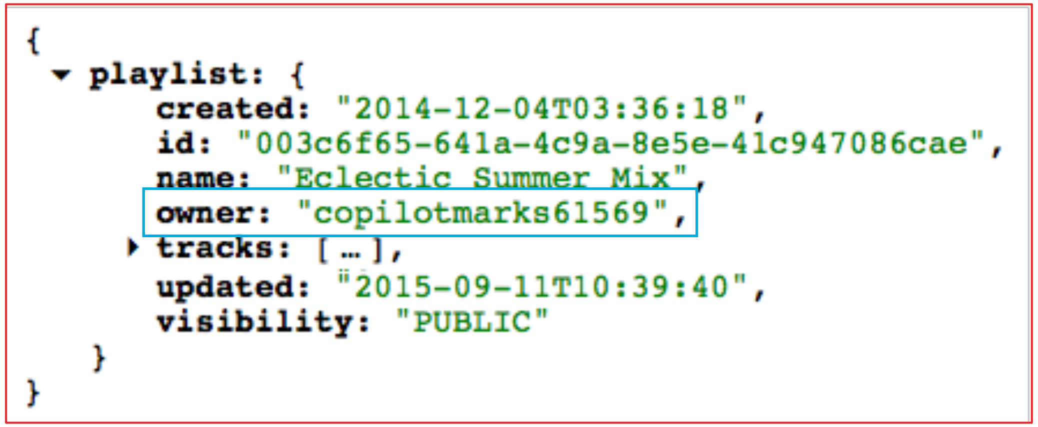
2 | Data Nesting

Data Nesting (aka Denormalization)

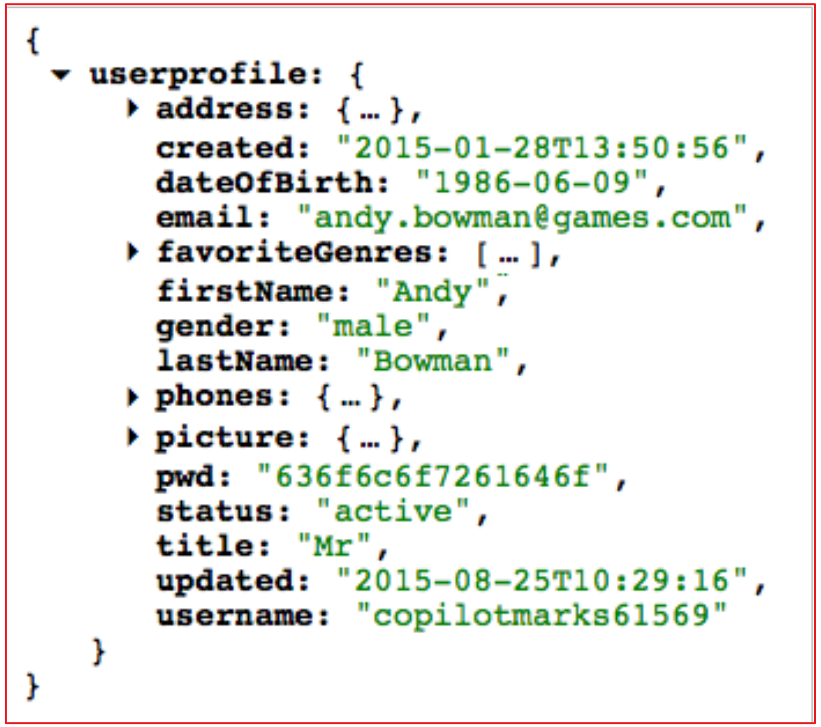
- As you know, relational database design promotes separating data using normalization, which doesn't scale
- For NoSQL systems, we often avoid normalization so that we can scale
- Nesting allows related objects to be organized into a hierarchical tree structure where you can have multiple levels of grouping
- Rule of thumb is to nest no more than 3 levels deep unless there is a very good reason to do so
- You will often want to include a timestamp in the nested data

Example #1 of Data Nesting

- Playlist with owner attribute containing username of corresponding userprofile



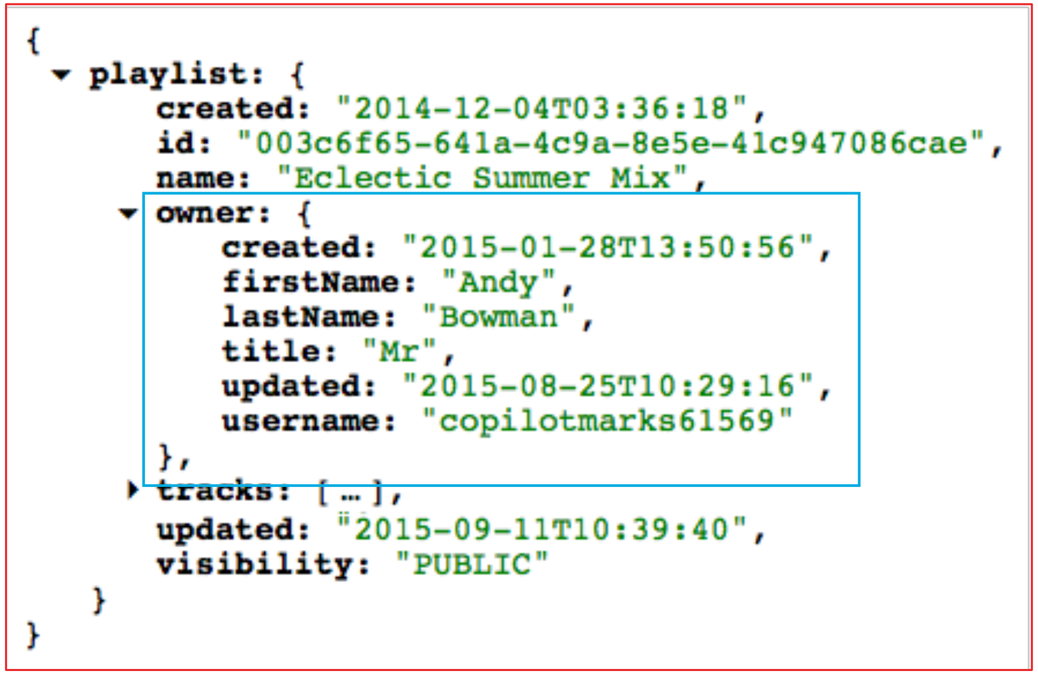
```
{
  ▾ playlist: {
        created: "2014-12-04T03:36:18",
        id: "003c6f65-641a-4c9a-8e5e-41c947086cae",
        name: "Eclectic Summer Mix",
        owner: "copilotmarks61569",
      ▸ tracks: [ … ],
        updated: "2015-09-11T10:39:40",
        visibility: "PUBLIC"
    }
}
```



```
{
  ▾ userprofile: {
      ▸ address: { … },
        created: "2015-01-28T13:50:56",
        dateOfBirth: "1986-06-09",
        email: "andy.bowman@games.com",
      ▸ favoriteGenres: [ … ],
        firstName: "Andy",
        gender: "male",
        lastName: "Bowman",
      ▸ phones: { … },
      ▸ picture: { … },
        pwd: "636f6c6f7261646f",
        status: "active",
        title: "Mr",
        updated: "2015-08-25T10:29:16",
        username: "copilotmarks61569"
    }
}
```

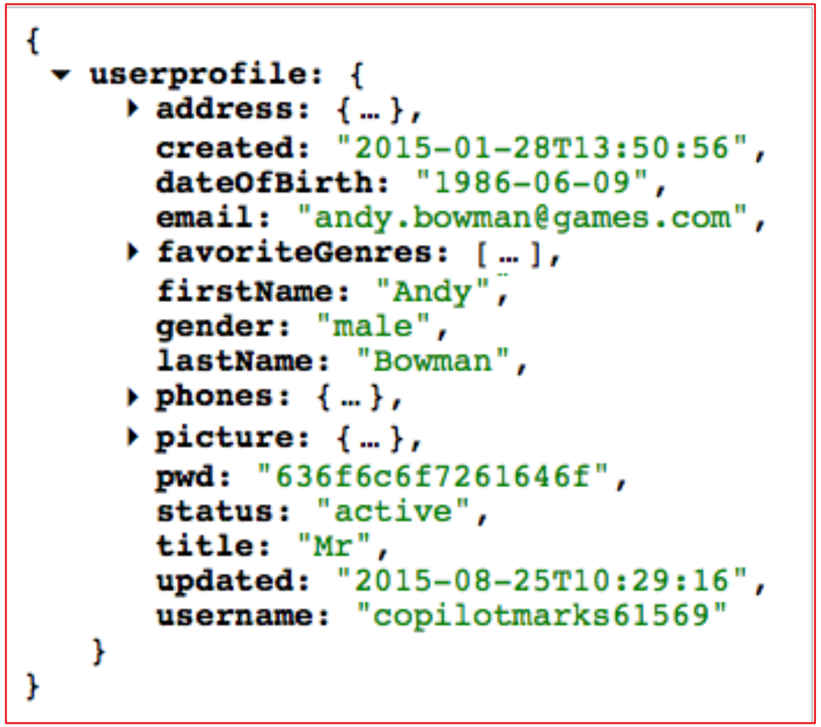
Example #1 of Data Nesting

- Playlist with owner attribute containing a subset of the corresponding userprofile



```
{
 ▾ playlist: {
      created: "2014-12-04T03:36:18",
      id: "003c6f65-641a-4c9a-8e5e-41c947086cae",
      name: "Eclectic Summer Mix",
    ▾ owner: {
         created: "2015-01-28T13:50:56",
         firstName: "Andy",
         lastName: "Bowman",
         title: "Mr",
         updated: "2015-08-25T10:29:16",
         username: "copilotmarks61569"
      },
    ▸ tracks: [ … ],
      updated: "2015-09-11T10:39:40",
      visibility: "PUBLIC"
   }
}
```

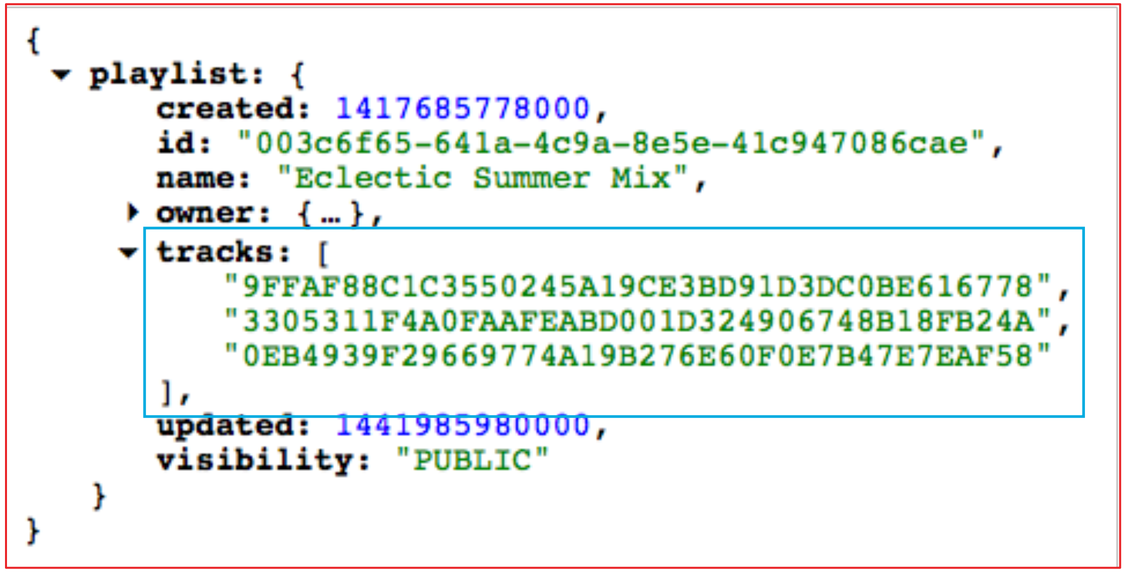
* Note the inclusion of the **updated** attribute



```
{
 ▾ userprofile: {
    ▸ address: { … },
      created: "2015-01-28T13:50:56",
      dateOfBirth: "1986-06-09",
      email: "andy.bowman@games.com",
    ▸ favoriteGenres: [ … ],
      firstName: "Andy",
      gender: "male",
      lastName: "Bowman",
    ▸ phones: { … },
    ▸ picture: { … },
      pwd: "636f6c6f7261646f",
      status: "active",
      title: "Mr",
      updated: "2015-08-25T10:29:16",
      username: "copilotmarks61569"
   }
}
```

Example #2 of Data Nesting

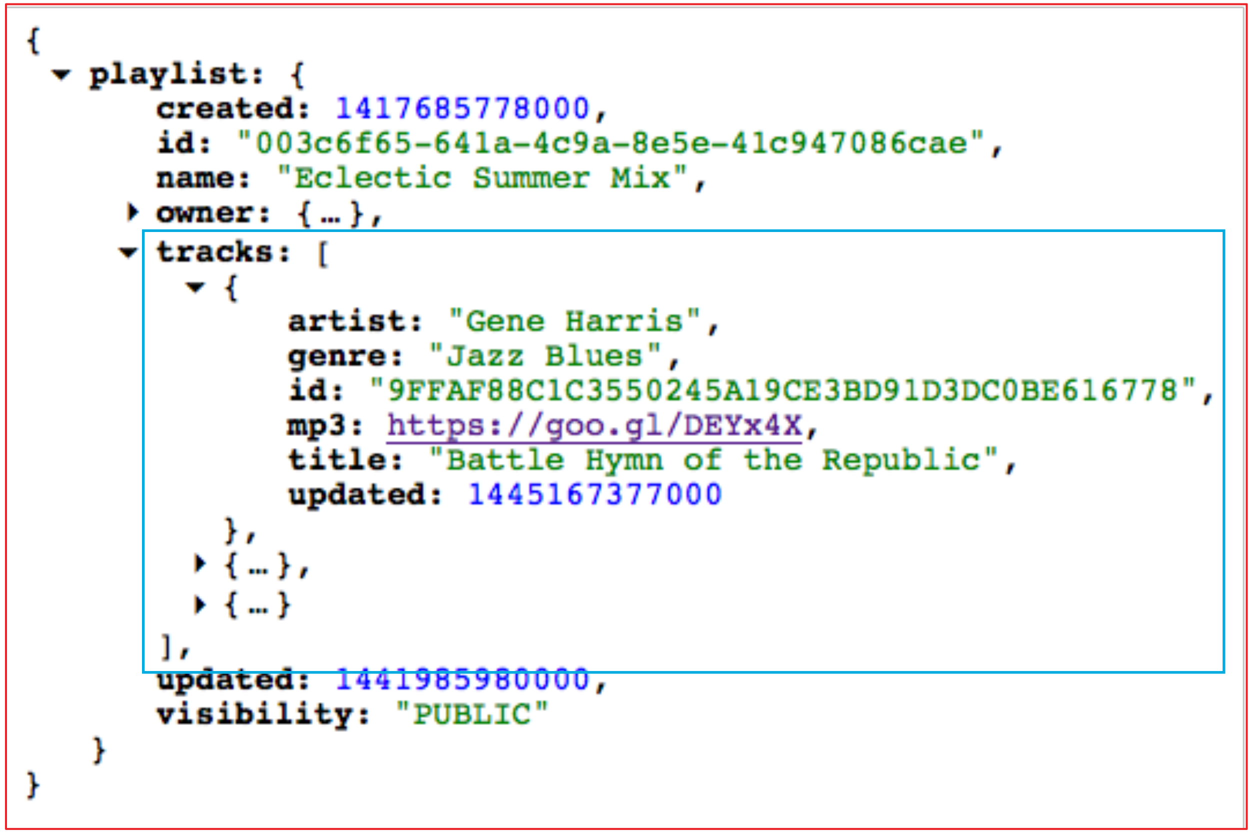
- Playlist with tracks attribute containing an array of track IDs



```
{
 ▾ playlist: {
       created: 1417685778000,
       id: "003c6f65-641a-4c9a-8e5e-41c947086cae",
       name: "Eclectic Summer Mix",
     ▸ owner: {…},
     ▾ tracks: [
           "9FFAF88C1C3550245A19CE3BD91D3DC0BE616778",
           "3305311F4A0FAAFEABD001D324906748B18FB24A",
           "0EB4939F29669774A19B276E60F0E7B47E7EAF58"
       ],
       updated: 1441985980000,
       visibility: "PUBLIC"
   }
}
```

Example #2 of Data Nesting

- Playlist with tracks attribute containing an array of track objects



```
{
 ▾ playlist: {
       created: 1417685778000,
       id: "003c6f65-641a-4c9a-8e5e-41c947086cae",
       name: "Eclectic Summer Mix",
     ▸ owner: {…},
     ▾ tracks: [
         ▾ {
               artist: "Gene Harris",
               genre: "Jazz Blues",
               id: "9FFAF88C1C3550245A19CE3BD91D3DC0BE616778",
               mp3: https://goo.gl/DEYx4X,
               title: "Battle Hymn of the Republic",
               updated: 1445167377000
           },
         ▸ {…},
         ▸ {…}
       ],
       updated: 1441985980000,
       visibility: "PUBLIC"
   }
}
```

* Note the inclusion of the **updated** attribute

3 Key Design

Natural Keys

- A key formed of attributes that exist in the real world:
  - Phone numbers
  - Usernames
  - Social security numbers
  - Account numbers
  - SKU, UPC or QR codes
  - Device IDs
- Often the first choice for document keys
- Be careful when working with any personally identifiable information (PII), sensitive personal information (SPI) or protected health information (PHI)

Surrogate Keys

- We often use surrogate keys when no obvious natural key exist
- They are not derived from application data
- They can be generated values
- 3305311F4A0FAAFEABD001D324906748B18FB24A (SHA-1)
- 003C6F65-641A-4CGA-8E5E-41C947086CAE (UUID)
- They can be sequential numbers (often implemented using the Counter feature of Couchbase Server)
- 456789, 456790, 456791, …

Key Value Patterns

- Common practice for users of Couchbase Server to follow patterns for formatting key values by using symbols such as single or double colons
- DocType::ID
  - userprofile::fredsmith79
  - playlist::003c6f65-641a-4c9a-8e5e-41c947086cae
- AppName::DocType::ID
  - couchmusic::userprofile::fredsmith79
- DocType::ParentID::ChildID
  - playlist::fredsmith79::003c6f65-641a-4c9a-8e5e-41c947086cae
- Supports easy document viewing in the Couchbase web console

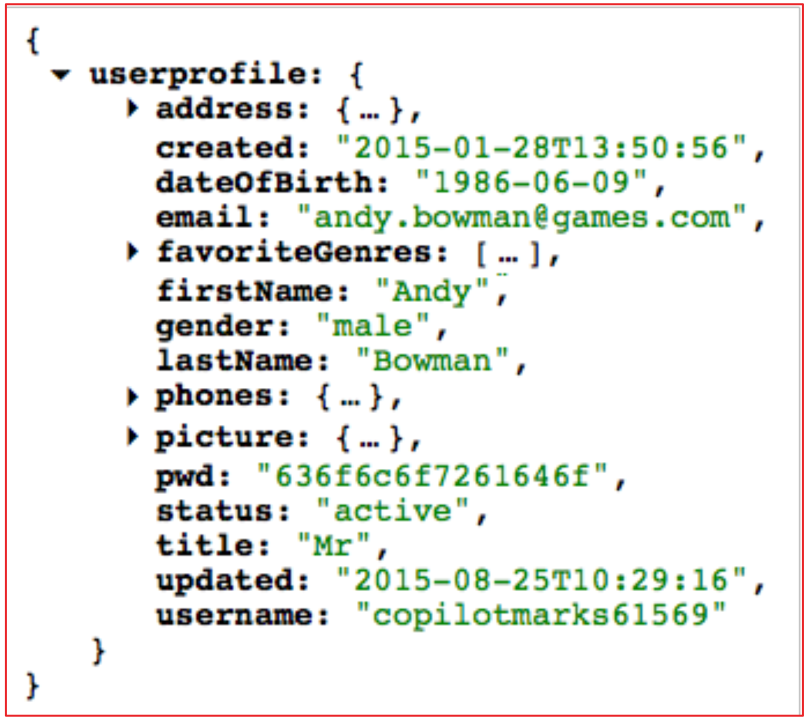
Lookup Key Pattern

- The purpose of the Lookup Key Pattern is to allow multiple ways to reach the same data, essentially a secondary index
  - For example, we want to lookup a Userprofile by their email address instead of their ID
- To accomplish this, we create another small document that refers to the Userprofile document we are interested in
- Implementing this pattern is straightforward, just create an additional document containing a single property that stores the key to the primary document
- With the introduction of N1QL, this pattern will be less commonly used

Example of Lookup Key Pattern

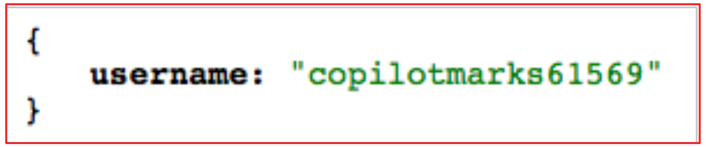
- Lookup document can be JsonDocument or StringDocument

userprofile::copilotmarks61569



```
{
  ▾ userprofile: {
      ▸ address: {…},
        created: "2015-01-28T13:50:56",
        dateOfBirth: "1986-06-09",
        email: "andy.bowman@games.com",
      ▸ favoriteGenres: […],
        firstName: "Andy",
        gender: "male",
        lastName: "Bowman",
      ▸ phones: {…},
      ▸ picture: {…},
        pwd: "636f6c6f7261646f",
        status: "active",
        title: "Mr",
        updated: "2015-08-25T10:29:16",
        username: "copilotmarks61569"
    }
}
```

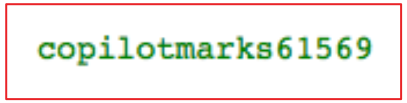
andy.bowman@games.com



```
{
    username: "copilotmarks61569"
}
```

JSON

andy.bowman@games.com

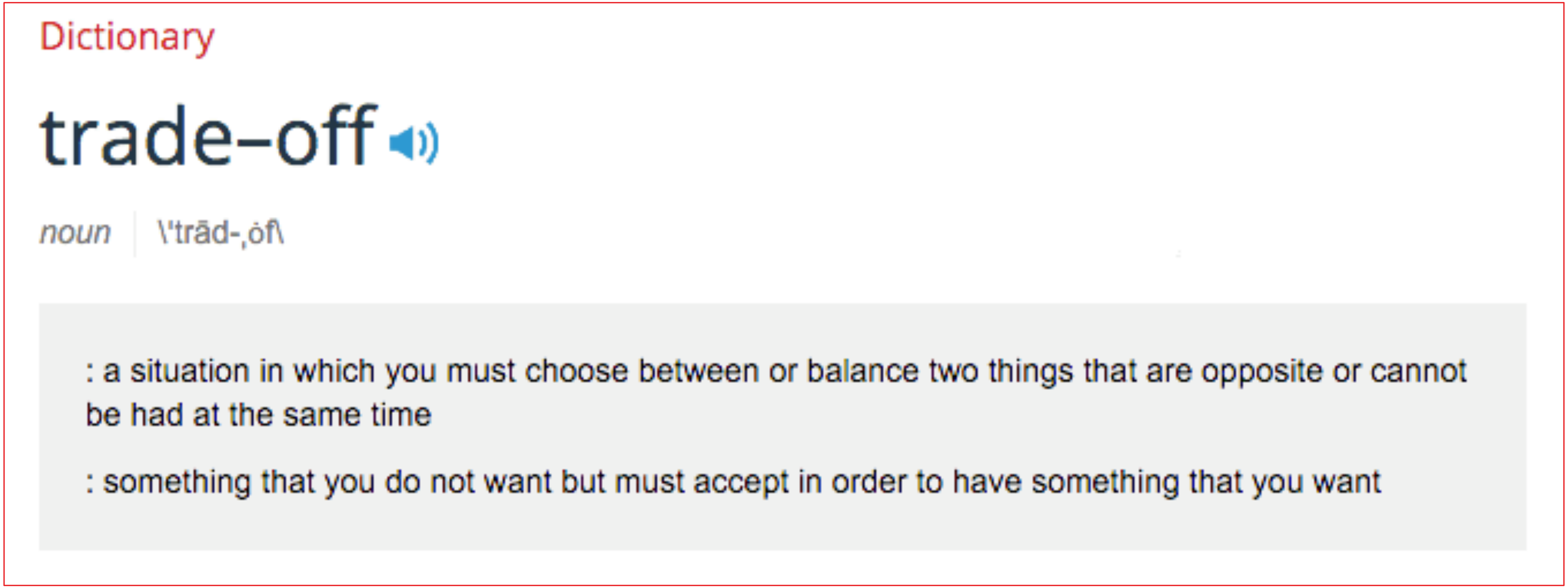


```
copilotmarks61569
```

String

4 Making Trade-offs

Definition



Dictionary

trade–off 🔊

noun | \'trād-ˌȯf\

: a situation in which you must choose between or balance two things that are opposite or cannot be had at the same time

: something that you do not want but must accept in order to have something that you want

Making Tough Choices

- Eric Brewer is famous for showing the trade-offs that are necessary when dealing with distributed systems
  - Consistency, availability and partition tolerance are all desirable properties but we must choose the ones that are most important for our use cases
- We must also make trade-offs in data modeling:
  - Document size
  - Atomicity
  - Complexity
  - Speed

Document Size

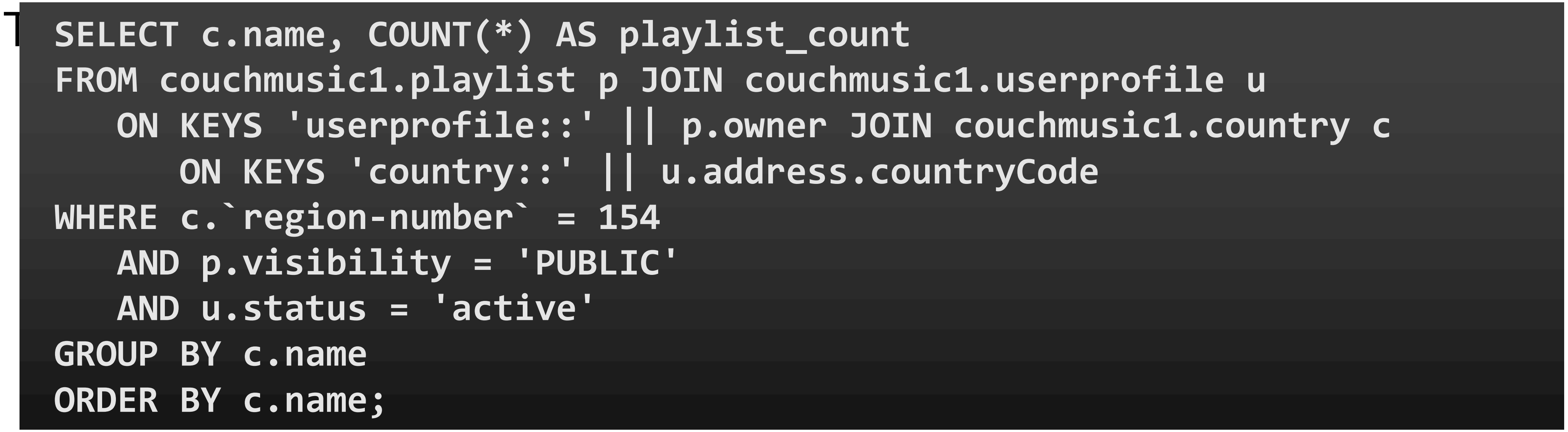
- Couchbase Server supports documents up to 20 Mb
- Larger documents take more disk space, more time to transfer across the network and more time to serialize/deserialize
- If you are dealing with documents that are potentially large (greater than 1 Mb), you must test thoroughly to find out if speed of access is adequate as you scale. If not, you will need to break up the document into smaller ones.
- You may need to limit the number of dependent child objects you embed

Atomicity

- Atomicity in Couchbase Server is at the document level
- Couchbase Server does not support transactions
  - They can be simulated if you are willing to write and maintain additional code to implement them (generally not recommended)
- If you absolutely need changes to be atomic, they will have to be part of the same document
- The maximum document size for Couchbase Server may limit how much data you can store in a single document

Complexity

- Complexity affects every area of software systems including data modeling
- We need to consider:
  - T



```
SELECT c.name, COUNT(*) AS playlist_count
FROM couchmusic1.playlist p JOIN couchmusic1.userprofile u
   ON KEYS 'userprofile::' || p.owner JOIN couchmusic1.country c
      ON KEYS 'country::' || u.address.countryCode
WHERE c.`region-number` = 154
   AND p.visibility = 'PUBLIC'
   AND u.status = 'active'
GROUP BY c.name
ORDER BY c.name;
```

  - The complexity of code for updating multiple copies of the same data

Speed

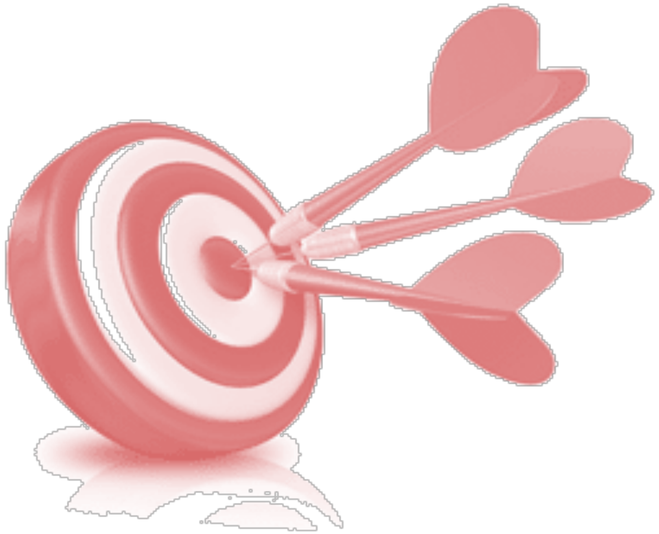
- As it relates to data modeling, speed of access is critical
- When using N1QL to access data, keep in mind that query by document key is fastest and query by secondary index is usually much slower
- If implementing an interactive use case, you will want to avoid using JOINs
- You can use data duplication to improve the speed of accessing related data and thus trade improved speed for greater complexity and larger document size
- Keep in mind that Couchbase Views can be used when up to the second accuracy is not required

Embed vs. Refer

- All of the previous trade-offs are usually rolled into a single decision – whether to embed or refer
- When to embed:
  - Reads greatly outnumber writes
  - You're comfortable with the slim risk of inconsistent data across the multiple copies
  - You're optimizing for speed of access
- When to refer:
  - Consistency of the data is a priority
  - You want to ensure your cache is used efficiently
  - The embedded version would be too large or complex

Summary

- In this module, you have learned to:
  - Make full use of JSON capabilities
  - Use data nesting to minimize the need for JOINs
  - Establish key value patterns and use them consistently
  - Be clear about the trade-offs you are making, document your decisions and the assumptions they are based on



Thank you

Couchbase