

Projection: Getting only what you need

INTRODUCTION TO MONGODB IN PYTHON

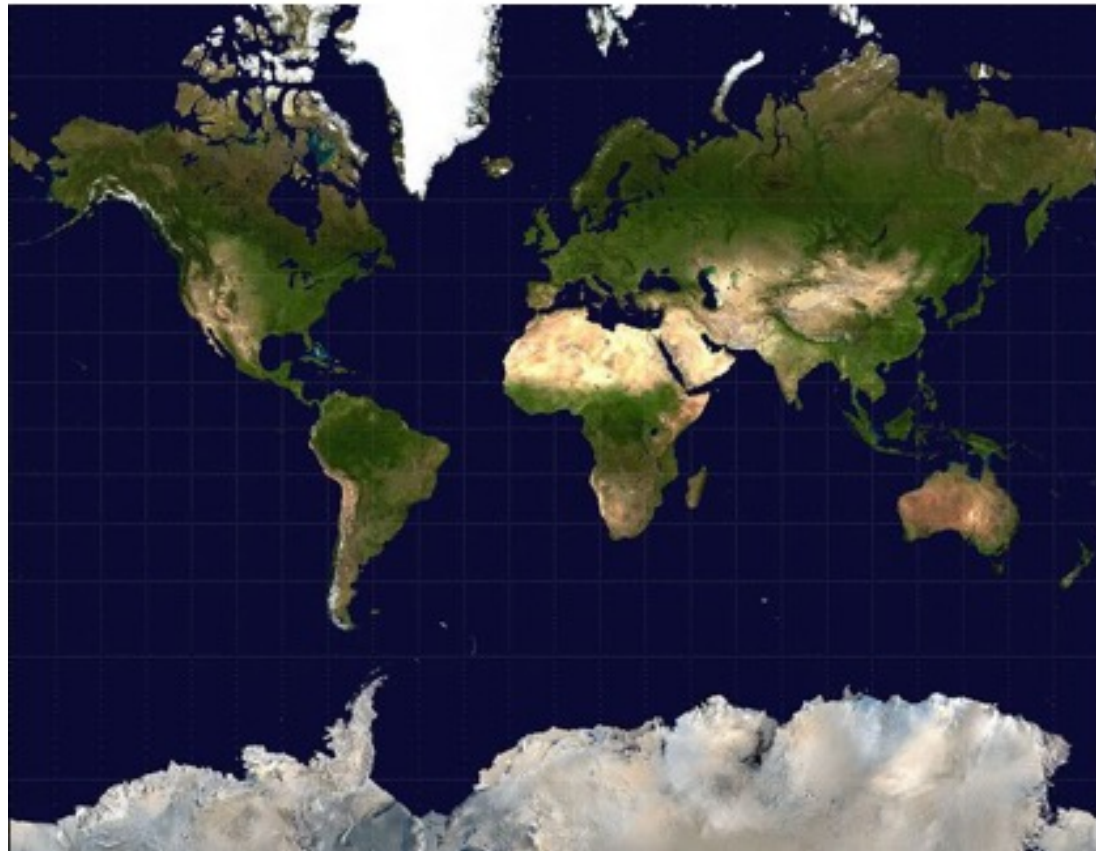


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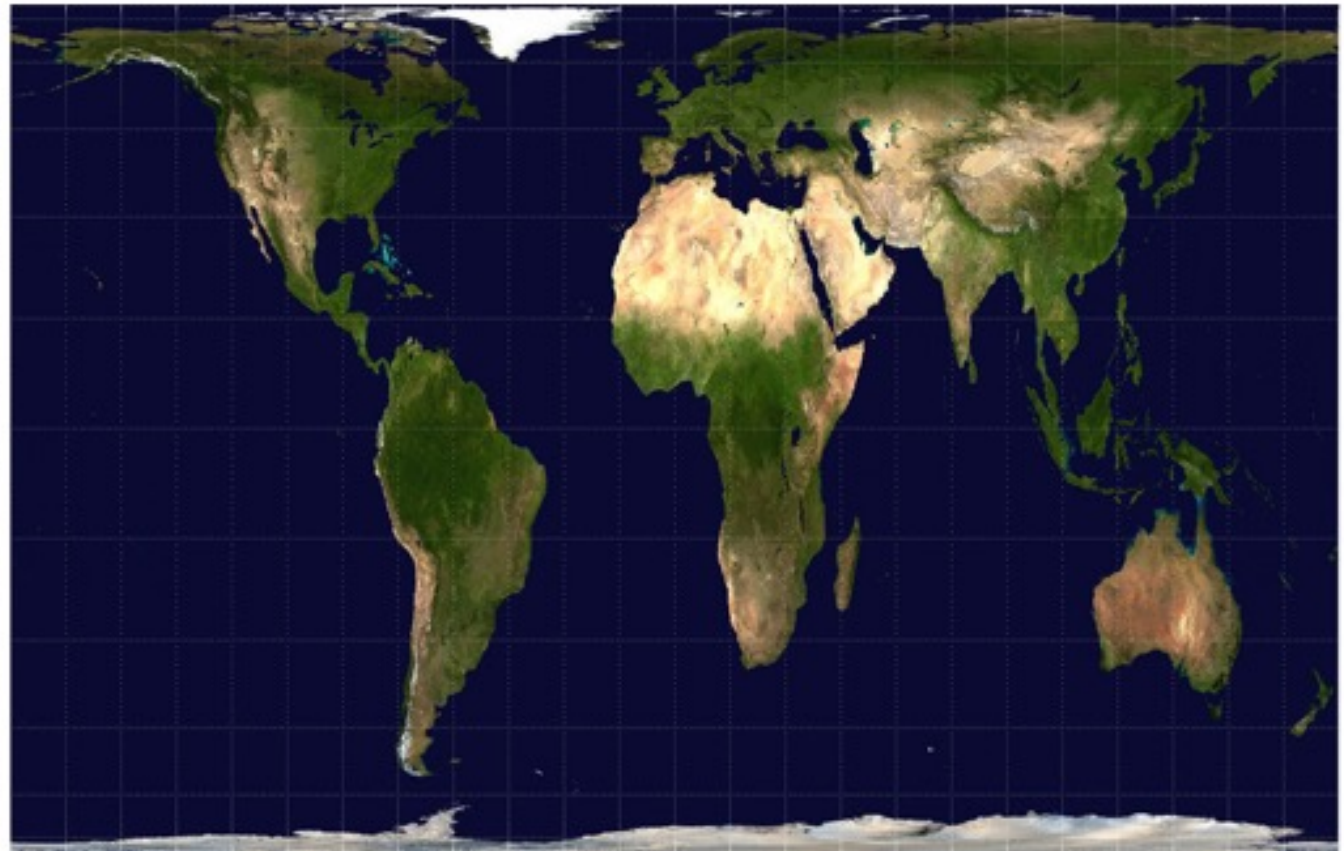
What is "projection"?

- reducing data to fewer dimensions
- asking certain data to "speak up"!

Mercator projection



Gall-Peters projection



Projection in MongoDB

```
# include only prizes.affiliations
# exclude _id
docs = db.laureates.find(
    filter={},
    projection={"prizes.affiliations": 1,
               "_id": 0})

type(docs)
```

```
<pymongo.cursor.Cursor at 0x10d6e69e8>
```

Projection as a dictionary:

- Include fields: `"field_name" : 1`
- `"_id"` is included by default

Projection in MongoDB

```
# include only prizes.affiliations
# exclude _id
docs = db.laureates.find(
    filter={},
    projection={"prizes.affiliations": 1,
               "_id": 0})
type(docs)
```

```
<pymongo.cursor.Cursor at 0x10d6e69e8>
```

```
# convert to list and slice
list(docs)[:3]
```

```
[{'prizes': [{'affiliations': [{'city': 'Munich',
                                'country': 'Germany',
                                'name': 'Munich University'}]}]},
 {'prizes': [{'affiliations': [{'city': 'Leiden',
                                'country': 'the Netherlands',
                                'name': 'Leiden University'}]}]},
 {'prizes': [{'affiliations': [{'city': 'Amsterdam',
                                'country': 'the Netherlands',
                                'name': 'Amsterdam University'}]}]}]
```

Missing fields

```
# use "gender":"org" to select organizations
# organizations have no bornCountry
docs = db.laureates.find(
    filter={"gender": "org"},
    projection=["bornCountry", "firstname"])
list(docs)
```

```
[{'_id': ObjectId('5bc56154f35b634065ba1dff'),
  'firstname': 'United Nations Peacekeeping Forces'},
 {'_id': ObjectId('5bc56154f35b634065ba1df3'),
  'firstname': 'Amnesty International'},
 ...
]
```

Projection as a list

- list the fields to include
["field_name1", "field_name2"]
- "_id" is included by default

Missing fields

```
# use "gender":"org" to select organizations
# organizations have no bornCountry
docs = db.laureates.find(
    filter={"gender": "org"},
    projection=["bornCountry", "firstname"])
list(docs)
```

```
[{'_id': ObjectId('5bc56154f35b634065ba1dff'),
  'firstname': 'United Nations Peacekeeping Forces'},
{'_id': ObjectId('5bc56154f35b634065ba1df3'),
  'firstname': 'Amnesty International'},
...
]
```

- only projected fields that *exist* are returned

```
docs = db.laureates.find({}, ["favoriteIceCreamFlavor"])
list(docs)
```

```
[{'_id': ObjectId('5bc56154f35b634065ba1dff')},
{'_id': ObjectId('5bc56154f35b634065ba1df3')},
{'_id': ObjectId('5bc56154f35b634065ba1db1')},
...
]
```

Simple aggregation

```
docs = db.laureates.find({}, ["prizes"])

n_prizes = 0
for doc in :
    # count the number of pizes in each doc
    n_prizes += len(doc["prizes"])
print(n_prizes)
```

941

```
# using comprehension
sum([len(doc["prizes"]) for doc in docs])
```

941

Let's project!

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Sorting

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Sorting post-query with Python

```
docs = list(db.prizes.find({"category": "physics"}, ["year"]))

print([doc["year"] for doc in docs][:5])
```

```
['2018', '2017', '2016', '2015', '2014']
```

```
from operator import itemgetter

docs = sorted(docs, key=itemgetter("year"))
print([doc["year"] for doc in docs][:5])
```

```
['1901', '1902', '1903', '1904', '1905']
```

```
docs = sorted(docs, key=itemgetter("year"), reverse=True)
print([doc["year"] for doc in docs][:5])
```

```
['2018', '2017', '2016', '2015', '2014']
```

Sorting in-query with MongoDB

```
cursor = db.prizes.find({"category": "physics"}, ["year"],
                        sort=[("year", 1)])
print([doc["year"] for doc in cursor][:5])
```

```
['1901', '1902', '1903', '1904', '1905']
```

```
cursor = db.prizes.find({"category": "physics"}, ["year"],
                        sort=[("year", -1)])
print([doc["year"] for doc in cursor][:5])
```

```
['2018', '2017', '2016', '2015', '2014']
```

```
['2018', '2017', '2016', '2015', '2014']
```

Primary and secondary sorting

```
for doc in db.prizes.find(
    {"year": {"$gt": "1966", "$lt": "1970"}},
    ["category", "year"],
    sort=[("year", 1), ("category", -1)]):
    print("{year} {category}".format(**doc))
```

```
1967 physics
1967 medicine
1967 literature
1967 chemistry
1968 physics
1968 peace
1968 medicine
1968 literature
1968 chemistry
1969 physics
1969 peace
1969 medicine
1969 literature
1969 economics
1969 chemistry
```

Sorting with pymongo versus MongoDB shell

In MongoDB shell:

- Example `sort` argument: `{"year": 1, "category": -1}`
- JavaScript objects retain key order as entered

In Python (< 3.7):

```
{"year": 1, "category": 1}
```

```
{'category': 1, 'year': 1}
```

```
[("year", 1), ("category", 1)]
```

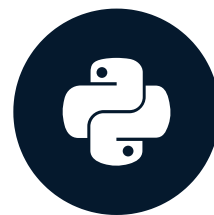
```
[('year', 1), ('category', 1)]
```

Let's get sorted!

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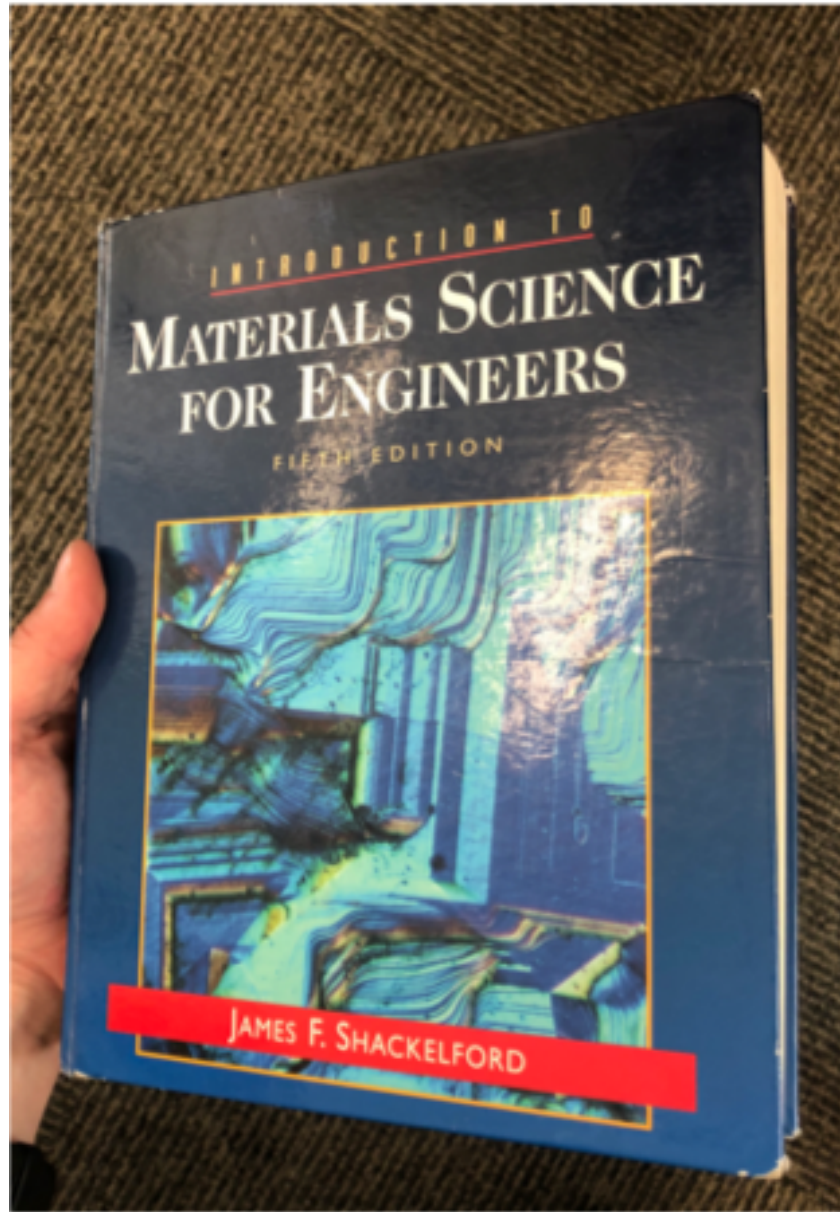
What are indexes?

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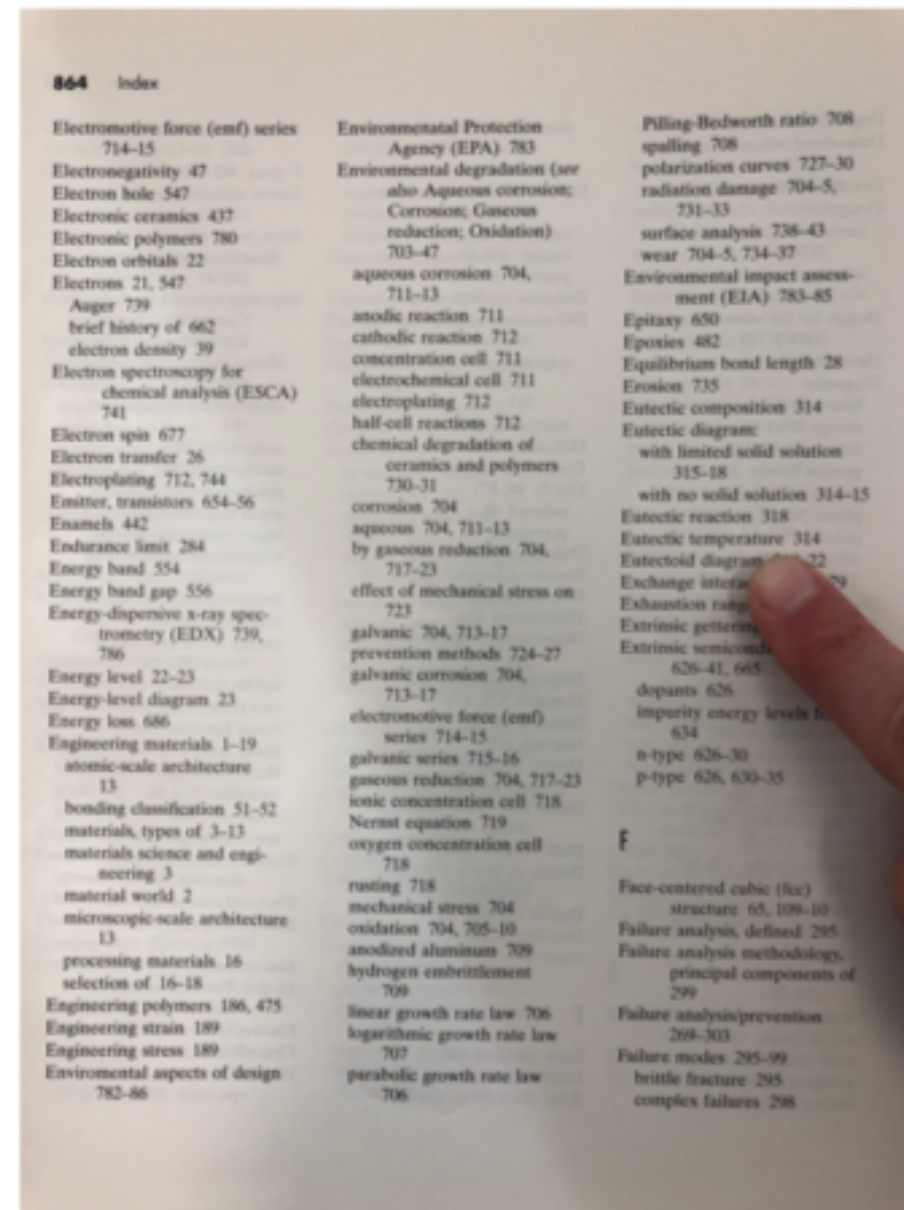
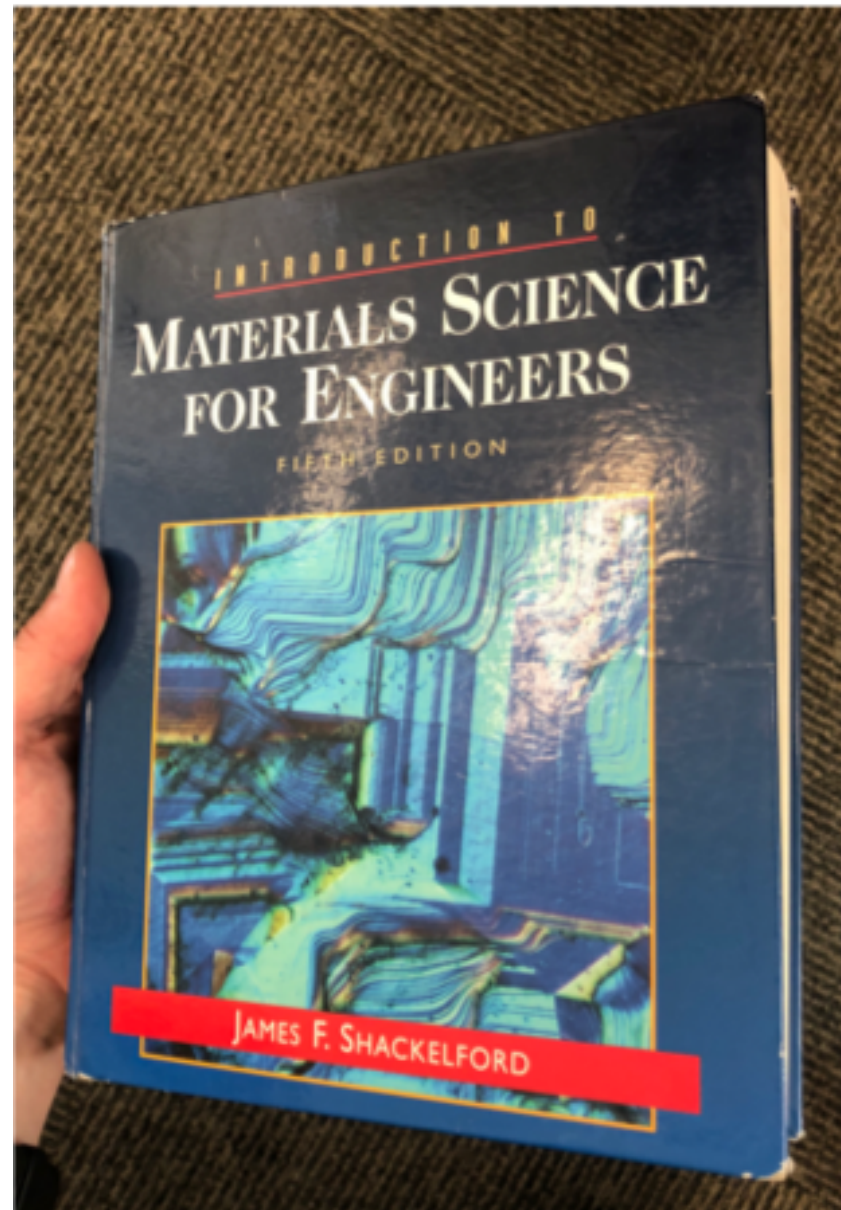


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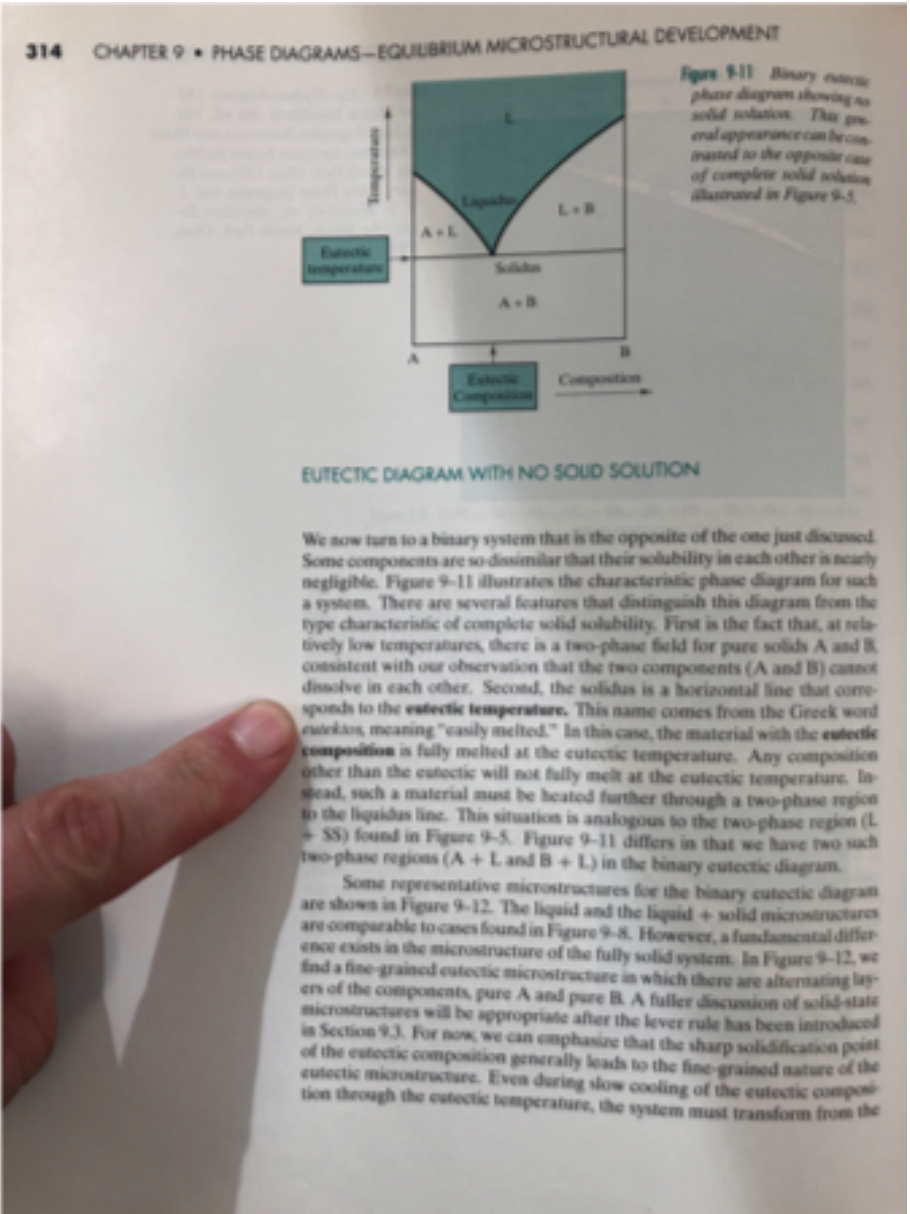
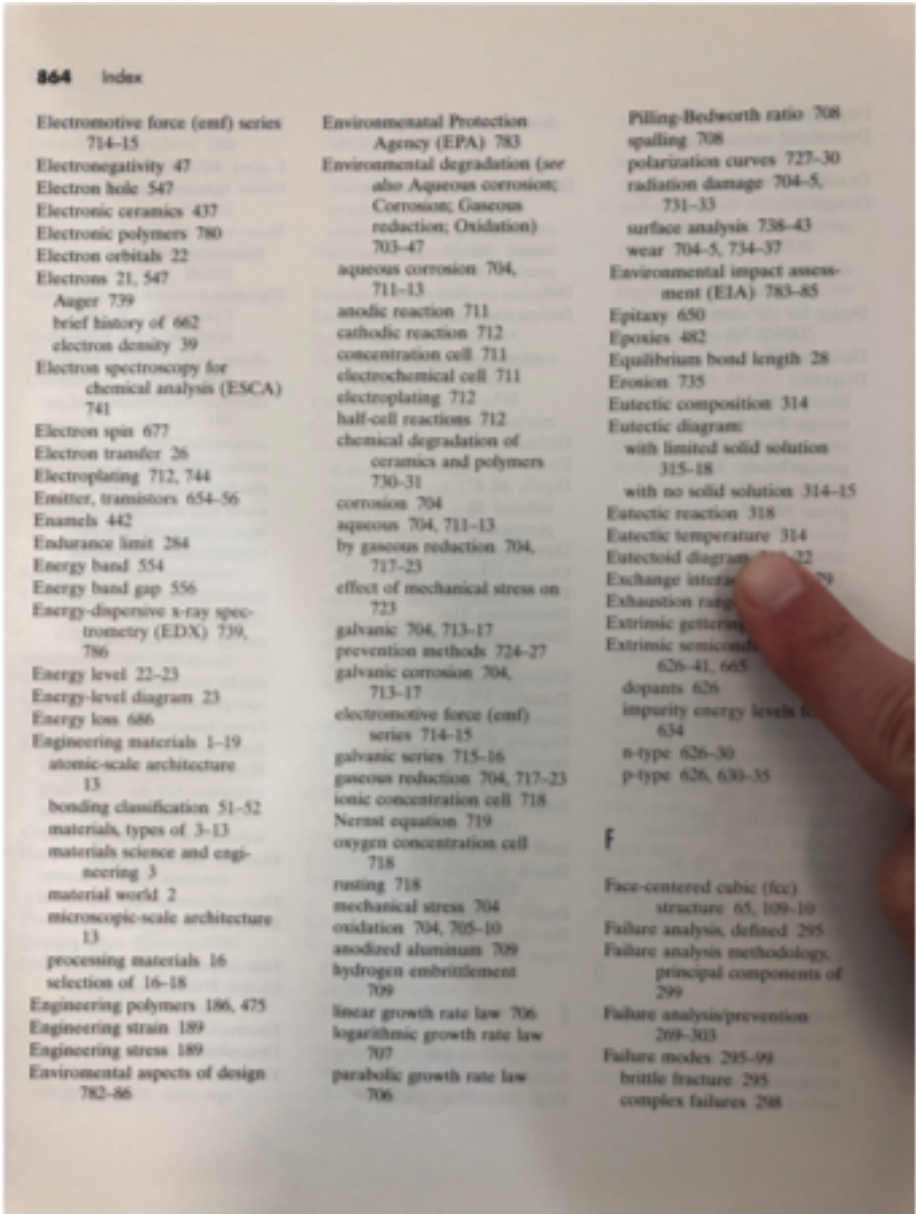
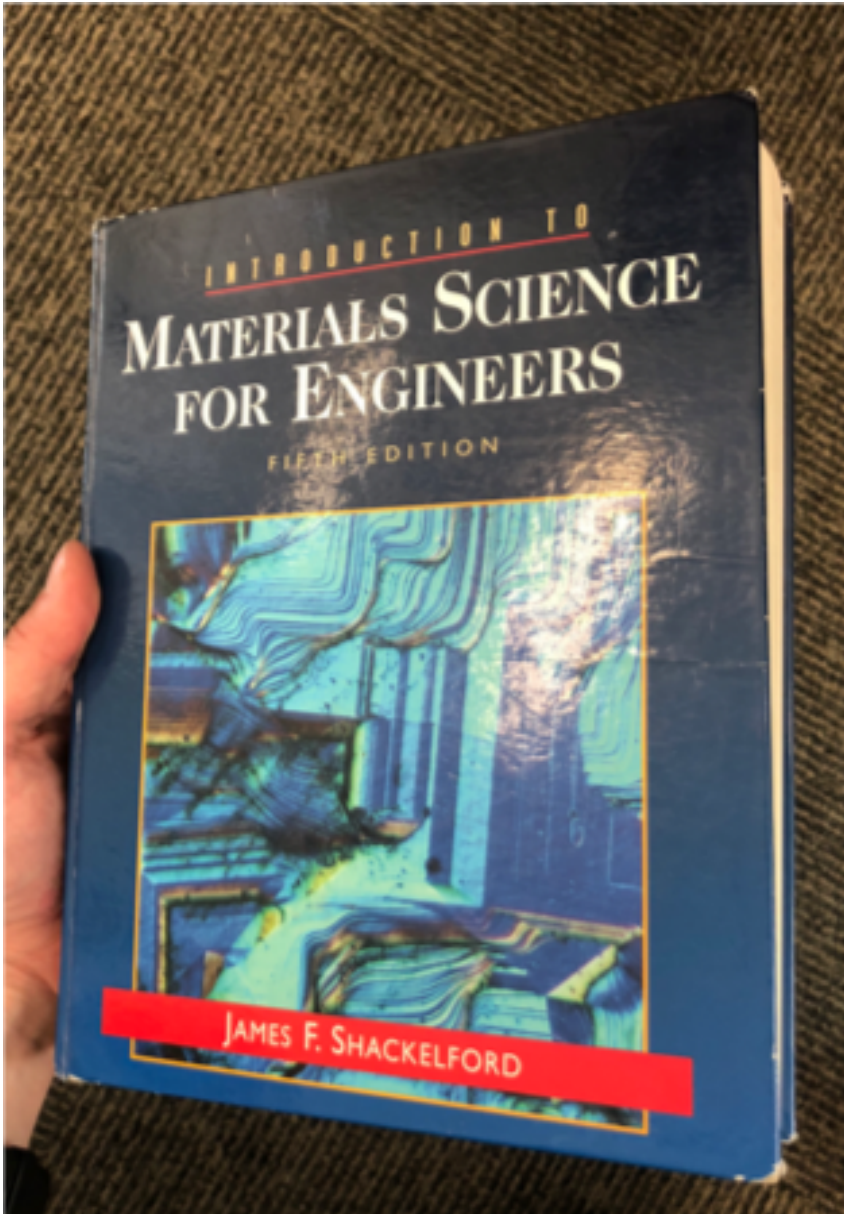
What are indexes?



What are indexes?



What are indexes?



When to use indexes?

- Queries with high specificity
- Large documents
- Large collections

Gauging performance before indexing

Jupyter Notebook `%%timeit` magic (same as `python -m timeit "[expression]"`)

```
%%timeit  
docs = list(db.prizes.find({"year": "1901"}))
```

524 μ s \pm 7.34 μ s per loop (mean \pm std. dev. of 7 runs, 1000 loops each)

```
%%timeit  
docs = list(db.prizes.find({}, sort=[("year", 1)]))
```

5.18 ms \pm 54.9 μ s per loop (mean \pm std. dev. of 7 runs, 100 loops each)

Adding a single-field index

- index model: list of (field, direction) pairs.
- directions: 1 (ascending) and -1 (descending)

```
db.prizes.create_index([("year", 1)])
```

```
'year_1'
```

```
%%timeit  
# Previously: 524  $\mu$ s  $\pm$  7.34  $\mu$ s  
docs = list(db.prizes.find({"year": "1901"}))
```

```
379  $\mu$ s  $\pm$  1.62  $\mu$ s per loop  
(mean  $\pm$  std. dev. of 7 runs, 1000 loops each)
```

```
%%timeit  
# Previously: 5.18 ms  $\pm$  54.9  $\mu$ s  
docs = list(db.prizes.find({}, sort=[("year", 1)]))
```

```
4.28 ms  $\pm$  95.7  $\mu$ s per loop  
(mean  $\pm$  std. dev. of 7 runs, 100 loops each)
```

```
4.28 ms  $\pm$  95.7  $\mu$ s per loop (mean  $\pm$  std. dev. of 7 runs,
```

Adding a compound (multiple-field) index

```
db.prizes.create_index([("category", 1), ("year", 1)])
```

- index "covering" a query with projection

```
list(db.prizes.find({"category": "economics"},  
                    {"year": 1, "_id": 0}))
```

Before

645 μ s \pm 3.87 μ s per loop
(mean \pm std. dev. of 7 runs, 1000 loops each)

After

503 μ s \pm 4.37 μ s per loop
(mean \pm std. dev. of 7 runs, 1000 loops each)

- index "covering" a query with projection and sorting

```
db.prizes.find_one({"category": "economics"},  
                   {"year": 1, "_id": 0},  
                   sort=[("year", 1)])
```

Before

673 μ s \pm 3.36 μ s per loop
(mean \pm std. dev. of 7 runs, 1000 loops each)

After

407 μ s \pm 5.51 μ s per loop
(mean \pm std. dev. of 7 runs, 1000 loops each)

Learn more: ask your collection and your queries

```
db.laureates.index_information() # always an index on "_id" field
```

```
{'_id_': {'v': 2, 'key': [('_id', 1)], 'ns': 'nobel.laureates'}}
```

```
db.laureates.find(  
    {"firstname": "Marie"}, {"bornCountry": 1, "_id": 0}).explain()
```

```
...  
'winningPlan': {'stage': 'PROJECTION',  
    'transformBy': {'bornCountry': 1, '_id': 0},  
    'inputStage': {'stage': 'COLLSCAN',  
    ...
```

```
db.laureates.create_index([("firstname", 1), ("bornCountry", 1)])  
db.laureates.find(  
    {"firstname": "Marie"}, {"bornCountry": 1, "_id": 0}).explain()
```

```
...  
'winningPlan': {'stage': 'PROJECTION',  
    'transformBy': {'bornCountry': 1, '_id': 0},  
    'inputStage': {'stage': 'IXSCAN',  
    'keyPattern': {'firstname': 1, 'bornCountry': 1},  
    'indexName': 'firstname_1_bornCountry_1',  
    ...
```

Let's practice!

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Limits and Skips with Sorts, Oh My!

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Limiting our exploration

```
for doc in db.prizes.find({}, ["laureates.share"]):
    share_is_three = [laureate["share"] == "3"
                      for laureate in doc["laureates"]]
    assert all(share_is_three) or not any(share_is_three)
```

```
for doc in db.prizes.find({"laureates.share": "3"}):
    print("{year} {category}".format(**doc))
```

```
2017 chemistry
2017 medicine
2016 chemistry
2015 chemistry
2014 physics
2014 chemistry
2013 chemistry
...
```

```
for doc in db.prizes.find({"laureates.share": "3"}, limit=3):
    print("{year} {category}".format(**doc))
```

```
2017 chemistry
2017 medicine
2016 chemistry
```

Skips and paging through results

```
for doc in db.prizes.find({"laureates.share": "3"}, limit=3):  
    print("{year} {category}".format(**doc))
```

```
2017 chemistry  
2017 medicine  
2016 chemistry
```

```
for doc in db.prizes.find({"laureates.share": "3"}, skip=3, limit=3):  
    print("{year} {category}".format(**doc))
```

```
2015 chemistry  
2014 physics  
2014 chemistry
```

```
for doc in db.prizes.find({"laureates.share": "3"}, skip=6, limit=3):  
    print("{year} {category}".format(**doc))
```

```
2013 chemistry  
2013 medicine  
2013 economics
```

Using cursor methods for {sort, skip, limit}

```
for doc in db.prizes.find({"laureates.share": "3"}).limit(3):  
    print("{year} {category}".format(**doc))
```

```
2017 chemistry  
2017 medicine  
2016 chemistry
```

```
for doc in (db.prizes.find({"laureates.share": "3"}).skip(3).limit(3)):  
    print("{year} {category}".format(**doc))
```

```
2015 chemistry  
2014 physics  
2014 chemistry
```

```
for doc in (db.prizes.find({"laureates.share": "3"})  
            .sort([("year", 1)])  
            .skip(3)  
            .limit(3)):  
    print("{year} {category}".format(**doc))
```

```
1954 medicine  
1956 physics  
1956 medicine
```

Simpler sorts of sort

```
cursor1 = (db.prizes.find({"laureates.share": "3"}).skip(3).limit(3)
          .sort([("year", 1)]))
```

```
cursor2 = (db.prizes.find({"laureates.share": "3"}).skip(3).limit(3)
          .sort("year", 1))
```

```
cursor3 = (db.prizes.find({"laureates.share": "3"}).skip(3).limit(3)
          .sort("year"))
```

```
docs = list(cursor1)
assert docs == list(cursor2) == list(cursor3)
for doc in docs:
    print("{year} {category}".format(**doc))
```

```
1954 medicine
1956 physics
1956 medicine
```

```
doc = db.prizes.find_one({"laureates.share": "3"},
                          skip=3, sort=[("year", 1)])
print("{year} {category}".format(**doc))
```

Limit or Skip Practice? Exactly.

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