How to Eliminate Surprises In Your Data

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The example pipeline

I’m gonna take my [data] to the old town [pipeline], gonna [process data] til I can’t no more

Example pipeline

- Input: a dataset that contains all track listens for a given day

```
{
      "name": "TrackPlay",
      "namespace": "com.spotify.surprises.schema",
      "type": "record",
      "fields": [
      {
            "name": "trackId",
            "type": "string"
      },
      {
            "name": "country",
            "type": "string"
      },
      {
            "name": "msPlayed",
            "type": "long"
      }
      ]
}
```

Example pipeline

- Input: a dataset that contains played songs
- Output: a dataset that contains the most-played songs

```
object TrackPlayCountJob {
  def main(cmdlineArgs: Array[String]): Unit = {
      val (sc, args) = ContextAndArgs(cmdlineArgs)

      sc.avroFile[TrackPlay](args("trackPlays"))
        .map(tp => (tp.getTrackId.toString, 1L))
        .groupByKey
        .map(t => (t._1, t._2.sum))
        .map { case (t, c) => s"$t\t$c" }
        .saveAsTextFile(args("output"))

      sc.close()
  }
}
```

The pipeline doesn’t exist in isolation

[data] queen, feel the beat of the [new hire team]

Open source tools for data quality

We'll float on, good [tools] are on the way

Integration testing

I want your love and I want your revenge
You and me could write a [pipeline test]

Example pipeline

- Input: a dataset that contains played songs
- Output: a dataset that contains the most-played songs
- Unit test: example inputs have expected outputs

```
  val input: Seq[TrackPlay] = List(
      mockTrackPlay("track1", 31000L),
      mockTrackPlay("track1", 33000L),
      mockTrackPlay("track2", 35000L)
  )

  val expectedOutput: Seq[String] = List(
      "track1\t2",
      "track2\t1"
  )

  s"A Track Play Count job" should "work" in {
      JobTest[TrackPlayCountJob.type]
      .args("--trackPlays=trackPlays.avro",
"--output=trackCounts.txt")
      .input(AvroIO("trackPlays.avro"), input)
      .output(TextIO("trackCounts.txt"))(_ should
containInAnyOrder (expectedOutput))
      .run()
  }
```

Ratatool - Scalacheck

- Our team is writing pipeline logic... need to write tests
  - Unit tests
  - Integration tests
  - Property-based tests?

Ratatool - Scalacheck

```
private def mockTrackPlay(trackId: String, msPlayed:
Long) = {
      TrackPlay.newBuilder()
      .setTrackId(trackId)
      .setMsPlayed(msPlayed)
      .setCountry("US")
      .build
  }
```

```
private def mockTrackPlay(trackId: String,
msPlayed: Long) = {
 specificRecordOf[TrackPlay]
   .amend(Gen.const(trackId))(_.setTrackId)
   .amend(Gen.const(msPlayed))(_.setMsPlayed)
   .sample.get
}
```

```
mockTrackPlay("trackId", 600000L)
// {"trackId": "trackId", "country": "ψ眩⑾", "msPlayed": 600000}
```

End to end tests - quickly

I’m the [DAG] guy....

Ratatool - Sampler

- Want to run pipeline end-to-end
- We have 232M MAU, so lots of track plays per day
- Pipelines can cost a lot of money or take a long time
- Downsample input to reduce iteration time

```
ratatool bigSampler avro
--in gs://bucket/input_tracks.avro
--out gs://bucket/sampled_tracks.avro
--sample=0.01
```

Ratatool - Sampler

Where are you running the end to end tests?

And I'm here to remind you
of the mess you left when you [wrote to prod]

Test Environment

- Now it’s time for our team to run their pipeline!
- Common issues & mistakes in the development lifecycle can create conflict or confusion
  - Multiple engineers testing at the same time
  - Engineers may accidentally publish test data to production
    - This can propagate downstream
  - Testing resources can eat up production quotas
  - Engineers can forget to clean up testing data

Testing changes in your dataset output

Turn and face the strange

Ratatool - Diffy

```
object TrackPlayCountJob {
  def main(cmdlineArgs: Array[String]): Unit = {
      val (sc, args) = ContextAndArgs(cmdlineArgs)

      sc.avroFile[TrackPlay](args("trackPlays"))
        .map(tp => (tp.getTrackId.toString, 1L))
        .groupByKey
        .map(t => (t._1, t._2.sum))
        .map { case (t, c) => s"$t\t$c" }
        .saveAsTextFile(args("output"))

      sc.close()
  }
}
```

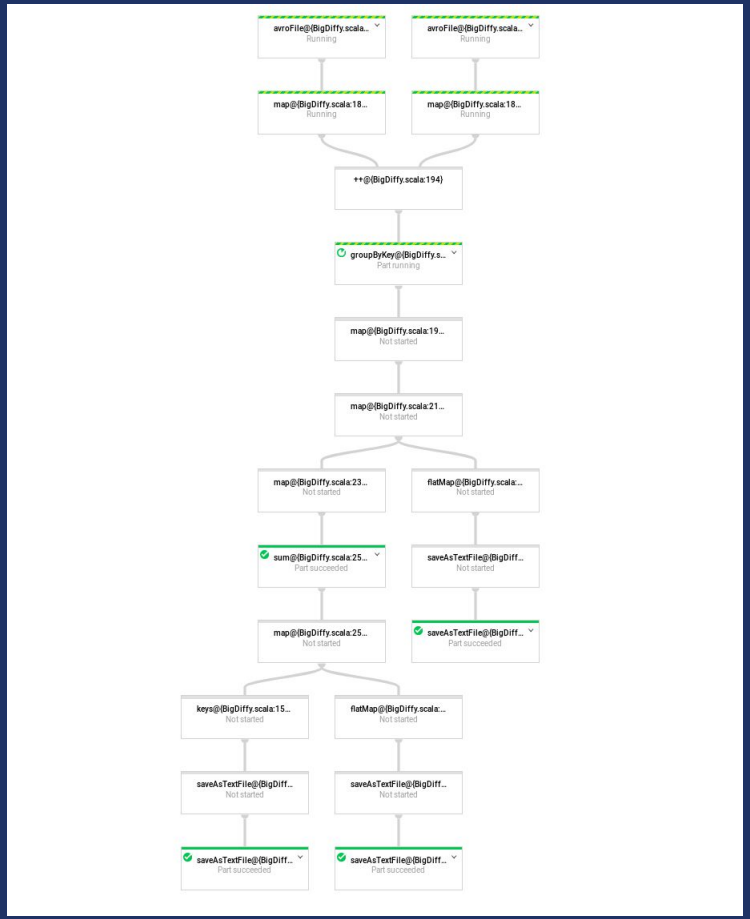
```
object TrackPlayCountJob {
  def main(cmdlineArgs: Array[String]): Unit = {
      val (sc, args) = ContextAndArgs(cmdlineArgs)

      sc.avroFile[TrackPlay](args("trackPlays"))
        .map(_.getTrackId)
        .countByValue
        .map { case (t, c) => s"$t\t$c" }
        .saveAsTextFile(args("output"))

      sc.close()
  }
}
```

Ratatool - Diffy

- Pipeline updated to be more performant
- Have we broken anything?

```
ratatool bigDiffy
--input-mode=avro
--key=track_id
--lhs=gs://bucket/unoptimized.avro
--rhs=gs://bucket/optimized.avro
--output=gs://bucket/diff
```

Ratatool - Diffy



Testing content in your dataset output

How was I supposed to know
that something wasn't right here?

Validation

- How do we have confidence in what the data actually contains?
  - Are our TrackIDs are actually TrackIDs?
  - How many invalid countries do I have?

```
{
	"name": "TrackPlay",
	"namespace": "com.spotify.surprises.schema",
	"type": "record",
	"fields": [
	{
		"name": "trackId",
		"type": "string"
	},
	{
		"name": "country",
		"type": "string"
	},
	{
		"name": "msPlayed",
		"type": "long"
	}
	]
}
```

Validation

- Have Avro record containing fields with avro types
- Records can have many fields to be validated
- Records can have Nesting or Repeated fields
- Primitive data types can represent many different kinds of data
    - A String could be a Track ID or a Country Code
- Many Data Engineers spread across different teams who have different expectations of their data
- Want to provide simple API for the pipeline author

Validation

```
trait ValidationType {
  def checkValid: Boolean
}


case class CountryCode(protected val data: String) extends ValidationType {
  override def checkValid: Boolean = Locale.getISOCountries.contains(data)
}
```

```
trait Validator[A <: ValidationType] {
  def validate(a: PreValidation[A]): PostValidation[A]
}
```

Validation

```
class ValidationTypeValidator[A <: ValidationType] extends Validator[A] {
 override def validate(data: PreValidation[A]): PostValidation[A] =
   data.validate
}

 implicit def vtv[T <: ValidationType]: Validator[T] = new ValidationTypeValidator[T]
```

Validation

```
object Validator {
  type Typeclass[T] = Validator[T]

  def combine[T](caseClass: CaseClass[Validator, T]): Validator[T] = new Validator[T] {
    override def validate(a: PreValidation[T]) : PostValidation[T] = {
      val mapped: Seq[PostValidation[T]] = caseClass.parameters.map(param =>
        param.typeclass.validate(param.dereference(a.data)))

      val record = caseClass.rawConstruct(mapped)

      if (mapped.exists(_.isInvalid)) {
        Invalid(record)
      } else {
        Valid(record)
      }
}
```

Validation

```
implicit class SCollectionValidator[T](sc: SCollection[T])(implicit vr: Validator[T]) {
 def validate(): SCollection[PostValidation[T]] = {
   sc.applyTransform(ParDo.of(new ValidatorDoFn[T](vr)))
 }
}
```

```
implicit class SCollectionConverter[GR <: GenericRecord](sc: SCollection[GR]) {
 def fromAvro[T](implicit c: AvroConverter[T]): SCollection[T] = {
   sc.applyTransform(ParDo.of(new FromAvroConverterDoFn(c)))
 }
}
```

Validation

- Magnolia can be used to derive Validator Typeclasses for our records
- Can also be used to derive Converters to/from Avro

```
case class TrackPlayCC(
 trackId: TrackId,
 country: Country,
 msPlayed: PosNum
)
```

```
object TrackPlayCountJob {
  def main(cmdlineArgs: Array[String]): Unit = {
      val (sc, args) = ContextAndArgs(cmdlineArgs)

      sc.avroFile[TrackPlay](args("trackPlays"))
      .fromAvro[TrackPlayCC]
      .validate()
      .map(_.trackId)
      .countByValue
      .map { case (t, c) => s"$t\t$c" }
      .saveAsTextFile(args("output"))

      sc.close()
  }
}
```

How do we know if upstream has changed?

I just took a DNA test, turns out I'm 100% that [data]

Statistical Profiling

- Our pipeline is running End-to-End
- How can we have a high level view of the actual production inputs/outputs?
  - What is the distribution of msPlayed?
  - How many distinct countries do I have?
  - What are the most common tracks?

Focus on easy to use tools

Spotify open source:

https://github.com/spotify/ratatool

https://github.com/spotify/elitzur (new in March 2020)

https://github.com/spotify/scio

https://twitter.com/SpotifyEng

Other open source:

https://github.com/propensive/magnolia

https://github.com/typelevel/scalacheck

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Songs in this talk: https://spoti.fi/2pMA6qu