Tensorflow Serving

Architecture/ Basic Tutorials

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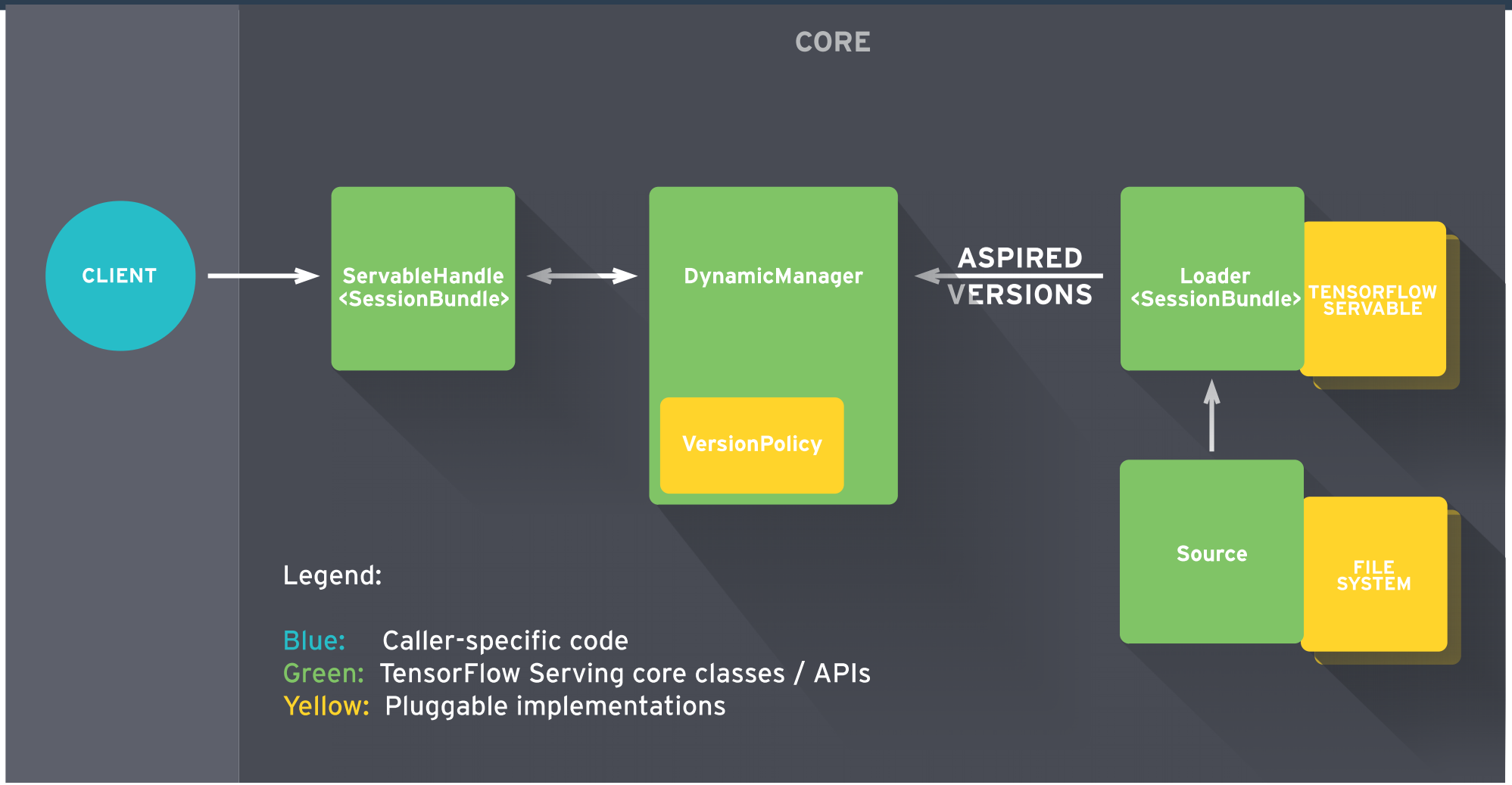
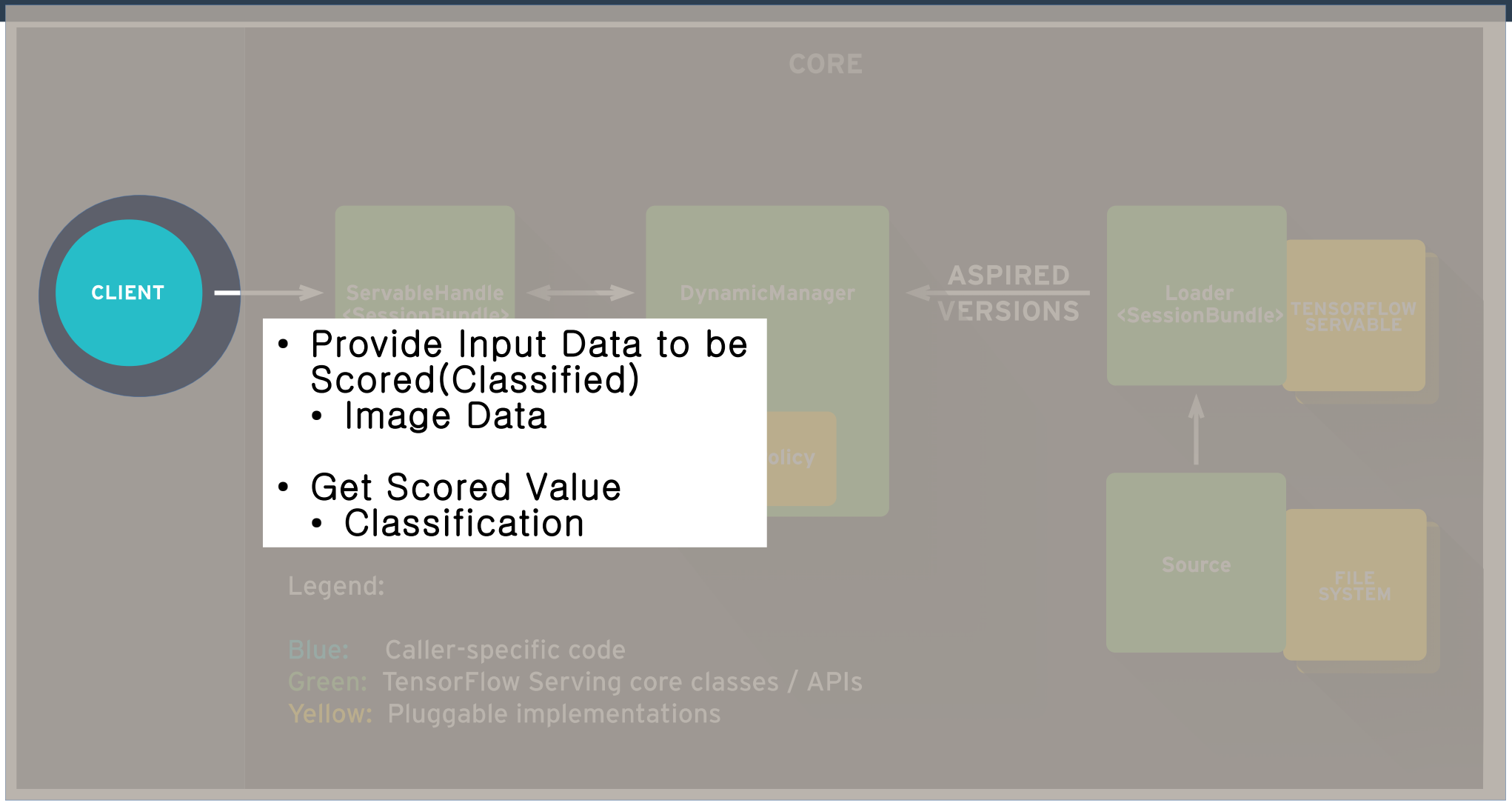
Covered...

- **Get Started**
  - Architecture Overview
  - Installation
- **Tutorials**
  - TensorFlow Serving Basics
  - TensorFlow Serving Advanced

Architecture Overview

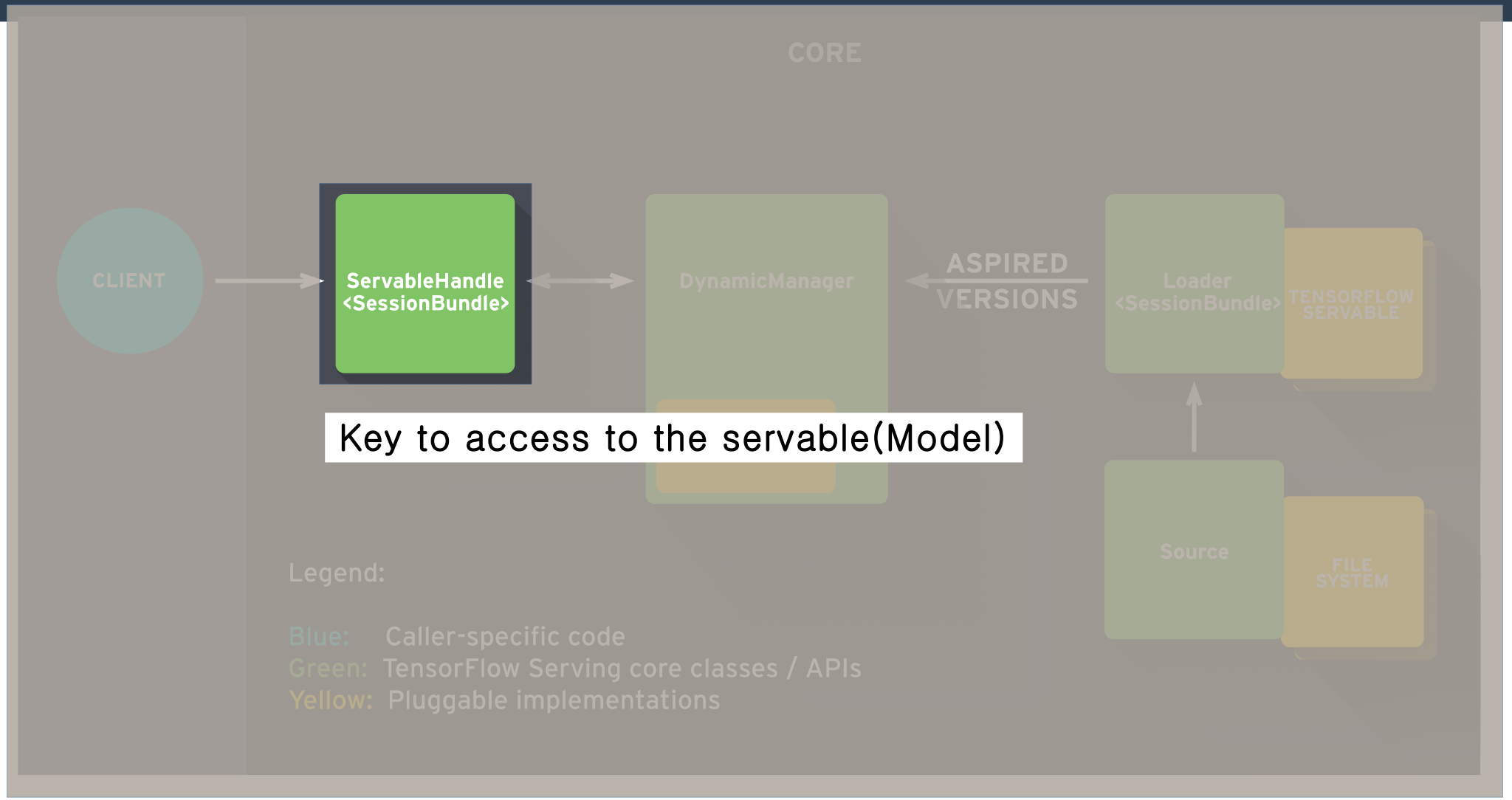


Architecture Overview

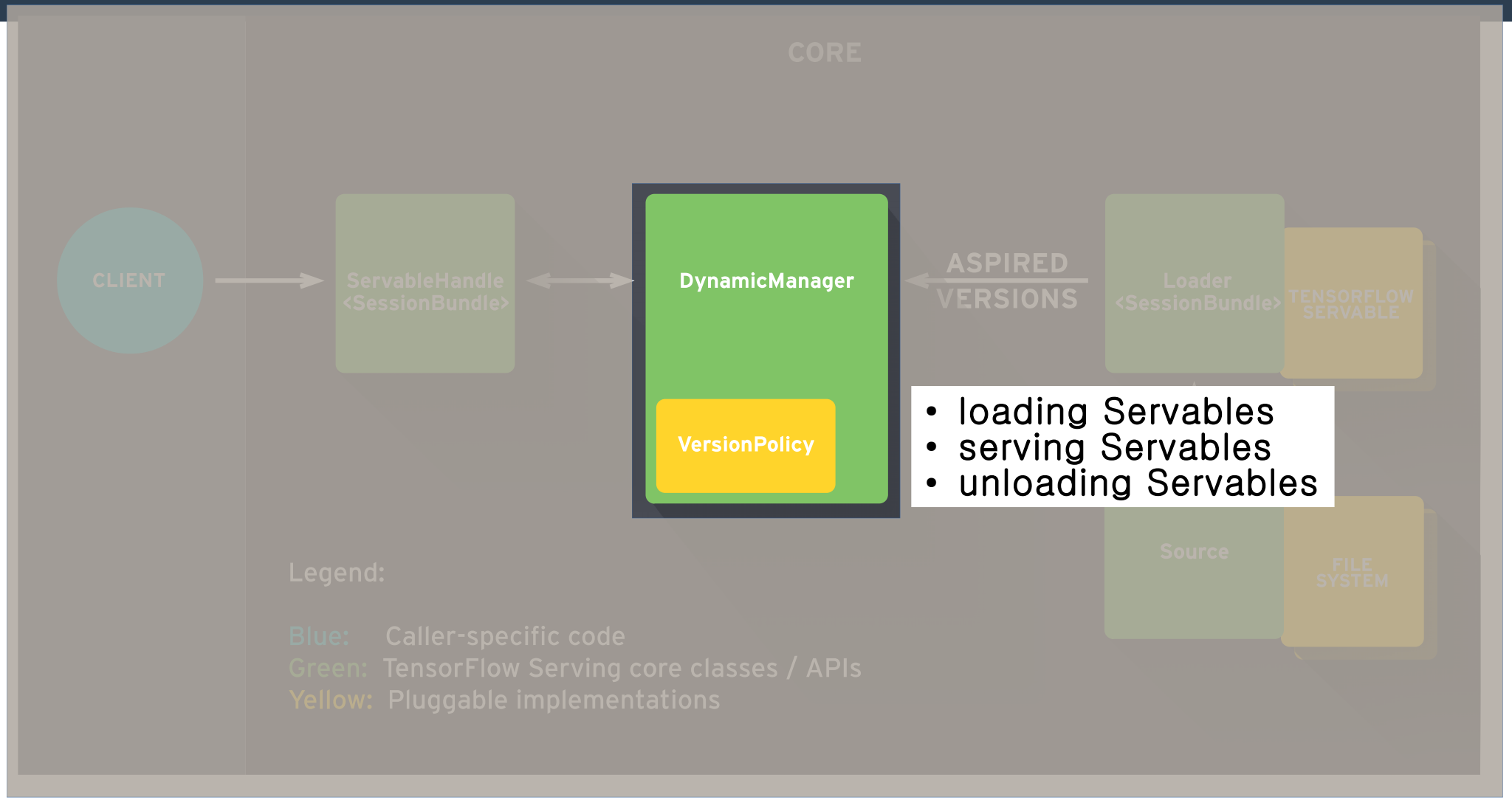


- Provide Input Data to be Scored(Classified)
  - Image Data
- Get Scored Value
  - Classification

Architecture Overview

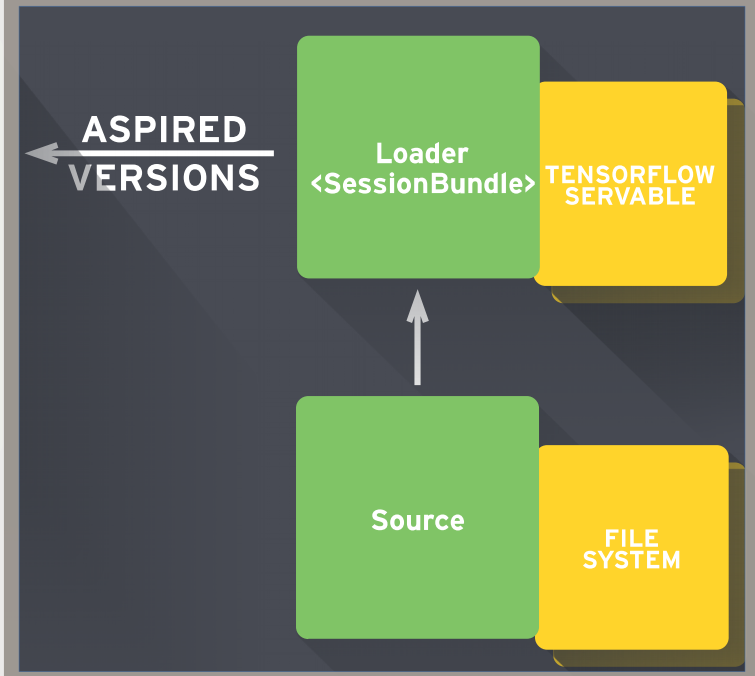


Architecture Overview

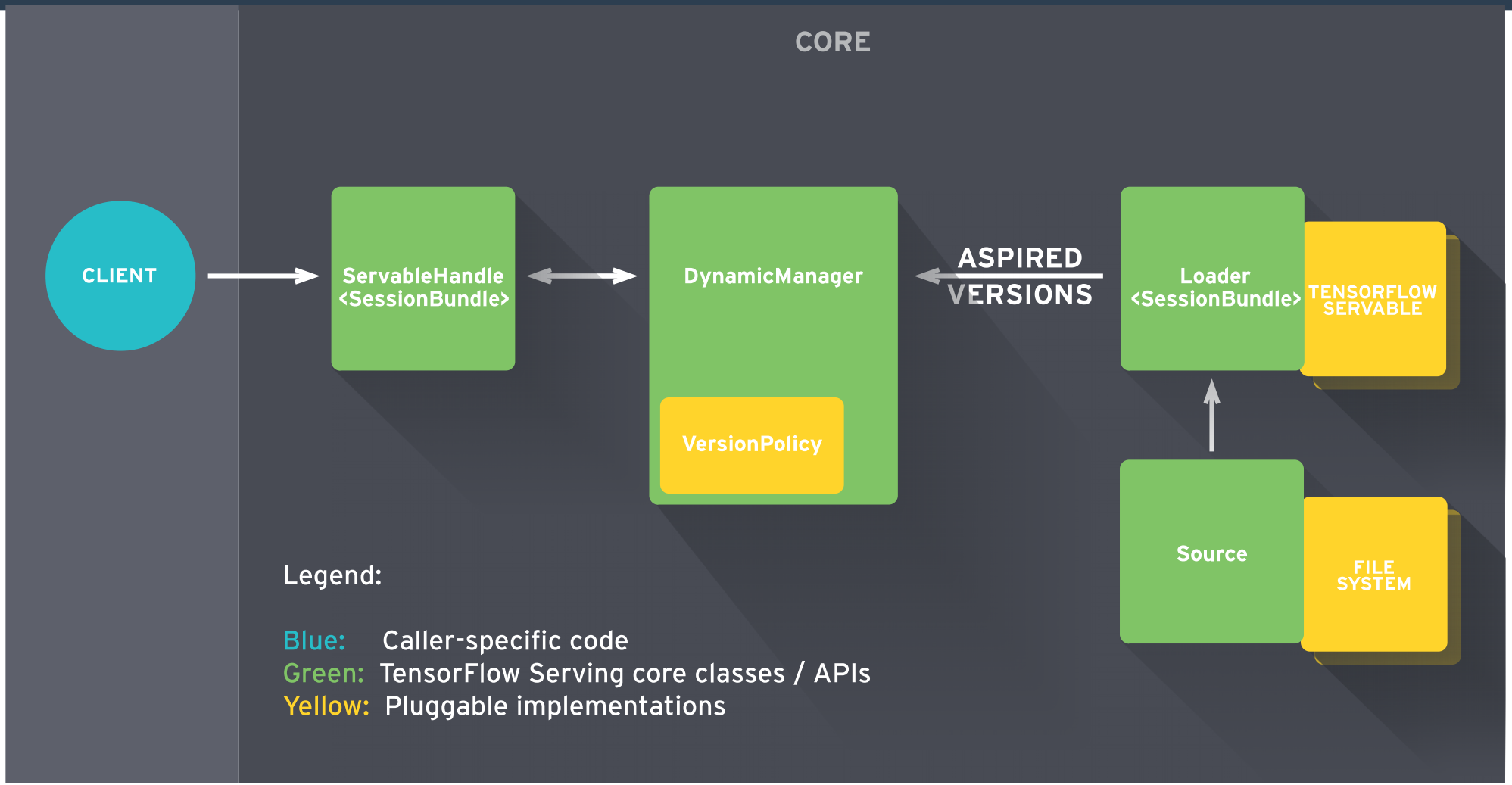


Architecture Overview

1. Servables
   1. Versions
   2. Model + Parameter(Weight, bias..)
   3. One Model can be sharded into several servable instances
2. Loaders
   1. Manage servable's lifecycle
   2. enable common infrastructure independent from specific learning algorithms
3. Sources
   1. originate servables.(stream of versions)
   2. one loader for each each version
   3. Aspired Versions – set of versions that should be loaded and ready



Architecture Overview



Installation

- **Prerequisites**
  - **Bazel**
    - https://github.com/bazelbuild/bazel/releases
    - Compiling Package
    - Java8 Recommended – (Set JAVA_HOME)
  - **Python 2.7(gRPC dependent)**
  - **GRPC(Google Remote Procedure Call)**
    - http://www.grpc.io/
    - Cloud api service protocol by google.
    - Use Protobuff for Data serialization of structured data
    - (sudo) pip install grpcio
  - **Annaconda User**
    - ~ $ conda create -n python2 python=2.7 anaconda
    - ~ $ source activate python2
    -

Installation – Other Dep.

- sudo apt-get update && sudo apt-get install -y \
  build-essential \
  curl \
  git \
  libfreetype6-dev \
  libpng12-dev \
  libzmq3-dev \
  pkg-config \
  python-dev \
  python-numpy \
  python-pip \
  software-properties-common \
  swig \
  zip \
  zlib1g-dev

Tutorial - Basics

- **1. Train and Export TensorFlow Model**
  - $>bazel build //tensorflow_serving/example:mnist_export
  - $>bazel-bin/tensorflow_serving/example/mnist_export /tmp/mnist_model
  -
- **2. Bring Up Inference Service**
  - $>bazel build //tensorflow_serving/example:mnist_inference
  - $>bazel-bin/tensorflow_serving/example/mnist_inference --port=9000 /tmp/mnist_model/00000001
  - (Load Exported Tensor Flow Model)
- **3. Test the Server**
  - $>bazel build //tensorflow_serving/example:mnist_client
  - $>bazel-bin/tensorflow_serving/example/mnist_client --num_tests=1000 --server=localhost:9000
  -

Train and Export TensorFlow Model

```
76  # Export model
77  # WARNING(break-tutorial-inline-code): The following code snippet is
78  # in-lined in tutorials, please update tutorial documents accordingly
79  # whenever code changes.
80  export_path = sys.argv[-1]
81  print 'Exporting trained model to', export_path
82  saver = tf.train.Saver(sharded=True)
83  model_exporter = exporter.Exporter(saver)
84  signature = exporter.classification_signature(input_tensor=x, scores_tensor=y)
85  model_exporter.init(sess.graph.as_graph_def(),
86              default_graph_signature=signature)
87  model_exporter.export(export_path, tf.constant(FLAGS.export_version), sess)
88  print 'Done exporting!'
```

Saver : Serialize graph variable values to the model export
Sess.graph.as_graph_def() : protobuf of the graph
default_graph_signature : model export signature
    exporter.classification_signature; Classification model
    Tensor binding
        input_tensor = x
        scores_tensor = y

Check Exported model

- **$>ls /tmp/mnist_model**
- **00000001**
-
- **$>ls /tmp/mnist_model/00000001**
- **checkpoint export-00000-of-00001 export.meta**
-
Export.meta : seriallized tensorflow::MetaGraphDef of the model.
-
-
Graph Def. + metadata(Signatures)
-
Export-????-of-???? : serialized variables of the graph

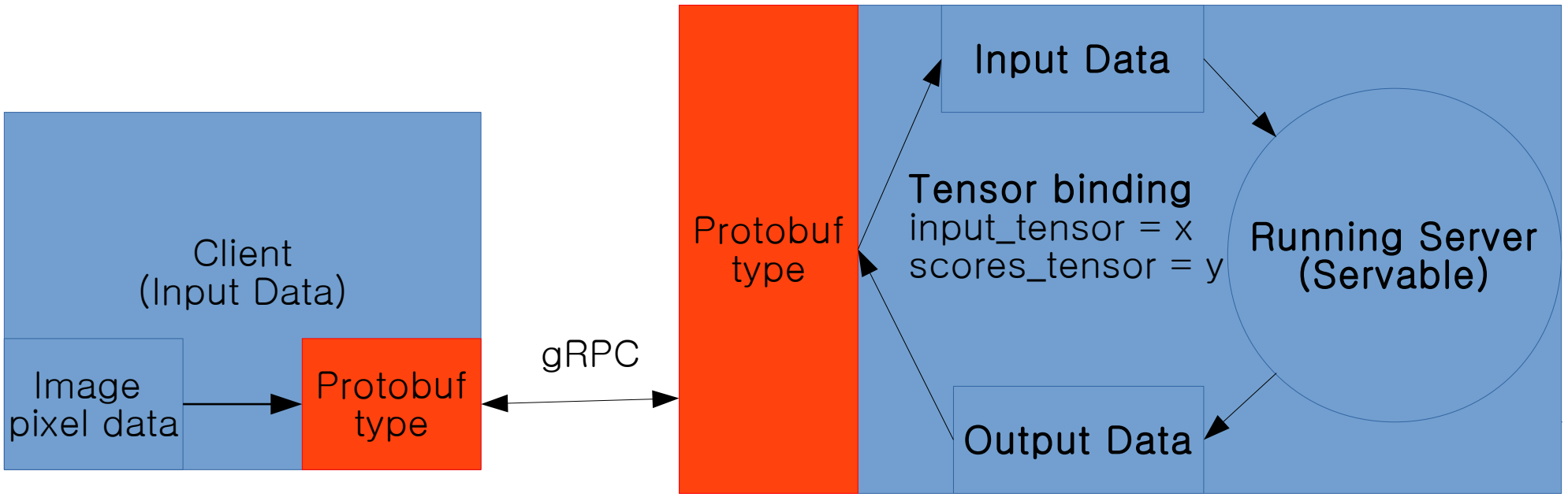
Bring Up Inference Service

- **Load Exported Tensorflow Model**

```
184   tensorflow::SessionOptions session_options;
185   std::unique_ptr<SessionBundle> bundle(new SessionBundle);
186   const tensorflow::Status status =
187     tensorflow::serving::LoadSessionBundleFromPath(session_options,
188                                 bundle_path, bundle.get());
189   if (!status.ok()) {
190    LOG(ERROR) << "Fail to load tensorflow export: " << status.error_message();
191    return -1;
192   }
193
194   RunServer(FLAGS_port, std::move(bundle));
195
196   return 0;
197 }
198
```

LoadSessionBundleFromPath : load exported tensorflow model
& Create SessionBundle

Bring Up Inference Service



Tutorial - Advanced

- **1. Version Management**
  - Dynamic Manager.
  - Unload Older versions and Load a new version models
- **2. Batching Scheduler**
  - The next task would cause the batch to exceed the size target.
  - Waiting for more tasks to be added would exceed the timeout.
  -

Tutorial - Advanced

```
413  UniquePtrWithDeps<tensorflow::serving::Manager> manager;
414  tensorflow::Status status = tensorflow::serving::simple_servers::
415    CreateSingleTFModelManagerFromBasePath(export_base_path, &manager);
416
417  TF_CHECK_OK(status) << "Error creating manager";
418
419  // Wait until at least one model is loaded.
420  std::vector<tensorflow::serving::ServableId> ready_ids;
421  // TODO(b/25545573): Create a more streamlined startup mechanism than polling.
422  do {
423   LOG(INFO) << "Waiting for models to be loaded...";
424   tensorflow::Env::Default()->SleepForMicroseconds(1 * 1000 * 1000 /*1 sec*/);
425   ready_ids = manager->ListAvailableServableIds();
426  } while (ready_ids.empty());
427
428  // Run the service.
429  RunServer(FLAGS_port, ready_ids[0].name, std::move(manager));
```

- **Version Management**
- CreateSingleTFModelManagerFromBasePath
  - SessionBundleSourceAdapter – SessionBundle Creater for each found Model in filesystem.
  - Dynamic Manager.

Tutorial - Advanced

- **Batch Scheduler**

```
void MnistServiceImpl::Classify(CallData* calldata) {
  ...
  std::unique_ptr<Task> task(new Task(calldata));
  tensorflow::Status status = batch_scheduler_->Schedule(std::move(task));
}
```

Task(calldata)

Batch Scheduler

Test and Run the Server

- **Export Trained Models**

Clear the export directory if it already exists:

```
$>rm -rf /tmp/mnist_model
```

Train (with 100 iterations) and export the first version of model:

```
$>bazel build //tensorflow_serving/example:mnist_export
$>bazel-bin/tensorflow_serving/example/mnist_export
--training_iteration=100 --export_version=1 /tmp/mnist_model
```

Train (with 2000 iterations) and export the second version of model:

```
$>bazel-bin/tensorflow_serving/example/mnist_export
--training_iteration=2000 --export_version=2 /tmp/mnist_model
```

Test and Run the Server

- **Run Server**

```
$>mkdir /tmp/monitored
$>cp -r /tmp/mnist_model/00000001 /tmp/monitored
$>bazel build //tensorflow_serving/example:mnist_inference_2
$>bazel-bin/tensorflow_serving/example/mnist_inference_2 --port=9000 /tmp/monitored
```

- **Model 1 (100 iteration)**

```
$>bazel build //tensorflow_serving/example:mnist_client
$>bazel-bin/tensorflow_serving/example/mnist_client --num_tests=1000 --server=localhost:9000
--concurrency=10
...
Inference error rate: 13.1%
```

- **Model 2 (1000 iteration)**

```
$>cp -r /tmp/mnist_model/00000002 /tmp/monitored
$>bazel-bin/tensorflow_serving/example/mnist_client --num_tests=1000 --server=localhost:9000
--concurrency=10
...
Inference error rate: 9.5%
```