Forecasting in the mlr Framework

Steve Bronder

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Goal: Make Forecasting Simple

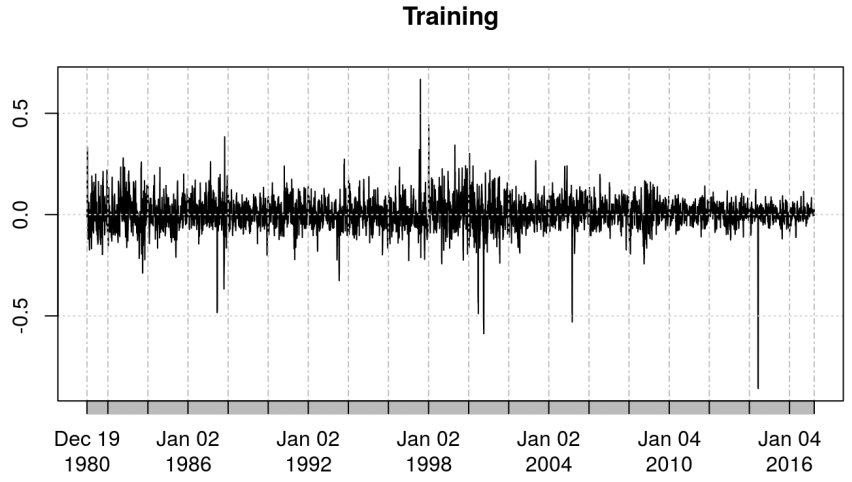
"We need to stop teaching abstinence and start teaching safe statistics" - Hadley Wickham

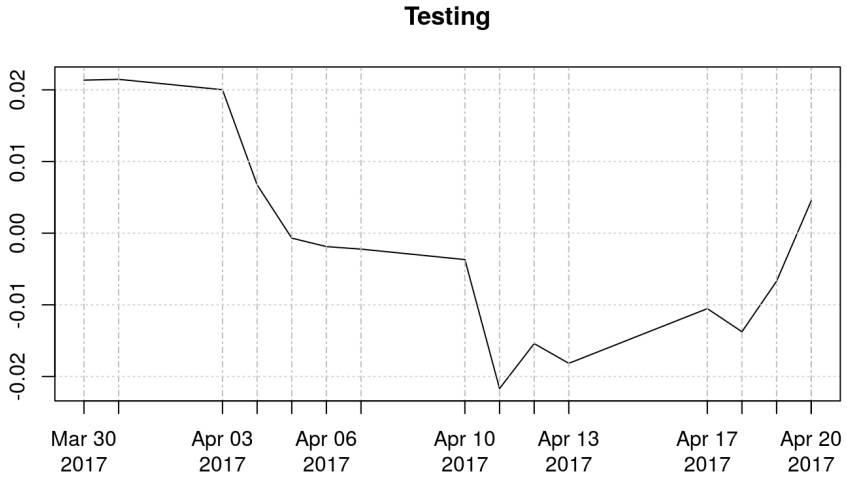
- No framework for tuning forecasting models
- R has great ML Packages and Forecasting Packages
- Forecasting and ML fields are divided

Goal: Simple Answer

Example Data

- Weekly Percent Change in Apple Closing Price
- Training: December 19th, 1980 : March 29th, 2017 (9147 days)
- Holdout: March 30th, 2017 : April 20th, 2017 (15 days)





Creating a Forecasting Task

- Task: Keeps data and meta-data for ML task

```
library(mlr)
aaplXtsTrain = data.frame(coredata(aaplXtsTrain),
  daily_dates = index(aaplXtsTrain))
aaplXtsTest = data.frame(coredata(aaplXtsTest),
  daily_dates = index(aaplXtsTest))

aaplTask = makeForecastRegrTask(
  id = "Weekly Percent Change in Apple Closing Price",
  data = aaplXtsTrain,
  target  = "Close",
  date.col = "daily_dates",
  frequency = 5L)
```

Creating a Forecasting Task: Info

```
aaplTask
```

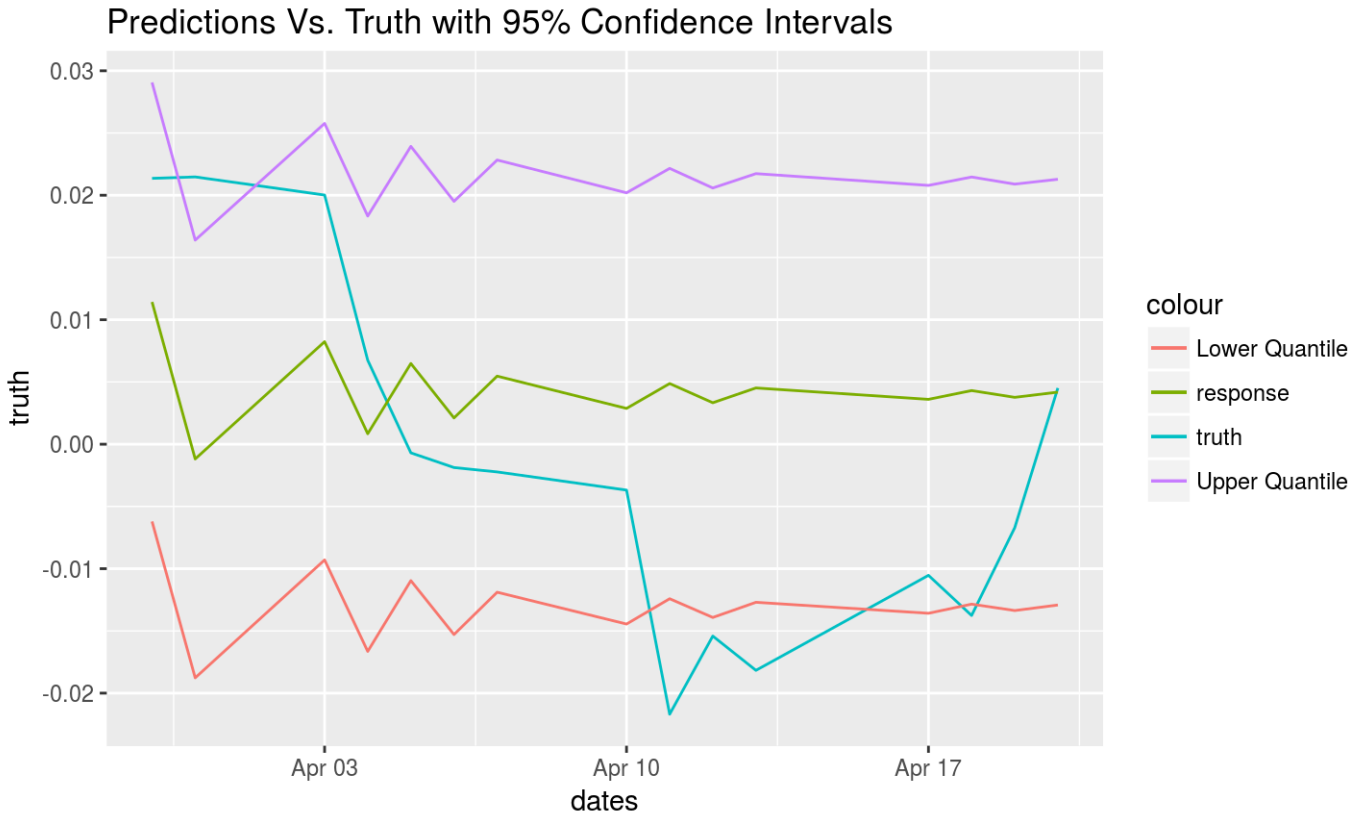
```
Task: Weekly Percent Change in Apple Closing Price
Type: fcregr
Target: Close
Observations: 9147
Dates:
 Start: 1980-12-19
 End:   2017-03-29
Frequency: 5
Features:
numerics  factors  ordered
       0        0        0
Missings: FALSE
Has weights: FALSE
Has blocking: FALSE
```

Training a Forecasting Learner

```
# Make learner
garch.mod = makeLearner("fcregr.garch", model = "sGARCH",
    garchOrder = c(1, 1), distribution.model = "sged",
    armaOrder = c(2, 2), n.ahead = 15, predict.type = "quantile",
    solver = "hybrid")
# Train and predict
garch.train = train(garch.mod, aaplTask)
predAapl = predict(garch.train, newdata = aaplXtsTest)
# Evaluate performance
performance(predAapl, measures = list(mase,
    rmse), task = aaplTask, model = garch.train)
```

```
      mase       rmse
0.17633953 0.01452162
```

Prediction Plot



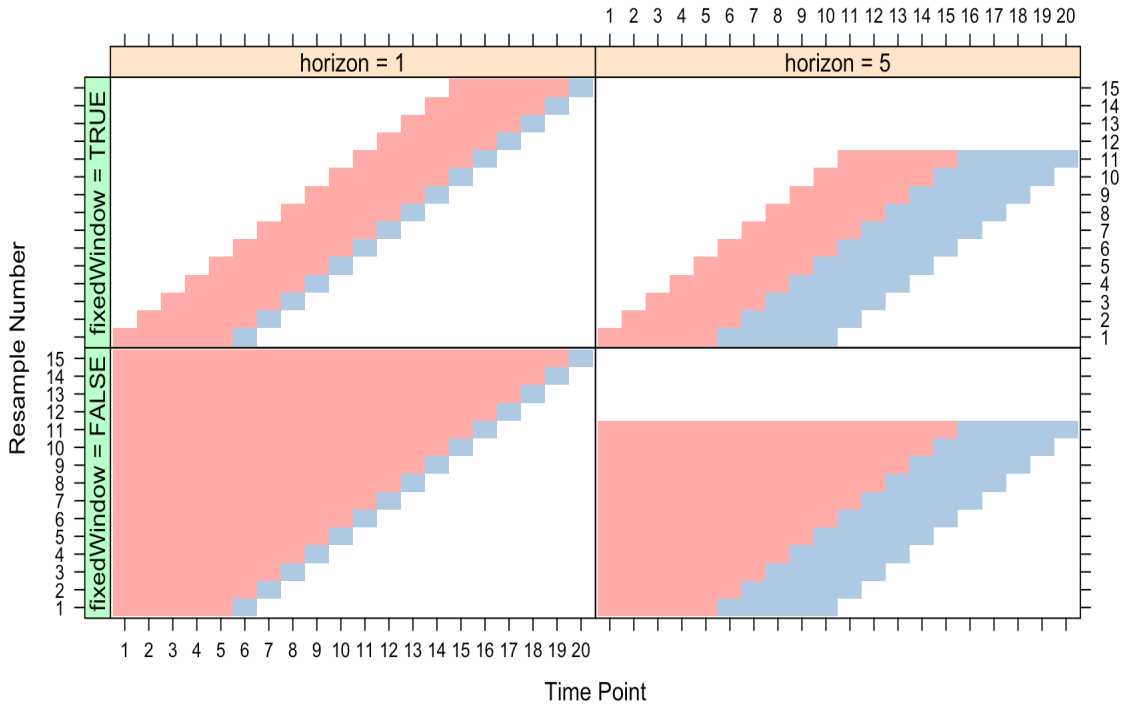
Tuning a Model: Param Set and Search

```
par_set = makeParamSet(
  makeDiscreteParam(id = "model",
                    values = c("sGARCH", "csGARCH", "fGARCH")),
  makeDiscreteParam("submodel", values = c("GARCH","TGARCH","AVGARCH"),
    requires = quote(model == 'fGARCH') ),
  makeIntegerVectorParam(id = "garchOrder", len = 2L,
                         lower = 1, upper = 15),
  makeIntegerVectorParam(id = "armaOrder", len = 2L,
                         lower = 1, upper = 15),
  makeLogicalParam(id = "include.mean"),
  makeLogicalParam(id = "archm"),
  makeDiscreteParam(id = "distribution.model",
                    values = c("norm","std","jsu", "sged")),
  makeDiscreteParam(id = "stationarity", c(0,1)),
  makeDiscreteParam(id = "scale", c(0,1))
)

ctrl = makeTuneControlIrace(budget = 250)
```

Tuning a Model: Resampling

- 21 growing window CV

```
resampDesc = makeResampleDesc("GrowingCV",
    horizon = 15L, initial.window = 0.5,
    skip = 220)
```



Tuning a Model: Tuning

```
garch.mod = makeLearner("fcregr.garch", n.ahead = 15, solver = 'hybrid')
library(parallelMap)
parallelStart("multicore", 7, level = "mlr.resample")
configureMlr(on.learner.error = "warn")
set.seed(1234)
garch.res = tuneParams(garch.mod, task = aaplTask,
                 resampling = resampDesc, par.set = par_set,
                 control = ctrl,
                 measures = mase)
parallelStop()
garch.res
```

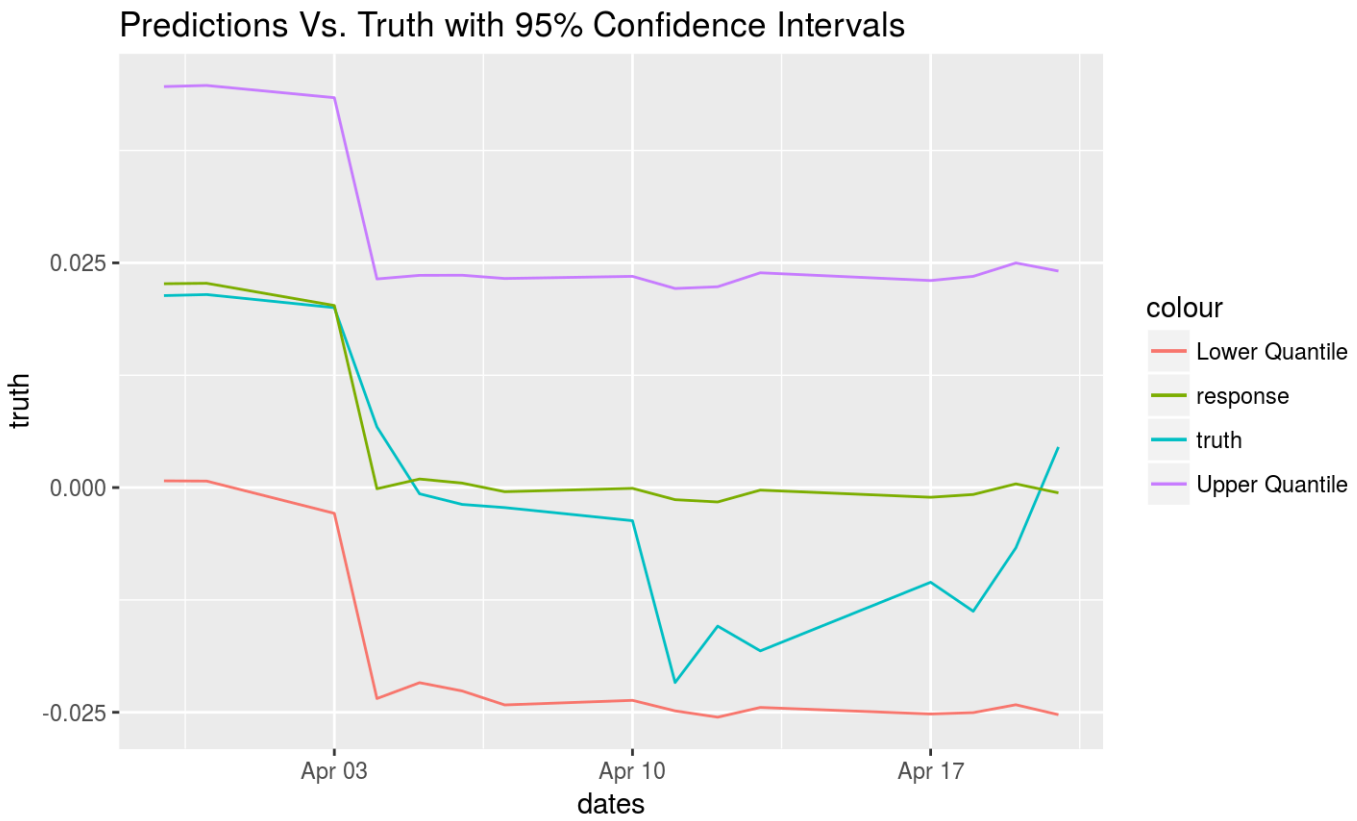
```
Tune result:
Op. pars: model=sGARCH; garchOrder=4,4; armaOrder=8,9; include.mean=FALSE; archm=FALSE; distri
mase.test.mean=0.494
```

Tuning a Model: Forecasting

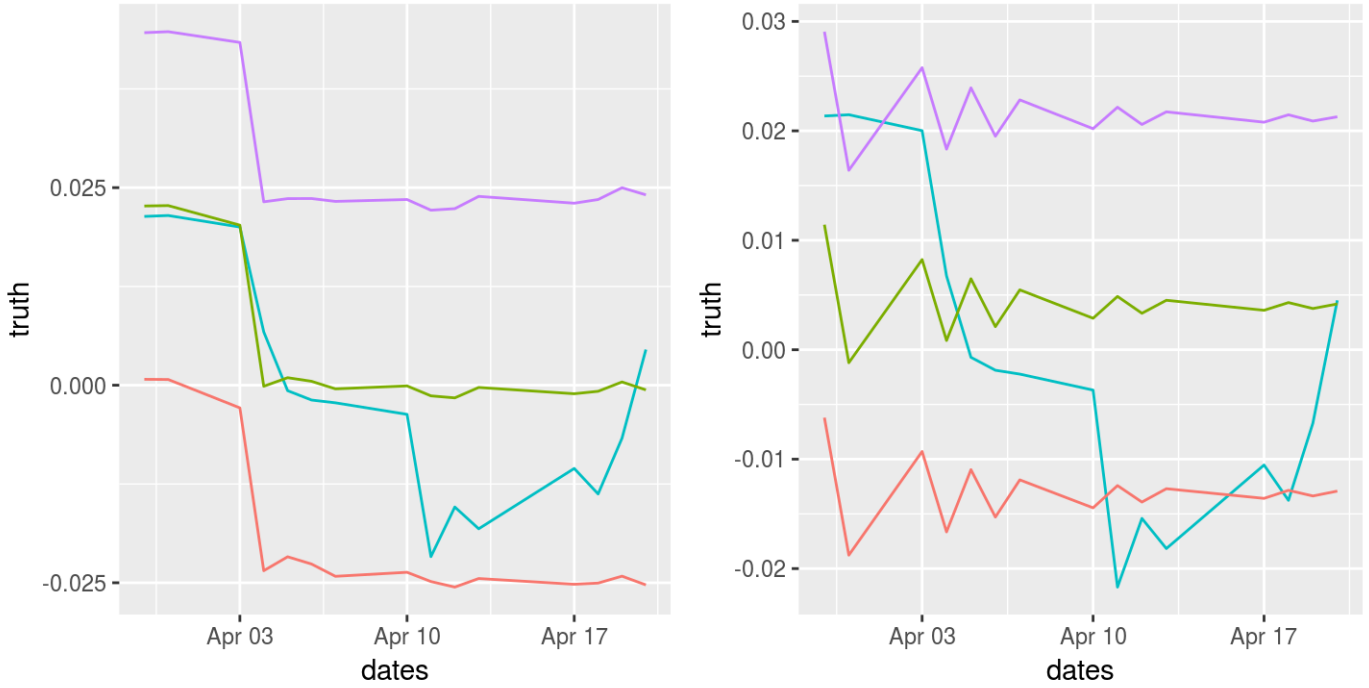
```
library(mlr)

# Train Final Model
garch.final = setHyperPars(garch.mod, par.vals = garch.res$x)
garch.train = train(garch.final, aaplTask)
# Predict
garch.pred = predict(garch.train, newdata = aaplXtsTest)
performance(garch.pred, measures = list(mase,
    rmse), task = aaplTask, model = garch.train)
```

```
       mase        rmse
0.099914625 0.009431966
```

Tuning a Model: Plot



Tuned Vs. Untuned



Prediction Vs. Truth:
Tuned Vs. Untuned

Conclusion

- We have a unified framework for forecasting and machine learning
- Forecasting mlr branch here
- Thank you for listening!
- sab2287@columbia.edu

Forecasting with ML: Task

```
# Make Standard Regression Task
aaplRegTask <- makeRegrTask(id = "Weekly Percent Change in Apple Closing Price",
    data = aaplXtsTrain[, "Close", drop = FALSE],
    target = "Close")

# Use AR(p,d) pre-processing
date_col = aaplXtsTrain$daily_dates
aaplXtsTest$daily_dates <- NULL
aaplLagTask = createLagDiffFeatures(aaplRegTask,
    lag = 1L:500L, difference = 1L:50L, difference.lag = 1L:50L,
    na.pad = FALSE, date.col = date_col)
```

Forecasting with ML: Parameters

```
ranger.lrn = makeLearner("regr.ranger", num.threads = 7)
par.set = makeParamSet(
  makeIntegerParam("num.trees", lower = 200, upper = 2500),
  makeLogicalParam("respect.unordered.factors"),
  makeIntegerParam("mtry", lower = 1, upper = 80),
  makeIntegerParam("min.node.size", lower = 1, upper = 10),
  makeDiscreteParam("splitrule", values = c("variance", "maxstat")),
  makeNumericParam("alpha", lower = .001, upper = .8 ),
  makeNumericParam("minprop", lower = .001, upper = .5)
)
```

Forecasting with ML: Tuning

```
library(mlrMBO)
mbo.ctrl = makeMBOControl()
mbo.ctrl = setMBOControlTermination(mbo.ctrl,
    max.eval = 100)
ctrl = mlr:::makeTuneControlMBO(mbo.control = mbo.ctrl)

tune_mod <- tuneParams(learner = ranger.lrn,
    task = aaplLagTask, measures = mase,
    resampling = resampDesc, par.set = par.set,
    control = ctrl)

tune_mod
```

```
Tune result:
Op. pars: num.trees=1295; respect.unordered.factors=TRUE; mtry=79; min.node.size=2; splitrule=
mase.test.mean=0.31
```

Forecasting with ML: Forecast

```
ranger.final = setHyperPars(ranger.learner,
    par.vals = tune_mod$x)
ranger.trn.model = train(ranger.final, aaplLagTask)
ranger.fc = forecast(ranger.trn.model, h = 15,
    newdata = aaplXtsTest[, "Close", drop = FALSE])
performance(ranger.fc, list(mase, rmse),
    task = aaplLagTask, model = ranger.trn.model)
```

```
      mase       rmse
0.44726774 0.01561785
```

Forecasting with ML: Plot