

A VISUAL GUIDE TO SUPERLEARNING



Superlearning, or stacking, weights the results of many individual statistical learning algorithms to create an optimal overall prediction algorithm. Superlearner predictions are expected to perform at least as well as any of the individual learners in large sample sizes.

STEP 1

Split data into 10 blocks in preparation for 10-fold cross validation.



STEP 2

Train multiple base learners on 9 of the 10 blocks of data.

```
fit_1a <- lmr_a( [blue block], [9 green blocks] )
fit_1b <- lmr_b( [blue block], [9 green blocks] )
fit_1c <- lmr_c( [blue block], [9 green blocks] )
```

Base learners can include any number of parametric or non-parametric supervised statistical learning algorithms.

An example of three base learners for a binary outcome could be random forest, gradient boosting, and logistic regression.

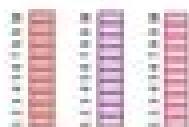
STEP 3

Obtain predictions from each base learner for the held-out block of data.

```
#<-- predict(fit_1a, newdata = [green block])
#<-- predict(fit_1b, newdata = [green block])
#<-- predict(fit_1c, newdata = [green block])
```

STEP 4

Repeat until each of the 10 blocks have served as the hold-out data and you have three sets of cross-validated predictions spanning the full data set.



STEP 5

Using a new learner, a metalearner, predict the outcome using the three sets of cross-validated predictions.

```
SL_fit <- meta_lmr( [blue block], [red blocks] + [purple blocks] )
```

The metalearner can be as simple as a generalized linear model. As with any statistical learning algorithm, the choice reflects a loss function we want to minimize.

STEP 6

Fit the base learners on the entire data set.

```
fit_a <- lm_r_a( [blue block] - [green block] )
fit_b <- lm_r_b( [blue block] - [green block] )
fit_c <- lm_r_c( [blue block] - [green block] )
```

STEP 7

Obtain predictions from the full data set for each learner.

```
#<-- predict(fit_a)
#<-- predict(fit_b)
#<-- predict(fit_c)
```

STEP 8

Use the coefficients from Step 5 to weight the full data predictions from Step 7. These are the final superlearner predictions.

```
#<-- predict(SL_fit, newdata = [green block])
```

The final superlearner predictions are a weighted combination, or ensemble, of the base learners' predictions.

STEP 9

To predict on new data, use the base learner fits to obtain base learner predictions (similar to Step 7), then input the base learner predictions into the metalearner fit (similar to Step 8) to obtain the final prediction.

EVALUATION

To test the prediction capability of the superlearner algorithm and prevent overfitting, the entire algorithm (Steps 1-8) could be cross-validated.

APPLICATION

There are several R packages to implement superlearning. This example uses the SuperLearner package to create a superlearner model for a binary outcome with three learners: gradient boosting (xgboost), random forest (ranger), and logistic regression (glm) with a loss function/metalearning step of negative log-likelihood (method="NLoglik").

```
SL_fit <- SuperLearner( [blue block], [green block] ,
family=binomial(),
SL.library = c("SL.xgboost",
"SL.ranger",
"SL.glm"),
method = "NLoglik")
```

REFERENCES

Targeted Learning, Chapter 3:
Superlearning by Eric Polley, Sherry Rose, and Mark van der Laan.

For a step-by-step tutorial with R code, explanations, and more references:
www.khstats.com/blog/tutorials/superlearning

Superlearning

Ludger Schiffler

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Superlearning Sheila Ostrander,Lynn Schroeder,1979-01-15 *Superlearning 2000* Sheila Ostrander,Lynn Schroeder,2012-03-07 A marvelous resource for those who do not want to be limited by their beliefs Read and learn about human potential yours and mine Bernard Siegel M D author of Love Medicine Miracles Speak Russian like a native play tennis like a pro and meet the challenges of a high tech world with high powered memory skills Superlearning 2000 is the fast fun and innovative learning technique that enables you to master any skill or subject from computers to athletics to conversational French in a fraction of traditional learning time Hailed by the Fortune 500 as the mental technology of the future proven by super achievers around the world this revolutionary program will unlock your limitless potential put you on the fast track to new opportunities and higher earnings change forever the way you think about learning Discover How you can fine tune your memory and learn anything 2 to 5 times faster simply by tuning in to the right kind of music Which world class mental techniques enhance athletic performance The step by step Superlearning techniques that keep you in step with technology How you can overcome learning blocks and even learning disabilities How to boost creativity rev up recall and acquire expert know how in any field while you relax **Superlearning 3000** Emily Diane Gunter,2010-11-11

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Sheila Ostrander,1979 Suggestopedic Methods and Applications Ludger Schiffler,2013-09-13 First Published in 1992 This book is required reading for any serious student of Suggestopedia Professor Schiffler has done a critical assessment of Dr Lozanov s work from its beginning up to 1985 **Encyclopedia of the Sciences of Learning** Norbert M. Seel,2011-10-05 Over the past century educational psychologists and researchers have posited many theories to explain how individuals learn i e how they acquire organize and deploy knowledge and skills The 20th century can be considered the century of psychology on learning and related fields of interest such as motivation cognition metacognition

etc and it is fascinating to see the various mainstreams of learning remembered and forgotten over the 20th century and note that basic assumptions of early theories survived several paradigm shifts of psychology and epistemology Beyond folk psychology and its na ve theories of learning psychological learning theories can be grouped into some basic categories such as behaviorist learning theories connectionist learning theories cognitive learning theories constructivist learning theories and social learning theories Learning theories are not limited to psychology and related fields of interest but rather we can find the topic of learning in various disciplines such as philosophy and epistemology education information science biology and as a result of the emergence of computer technologies especially also in the field of computer sciences and artificial intelligence As a consequence machine learning struck a chord in the 1980s and became an important field of the learning sciences in general As the learning sciences became more specialized and complex the various fields of interest were widely spread and separated from each other as a consequence even presently there is no comprehensive overview of the sciences of learning or the central theoretical concepts and vocabulary on which researchers rely The Encyclopedia of the Sciences of Learning provides an up to date broad and authoritative coverage of the specific terms mostly used in the sciences of learning and its related fields including relevant areas of instruction pedagogy cognitive sciences and especially machine learning and knowledge engineering This modern compendium will be an indispensable source of information for scientists educators engineers and technical staff active in all fields of learning More specifically the Encyclopedia provides fast access to the most relevant theoretical terms provides up to date broad and authoritative coverage of the most important theories within the various fields of the learning sciences and adjacent sciences and communication technologies supplies clear and precise explanations of the theoretical terms cross references to related entries and up to date references to important research and publications The Encyclopedia also contains biographical entries of individuals who have substantially contributed to the sciences of learning the entries are written by a distinguished panel of researchers in the various fields of the learning sciences

Superlearning 2000 ,1993-06-05 **Controversies in ELT** Maurice Claypole,2010 This thought provoking and informative collection of essays covers a broad spectrum of topics including Why the communicative approach is dead and what to do about it How to implement blended learning in day to day English teaching Virtual worlds and why English teachers should get a second life The different roles played by the language teacher The value of translation in language teaching Whether native English speakers really make better teachers Why you should NOT be teaching International English A more effective way to teach Technical English The truth about Superlearning and suggestopaedia The secret to being a good English teacher And as you might expect from a book subtitled what you always wanted to know about teaching English but were afraid to ask it even includes a chapter on teaching the English of that forbidden subject sex Also released for the first time in book form are chapters on the author s unique insight into the correlation between language set theory and fractal mathematics and the consequences for English teachers Controversy is evident from the very first chapter

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