# A VISUAL GUIDE TO SUPERLEARNING

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**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.
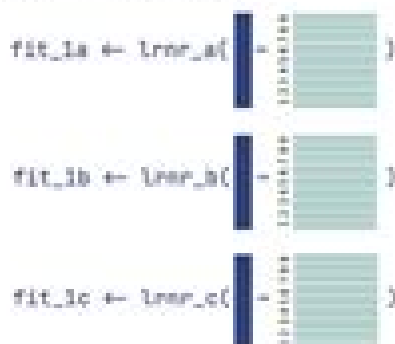
## STEP 1

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



## STEP 2

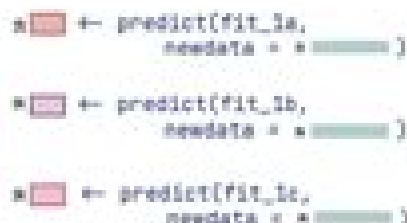Train multiple base learners on 9 of the 10 blocks of data.



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

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*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.



## 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.
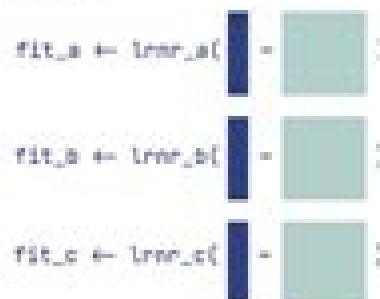


## STEP 5

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



*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.*
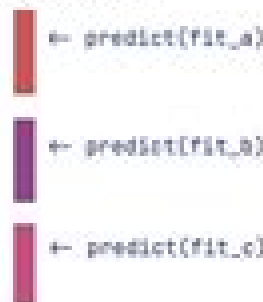
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## STEP 6

Fit the base learners on the entire data set.



## STEP 7

Obtain predictions from the full data set for each learner.



## STEP 8

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



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

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## 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 cabability 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="NNLogLik"):



```
SL_fit <- SuperLearner(   ,

   family=binomial(),
   SL.library = c("SL.xgboost",
                  "SL.ranger",
                  "SL.glm"),
   method = "NNLogLik")
```

### REFERENCES

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

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

# Superlearning

**M Mark**

**Superlearning:**

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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 it was

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**Table of Contents Superlearning**

1. Understanding the eBook Superlearning
    - The Rise of Digital Reading Superlearning
    - Advantages of eBooks Over Traditional Books
2. Identifying Superlearning
    - Exploring Different Genres
    - Considering Fiction vs. Non-Fiction
    - Determining Your Reading Goals
3. Choosing the Right eBook Platform
    - Popular eBook Platforms
    - Features to Look for in an Superlearning
    - User-Friendly Interface
4. Exploring eBook Recommendations from Superlearning
    - Personalized Recommendations
    - Superlearning User Reviews and Ratings
    - Superlearning and Bestseller Lists
5. Accessing Superlearning Free and Paid eBooks
    - Superlearning Public Domain eBooks
    - Superlearning eBook Subscription Services
    - Superlearning Budget-Friendly Options
6. Navigating Superlearning eBook Formats

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