



Are published
complex
prediction
rules
applicable?

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Hornung

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Are published complex prediction rules currently applicable for readers? A survey of applied random forest literature and recommendations

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- **prediction rule: empirically learned** function which uses **covariate data** of a patient to **return a prediction** of his/her value of a specific phenotype variable
- prediction rules **presented and evaluated in numerous articles** in the biomedical literature
- **important question:** Are these rules **accessible to readers** interested to apply them?
- **Answer depends on** various factors, among them importantly the **choice of the method** to construct the prediction rule.



Differing model complexities of logistic regression and Random Forest

Are published complex prediction rules applicable?

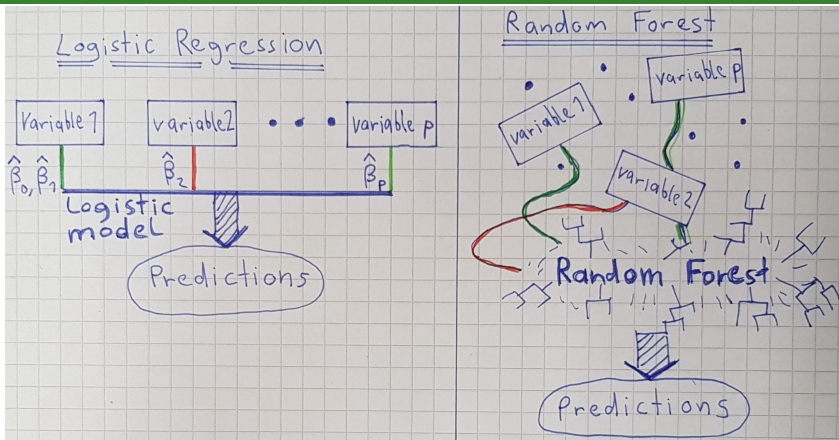
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logistic regression: $\hat{\beta}_0, \hat{\beta}_1, \dots, \hat{\beta}_p$ available \Rightarrow rule applicable 😊

Random Forest (RF): long-lasting, easy to use **software solution required** 😞



Applicability of published RF prediction rules?

A Systematic literature review

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- **study cohort: 30 research papers** that present a prediction rule obtained using **RF** (journal: PLOS ONE, field: medical and health science, time frame: 2014/2015)

- **study goals:**
 - 1 Provide an **empirically grounded up-to-date picture** on the **applicability** of published RF prediction rules.

 - 2 Give **recommendations** on **making RF prediction rules applicable**.



Results

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- prediction rule **available without intervention** ✓✓ :
1 of 30 **papers (3%)**
- prediction rule **constructable** using available
data + code ✓ :
1 of 30 **papers (3%)**
- prediction rule **constructable after obtaining material
from** corresponding authors ✓ :
8 of 30 **papers (27%)**
- prediction rule **not constructable after contacting**
corresponding authors ✗ :
20 of 30 **papers (67%)** (9 no response, 11 necessary
material not sent)

Options for making complex prediction rules applicable I

- **Option A:** providing a **software object** (e.g., R object `randomForest` usable by R function `predict()`)
 - training **data not required**
 - prediction rule **not modifiable**

- **Option B:** providing **data and code**
 - **adaptation** of prediction rule **possible**
 - analysis flow **completely transparent**
 - results **reproducible**
 - training **data** must be provided

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Options for making complex prediction rules applicable II

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- **Option C:** providing an **online tool** (e.g., using R package shiny)
 - **no knowledge** of software required
 - **fast** applicability
 - prediction rule **not modifiable**
- **Option D:** providing a Predictive Model Markup Language (**PMML**) document ("**interchange format**")
 - **software independent** ⇒ **permanent** applicability
 - integration of **data preprocessing** steps possible
 - **specialized knowledge required**
 - prediction rule **not modifiable**

Choice **depends on context** – **no** universally **best option**.



Recommendations

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- authors' **homepages** often **not longstanding** ✗
 - ⇒ Provide **materials in the paper supplement**.
 - ⇒ **permanent** availability ✓
- Provide a **meticulous description of** the steps needed to obtain a **prediction** using the prediction rule.
 - ⇒ **intrinsic applicability check**
 - ⇒ **facilitates** in particular the conduction of complicated **pre-processing steps**
- Beyond the scope of the survey, our **recommendations** are **applicable also to other prediction methods** than RF.



Further notes & conclusions

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- published RF prediction rules **not always intended for immediate application** (“proof of principle”)
- **Nevertheless:** Published RF prediction rules are **to date seldom applicable**; **contacting** the corresponding **authors very often does not help.**
- Actual situation **might be even worse due to optimistic study design** (investigators’ expertise, journal choice, considered time frame).
- **lack of awareness** of limited applicability of prediction rules **in the scientific community**

References and thank you for your attention!



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Collecting information + contacting paper authors

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- **From each paper** the **same information** was extracted.
- All information was **gathered by two statisticians independently**.
- **information included:**
 - **type of data** (e.g., clinical, omics, imaging)
 - **software** used (e.g., R (package), Weka, Matlab)
 - complex **data preprocessing** necessary?
 - **availability of data / of codes** used to produce the RF (supplementary files, external link, not available)
- **contacted authors if** prediction rule **not obtainable** by provided information



Applicability: comparison with **logistic regression**

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■ **study design:**

- **122** PubMed listed **papers** that present a prediction rule obtained using **logistic regression** (time frame: 2014/2015)
- **no contacting** of paper authors (\Rightarrow pessimistic bias!)
- **not well comparable to** survey on **RF** (only low-dimensional data, stronger focus on medical papers)

■ **results:**

- prediction rule **available/constructable** ✓:
55 of 122 **papers (45%)**
- prediction rule **not available/constructable** ✗:
67 of 122 **papers (55%)**

■ **conclusions:**

- **much better applicability** for logistic regression **than for RF**
- still much **room for improvement**