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date of birth 08/27/1991A question I get asked a lot on my email list is: what is the best programming language for machine learning?

I’ve replied to this question many times now it’s about time to explore this further in a blog post. Ultimately, the programming language you use for machine learning should consider your own requirements and predilections. No one can meaningfully address those concerns for you.

What Languages Are Being Used

Before I give you my opinion, it is good to have  a look around to see what languages and platforms are popular in self-selected communities of data analysis and machine learning professionals.

KDnuggets has had language polls forever. A recent poll is titled “What programming/statistics languages you used for an analytics / data mining / data science work in 2013“. The trends are almost identical to the previous year. The results suggest heavy use of R and Python and SQL for data access. SAS and MATLAB rank higher than I would have expected. I’d expect SAS accounts for larger corporate (Fortune 500) data analysis and MATLAB for engineering, research and student use.

Kaggle offer machine learning competitions and have polled their user base as to the tools and programming languages used by participants in competitions. They posted results in 2011 titledKagglers’ Favorite Tools (also see the forum discussion). The results suggested the abundant use of R. The results also show good use of MATLAB and SAS with much lower Python representation. I can attest that I prefer R over Python for competition work. It just feels though it has more on offer in terms of data analysis and algorithm selection.

Ben Hamner, Kaggle Admin and author of the blog post above on the Kaggle blog goes into more detail on the options when it comes to programming languages for machine learning in a forum post titled “What tools do people generally use to solve problems“.

Ben comments that MATLAB/Octave is a good language for matrix operations and can be good when working with a well defined feature matrix. Python is fragmented by comprehensive and can be very slow unless you drop into C. He prefers Python when not working with a well defined feature matrix and uses Pandas and NLTK. Ben comments that “As a general rule, if it’s found to be interesting for statisticians, it’s been implemented in R” (well said). He also complains about the language itself being ugly and painful to work with. Finally, Ben comments on Julia that doesn’t have much to offer in the way of libraries but is his new favorite language. He comments that it has the conciseness of languages like MATLAB and Python with the speed of C.

Anthony Goldbloom, the CEO of Kaggle gave a presentation to the Bay Area R user group in 2011 on the popularity of R in Kaggle competitions titled Predictive modeling competitions: making data science a sport (see the powerpoint slides). The presentation slides give more detail on the use of programming languages and suggest an Other category that is as close to as large as large as the usage of R. It would be nice to have the raw data that was collected (why didn’t they release it to their own data community, seriously!?).

John Langford on his blog Hunch has an excellent article on the properties of a programming language to consider when working with machine learning algorithms titled “Programming Languages for Machine Learning Implementations“. He divides the properties into concerns of speed and the concerns of programability (programming ease). He points to powerful industry standard implementations of algorithms, all in C and comments that he has not used R or MATLAB (the post was written 8 years ago). Take some time and read some of the comments by academics and industry specialists alike. This is a deep and nuanced problem that really comes down to the specifics of the problem you are solving and the environment in which you are solving it.

Machine Learning Languages

I think of programming languages in the context of the machine learning activities I want to perform.

MATLAB/Octave

I think MATLAB is excellent for representing and working with matrices. As such, I think it’s an excellent language or platform to use when climbing into the linear algebra of a given method. I think it’s suited to learning about algorithms both superficially the first time around and deeply when you are trying to figure something out or go deep into the method. For example, it’s popular in university courses for beginners, like Andrew Ng’s Coursera Machine Learning course.

R

R is a workhorse for statistical analysis and by extension machine learning. Much talk is given to the learning curve, I didn’t really see the problem. It is the platform to use to understand and explore your data using statistical methods and graphs. It has a n enormous number of machine learning algorithms, and advanced implementations too written by the developers of the algorithm.

I think you can explore, model and prototype with R. I think it suits one-off projects with an artefact like a set of predictions, report or research paper. For example, it is the most popular platform for machine learning competitors such as Kaggle.

Python

Python if a popular scientific language and a rising star for machine learning. I’d be surprised if it can take the data analysis mantle from R, but matrix handling in NumPy may challenge MATLAB and communication tools like IPython are very attractive and a step into the future of reproducibility.

I think the SciPy stack for machine learning and data analysis can be used for one-off projects (like papers), and frameworks like scikit-learn may be mature enough to be used in production systems.

Java-family/C-family

Implementing a system that uses machine learning is an engineering challenge like any other. You need good design and developed requirements. Machine learning is algorithms, not magic. When it comes to serious production implementations, you need a robust library or you customize an implementation of the algorithm for your needs.

There are robust libraries, for example Java has Weka and Mahout. Also note that the deeper implementations of core algorithms like regression (LIBLINEAR) and SVM (LIBSVM) are written in C and leveraged by Python and other toolkits. I think you are serious you may prototype in R or Python, but you will implement in a heavier language for reasons such as execution speed and system reliability. For example, the backend of BigML is implemented in Clojure.

Other Concerns

Not a Programmer: If you are not a programmer (or not a confident programmer) I recommend playing machine learning via a GUI interface like Weka.

One Language for Research and Ops: You may want to use the same language for prototyping and for production to reduce risk of not effectively transferring the results.

Pet Language: You may have a pet language of favorite language and want to stick to that. You can implement algorithms yourself or leverage libraries. Most languages have some form of machine learning package, however primitive.

Wisconsin Division

of Safety and Buildings

Application No.

Wisconsin Uniform Building

Permit Application

Wisconsin Stats. 101.63, 101.73

Instructions on back of second ply. The information you provide may be

used by other government agency programs [(Privacy Law, s. 15.04 (1)(m)]

PERMIT REQUESTED

Constr.

HVAC

Electric

Owner’s Name

Mailing Address

Contractor Name & Type

Dwelling Contractor (Constr.)

Lic/Cert#

Plumbing

Parcel No.

Erosion Control

Other:

Tel.

Mailing Address

Dwelling Contr. Qualifier

Tel. & Fax

The Dwelling Contr. Qualifier shall be an owner,

CEO, COB or employee of the Dwelling Contr.

HVAC

Electrical

Plumbing

PROJECT

LOCATION

Lot area

Sq.ft.

One acre or more of

soil will be disturbed

Building Address

Town

Village

City of

County

Zoning District(s)

Subdivision Name

Zoning Permit No.

Setbacks:

Front

3. OCCUPANCY

Single Family

Two Family

Garage

Other:

Repair

Raze

Move

2. AREA INVOLVED (sq ft)

Unit 1

Unit 2

Total

4. CONST. TYPE

Site-Built

6. ELECTRIC

Entrance Panel

Amps: \_\_\_\_\_\_\_

Underground

Overhead

7.WALLS

Wood Frame

Steel

Mfd. per WI UDC

Mfd. per US

HUD

Unfin.

Bsmt

Living

Area

5. STORIES

1-Story

Garage

Deck/

Porch

Totals

9. HVAC EQUIP.

Furnace

Radiant Basebd

Heat Pump

Boiler

Central AC

Fireplace

Other:

ICF

Timber/Pole

Other:

Rear

Permanent

Other:

Other:

E/W

Block No.

Left

Right

ft.

ft.

12. ENERGY SOURCE

Fuel

Nat

LP

Gas

Space Htg

Water Htg

Oil

Elec

ft.

Solid

Solar

Geo

13. HEAT LOSS

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ BTU/HR Total Calculated

Envelope and Infiltration Losses (available from "Total

Building Heating Load" on Rescheck report)

Sanitary Permit#

8. USE

Seasonal

2-Story

10. SEWER

Municipal

N, R

Lot No.

ft.

1. PROJECT

New

Alteration

Addition

Other:

,T

\_\_\_\_\_ 1/4, \_\_\_\_\_\_ 1/4, of Section

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

11. WATER

14. EST. BUILDING COST w/o LAND

Municipal

Plus Basement

On-Site Well

$

I understand that I: am subject to all applicable codes, laws, statutes and ordinances, including those described on the reverse side of the last ply of this form; am subject to

any conditions of this permit; understand that the issuance of this permit creates no legal liability, express or implied, on the state or municipality; and certify that all the above

information is accurate. If one acre or more of soil will be disturbed, I understand that this project is subject to ch. NR 151 regarding additional erosion control and stormwater

management and the owner shall sign the statement on the back of the permit if not signing below. I expressly grant the building inspector, or the inspector's authorized agent,

permission to enter the premises for which this permit is sought at all reasonable hours and for any proper purpose to inspect the work which is being done.

I vouch that I am or will be an owner-occupant of this dwelling for which I am applying for an erosion control or construction permit without a Dwelling

Contractor Certification and have read the cautionary statement regarding contractor responsibility on the reverse side of the last ply of this form.

APPLICANT (Print:) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Sign:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

APPROVAL CONDITIONS

ISSUING

JURISDICTION

Town of

DATE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

This permit is issued pursuant to the following conditions. Failure to comply may result in suspension or revocation of this

permit or other penalty.

See attached for conditions of approval.

Village of

City of

County of

State→

State-Contracted Inspection

Agency#:

Municipality Number of Dwelling Location

\_\_\_\_ \_\_\_\_ - \_\_\_\_ \_\_\_\_ \_\_\_\_

FEES:

Plan Review

Inspection

Wis. Permit Seal

Other

$

$

$

$

Total

$ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

PERMIT(S) ISSUED

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

SBD-5823(R11/11) Distribute:

Construction

HVAC

Electrical

Plumbing

Erosion Control

\_\_\_\_\_\_\_\_\_\_\_\_\_

Ply 1 – Issuing Jurisdiction;

WIS PERMIT SEAL #

PERMIT ISSUED BY:

Name\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date \_\_\_\_\_\_\_\_\_\_\_\_ Tel. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Cert No. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ply 2- Issuer forwards to state w/in 30 days;

Ply 3- Inspector;

Ply 4- Applicant

?INSTRUCTIONS

The owner, builder or agents shall complete the application form down through the Signature of Applicant block and submit it and

building plans and specifications to the enforcing jurisdiction, which is usually your municipality or county. Permit application

data is used for statewide statistical gathering on new one- and two-family dwellings, as well as for local code administration.

Please type or use ink and press firmly with multi-ply form.

PERMIT REQUESTED

 Check off type of Permit Requested, such as structural, HVAC, Electrical or Plumbing.

 Fill in owner's current Mailing Address and Telephone Number.

 If the project will disturb one acre or more of soil, the project is subject to the additional erosion control and stormwater

provisions of ch. NR 151 of the WI Administrative Code. Checking this box will satisfy the related notification requirements

of ch. NR 216.

 Fill in Contractor and Contractor Qualifier Information. Per s. 101.654 (1) WI Stats., an individual taking out an erosion

control or construction permit shall enter his or her dwelling contractor certificate number, and name and certificate number

of the dwelling contractor qualifier employed by the contactor, unless they reside or will reside in the dwelling. Per s. 101.63

(7) Wis. Stats., the master plumber name and license number must be entered before issuing a plumbing permit.

PROJECT LOCATION

 Fill in Building Address (number and street or sufficient information so that the building inspector can locate the site.

 Local zoning, land use and flood plain requirements must be satisfied before a building permit can be issued. County

approval may be necessary.

 Fill in Zoning District, lot area and required building setbacks.

PROJECT DATA - Fill in all numbered project data blocks (1-14) with the required information. All data blocks must be filled in,

including the following:

2. Area (involved in project):

Basements - include unfinished area only

Living area - include any finished area including finished areas in basements

Two-family dwellings - include separate and total combined areas

3. Occupancy - Check only "Single-Family" or "Two-Family" if that is what is being worked on. In other words, do not check

either of these two blocks if only a new detached garage is being built, even if it serves a one or two family dwelling. Instead,

check "Garage" and number of stalls. If the project is a community based residential facility serving 3 to 8 residents, it is

considered a single-family dwelling.

9. HVAC Equipment - Check only the major source of heat, plus central air conditioning if present. Only check "Radiant

Baseboard" if there is no central source of heat.

10. Plumbing - A building permit cannot be issued until a sanitary permit has been issued for any new or affected existing private

onsite wastewater treatment system.

14. Estimated Cost - Include the total cost of construction, including materials and market rate labor, but not the cost of land or

landscaping.

SIGNATURE – The owner or the contractor’s authorized agent shall sign and date this application form. If you do not possess the

Dwelling Contractor certification, then you will need to check the owner-occupancy statement for any erosion control or

construction permits.

CONDITIONS OF APPROVAL - The authority having jurisdiction uses this section to state any conditions that must be complied

with pursuant to issuing the building permit.

ISSUING JURISDICTION: This must be completed by the authority having jurisdiction.

 Check off Jurisdiction Status, such as town, village, city, county or state and fill in Municipality Name

 Fill in State Inspection Agency number only if working under state inspection jurisdiction.

 Fill in Municipality Number of Dwelling Location

 Check off type of Permit Issued, such as construction, HVAC, electrical or plumbing.

 Fill in Wisconsin Uniform Permit Seal Number, if project is a new one- or two-family dwelling.

 Fill in Name and Inspector Certification Number of person reviewing building plans and date building permit issued.

INSPECTORS: PLEASE RETURN SECOND PLY WITHIN 30 DAYS AFTER ISSUANCE TO (You may fold

along the dashed lines and insert this form into a window envelope.):

Safety & Buildings Division

P O Box 2509

Madison, WI 53701-2509

?(Part of Ply 4 for Applicants)

Cautionary Statement to Owners Obtaining Building Permits

101.65(lr) of the Wisconsin Statutes requires municipalities that enforce the Uniform Dwelling Code to

provide an owner who applies for a building permit with a statement advising the owner that:

If the owner hires a contractor to perform work under the building permit and the contractor is not bonded

or insured as required under s. 101.654 (2) (a), the following consequences might occur:

(a) The owner may be held liable for any bodily inquiry to or death of others or for any damage to

the property of others that arises out of the work performed under the building permit or that is caused by

any negligence by the contractor that occurs in connection with the work performed under the building

permit.

(b) The owner may not be able to collect from the contractor damages for any loss sustained by

the owner because of a violation by the contractor of the one- and two- family dwelling code or an

ordinance enacted under sub. (1) (a), because of any bodily injury to or death of others or damage to the

property of others that arises out of the work performed under the building permit or because of any

bodily injury to or death of others or damage to the property of others that is caused by any negligence by

the contractor that occurs in connection with the work performed under the building permit.

Cautionary Statement to Contractors for Projects Involving Building Built Before 1978

If this project is in a dwelling or child-occupied facility, built before 1978, and disturbs 6 sq. ft. or more

of paint per room, 20 sq. ft. or more of exterior paint, or involves windows, then the requirements of ch.

DHS 163 requiring Lead-Safe Renovation Training and Certification apply. Call (608)261-6876 or go to

the Wisconsin Department of Health Services’ lead homepage for details of how to be in compliance

Wetlands Notice to Permit Applicants

You are responsible for complying with state and federal laws concerning the construction near or on

wetlands, lakes, and streams. Wetlands that are not associated with open water can be difficult to

identify. Failure to comply may result in removal or modification of construction that violates the law or

other penalties or costs. For more information, visit the Department of Natural Resources wetlands

identification web page or contact a Department of Natural Resources service center.

Additional Responsibilities for Owners of Projects Disturbing One or More Acre of Soil

I understand that this project is subject to ch. NR 151 regarding additional erosion control and stormwater

management and will comply with those standards.

Owner's Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Contractor Credential Requirements

All contractors shall possess an appropriate contractor credential issued by the Wisconsin Division of

Safety and Buildings. Contractors are also required to only subcontract with contractors that hold the

appropriate contractor credentials.

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