ITEA automatic report

ITEA_summarizer

Wednesday 14th July, 2021, 11:38

Automatic report created by *ITEA_summarizer* package. This report makes usage of several methods to automatically inspect and explain the final expression found in the evolutionary process performed by the ITEA algorithm.

Descriptive statistics of the data

Reporting descriptive statistics for 5 (from a total of 8) features contained on the training data. The features were selected based on the absolute final importance.

	AveBedrms	MedInc	Longitude	Latitude	AveOccup
count	13828.000000	13828.000000	13828.000000	13828.000000	13828.000000
mean	1.097533	3.876745	-119.585098	35.651238	3.128660
std	0.445688	1.903102	2.005127	2.134064	12.646130
min	0.333333	0.499900	-124.350000	32.550000	0.692308
25%	1.006623	2.568575	-121.810000	33.940000	2.432189
50%	1.049552	3.538750	-118.510000	34.270000	2.819702
75%	1.100283	4.756600	-118.010000	37.720000	3.282093
max	25.636364	15.000100	-114.310000	41.950000	1243.333333

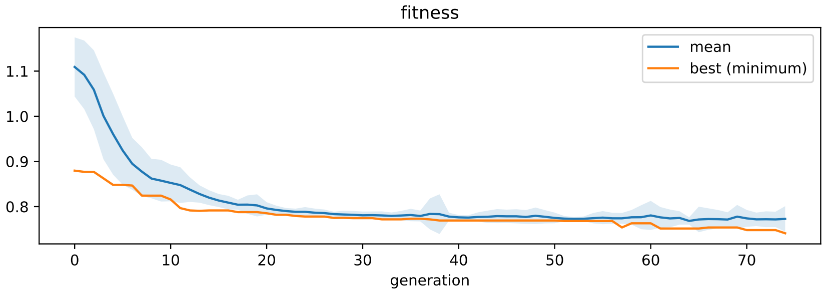
Algorithm Hyper-parameters

The following hyperparameters were used to execute the algorithm. If the random_state parameter was set to an integer value (or a numpy randomState instance was given), then it is possible to repeat the exact execution by using the same training data and the parameters listed below.

```
expolim : (0, 2)
gens : 75
max_terms : 5
popsize : 75
random_state : 42
simplify_method : simplify_by_var
verbose : 10
tfuncs : [log, sqrt.abs, id, sin, cos, exp]
```

Evolution convergence

The algorithm took 331.013 seconds to completely run. Below are the plots for the average fitness of the population and the best individual fitness for each generation.



Best expression

The best expression corresponds to the expression with the best fitness on the last generation before the evolution ends. Not necessarily it will be the simpliest or the global optimum expression of the evoution. The final expression is a regressor with a fitness of 0.741, and the number of IT terms is 5. Below is an LaTeX representation of the expression:

$$
\begin{aligned}
ITExpr = &\underbrace{\beta_0 \cdot log(MedInc \cdot Population \cdot AveOccup \cdot Latitude^2)}_{\text{term 0}} \\
&+ \underbrace{\beta_1 \cdot log(MedInc^2 \cdot AveBedrms \cdot Longitude^2)}_{\text{term 1}} \\
&+ \underbrace{\beta_2 \cdot log(MedInc \cdot Population \cdot AveOccup \cdot Latitude \cdot Longitude^2)}_{\text{term 2}} \\
&+ \underbrace{\beta_3 \cdot log(MedInc^2 \cdot AveRooms^2 \cdot AveBedrms \cdot AveOccup \cdot Latitude^2 \cdot Longitude^2)}_{\text{term 3}} \\
&+ \underbrace{\beta_4 \cdot log(MedInc^2 \cdot Population^2 \cdot AveOccup^2 \cdot Latitude^2 \cdot Longitude^2)}_{\text{term 4}} + I_0
\end{aligned} \tag{1}
$$

Best expression metrics

On the next page is reported a table containing the coefficients for the previous expression, as well as some metrics calculated for each term individually:

- **coef:** coefficient of each term (or coefficients, if the itexpr is an instance of ITExpr_classifier);
- **coef stderr:** the standard error of the coefficients;
- **disentang.:** mean pairwise disentanglement between each term when compared with the others;
- **M.I.:** mean continuous mutual information between each term when compared with the others;
- **pred. var.:** variance of the predicted outcomes for each term when predicting the training data.

	coef	func	coef stderr	disentang.	M.I.	pred. var.
term 0	-15.231	log	0.331	0.610	1.399	214.205
term 1	1.323	log	0.02	0.377	0.499	1.521
term 2	37.981	log	0.816	0.610	1.486	1341.802
term 3	-0.399	log	0.014	0.376	0.508	0.301
term 4	-11.439	log	0.273	0.609	1.439	487.150
term 5	-202.481	intercept	4.269	0.000	0.000	0.000

Partial derivatives

$$\frac{\partial}{\partial MedInc} ITExpr \tag{2}$$
$$= \underbrace{1\beta_0 \cdot log'(MedInc \cdot Population \cdot AveOccup \cdot Latitude^2)(Population \cdot AveOccup \cdot Latitude^2)}_{\text{term 0}}$$
$$+ \underbrace{2\beta_1 \cdot log'(MedInc^2 \cdot AveBedrms \cdot Longitude^2)(MedInc \cdot AveBedrms \cdot Longitude^2)}_{\text{term 1}}$$
$$+ \underbrace{1\beta_2 \cdot log'(MedInc \cdot Population \cdot AveOccup \cdot Latitude \cdot Longitude^2)(Population \cdot AveOccup \cdot Latitude \cdot Longit}_{\text{term 2}}$$
$$+ \underbrace{2\beta_3 \cdot log'(MedInc^2 \cdot AveRooms^2 \cdot AveBedrms \cdot AveOccup \cdot Latitude^2 \cdot Longitude^2)(MedInc \cdot AveRooms^2 \cdot A}_{\text{term 3}}$$
$$+ \underbrace{2\beta_4 \cdot log'(MedInc^2 \cdot Population^2 \cdot AveOccup^2 \cdot Latitude^2 \cdot Longitude^2)(MedInc \cdot Population^2 \cdot AveOccup^2 \cdot}_{\text{term 4}}$$

$$\frac{\partial}{\partial HouseAge} ITExpr = 0.0 \tag{3}$$

$$\frac{\partial}{\partial AveRooms} ITExpr \tag{4}$$
$$= \underbrace{2\beta_3 \cdot log'(MedInc^2 \cdot AveRooms^2 \cdot AveBedrms \cdot AveOccup \cdot Latitude^2 \cdot Longitude^2)(MedInc^2 \cdot AveRooms \cdot Ave}_{\text{term 3}}$$

$$\frac{\partial}{\partial AveBedrms} ITExpr = \underbrace{1\beta_1 \cdot log'(MedInc^2 \cdot AveBedrms \cdot Longitude^2)(MedInc^2 \cdot Longitude^2)}_{\text{term 1}} \quad (5)$$

$$+ \underbrace{1\beta_3 \cdot log'(MedInc^2 \cdot AveRooms^2 \cdot AveBedrms \cdot AveOccup \cdot Latitude^2 \cdot Longitude^2)(MedInc^2 \cdot AveRooms^2 \cdot}_{\text{term 3}}$$

$$\frac{\partial}{\partial Population} ITExpr \quad (6)$$

$$= \underbrace{1\beta_0 \cdot log'(MedInc \cdot Population \cdot AveOccup \cdot Latitude^2)(MedInc \cdot AveOccup \cdot Latitude^2)}_{\text{term 0}}$$

$$+ \underbrace{1\beta_2 \cdot log'(MedInc \cdot Population \cdot AveOccup \cdot Latitude \cdot Longitude^2)(MedInc \cdot AveOccup \cdot Latitude \cdot Longitud}_{\text{term 2}}$$

$$+ \underbrace{2\beta_4 \cdot log'(MedInc^2 \cdot Population^2 \cdot AveOccup^2 \cdot Latitude^2 \cdot Longitude^2)(MedInc^2 \cdot Population \cdot AveOccup^2 \cdot}_{\text{term 4}}$$

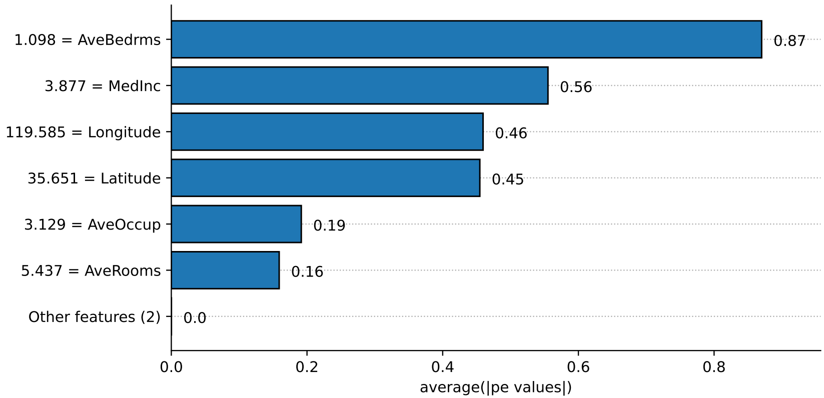
$$\frac{\partial}{\partial AveOccup} ITExpr \tag{7}$$
$$= \underbrace{1\beta_0 \cdot log'(MedInc \cdot Population \cdot AveOccup \cdot Latitude^2)(MedInc \cdot Population \cdot Latitude^2)}_{\text{term 0}}$$
$$+ \underbrace{1\beta_2 \cdot log'(MedInc \cdot Population \cdot AveOccup \cdot Latitude \cdot Longitude^2)(MedInc \cdot Population \cdot Latitude \cdot Longitu}_{\text{term 2}}$$
$$+ \underbrace{1\beta_3 \cdot log'(MedInc^2 \cdot AveRooms^2 \cdot AveBedrms \cdot AveOccup \cdot Latitude^2 \cdot Longitude^2)(MedInc^2 \cdot AveRooms^2 \cdot}_{\text{term 3}}$$
$$+ \underbrace{2\beta_4 \cdot log'(MedInc^2 \cdot Population^2 \cdot AveOccup^2 \cdot Latitude^2 \cdot Longitude^2)(MedInc^2 \cdot Population^2 \cdot AveOccup \cdot}_{\text{term 4}}$$

$$\frac{\partial}{\partial Latitude} ITExpr \tag{8}$$
$$= \underbrace{2\beta_0 \cdot log'(MedInc \cdot Population \cdot AveOccup \cdot Latitude^2)(MedInc \cdot Population \cdot AveOccup \cdot Latitude)}_{\text{term 0}}$$
$$+ \underbrace{1\beta_2 \cdot log'(MedInc \cdot Population \cdot AveOccup \cdot Latitude \cdot Longitude^2)(MedInc \cdot Population \cdot AveOccup \cdot Longit}_{\text{term 2}}$$
$$+ \underbrace{2\beta_3 \cdot log'(MedInc^2 \cdot AveRooms^2 \cdot AveBedrms \cdot AveOccup \cdot Latitude^2 \cdot Longitude^2)(MedInc^2 \cdot AveRooms^2 \cdot}_{\text{term 3}}$$
$$+ \underbrace{2\beta_4 \cdot log'(MedInc^2 \cdot Population^2 \cdot AveOccup^2 \cdot Latitude^2 \cdot Longitude^2)(MedInc^2 \cdot Population^2 \cdot AveOccup^2 \cdot}_{\text{term 4}}$$

$$
\begin{aligned}
\frac{\partial}{\partial Longitude} ITExpr = & \underbrace{2\beta_1 \cdot log'(MedInc^2 \cdot AveBedrms \cdot Longitude^2)(MedInc^2 \cdot AveBedrms \cdot Longitude)}_{\text{term 1}} \qquad (9) \\
& + \underbrace{2\beta_2 \cdot log'(MedInc \cdot Population \cdot AveOccup \cdot Latitude \cdot Longitude^2)(MedInc \cdot Population \cdot AveOccup \cdot Latitu}_{\text{term 2}} \\
& + \underbrace{2\beta_3 \cdot log'(MedInc^2 \cdot AveRooms^2 \cdot AveBedrms \cdot AveOccup \cdot Latitude^2 \cdot Longitude^2)(MedInc^2 \cdot AveRooms^2 \cdot}_{\text{term 3}} \\
& + \underbrace{2\beta_4 \cdot log'(MedInc^2 \cdot Population^2 \cdot AveOccup^2 \cdot Latitude^2 \cdot Longitude^2)(MedInc^2 \cdot Population^2 \cdot AveOccup^2 \cdot}_{\text{term 4}}
\end{aligned}
$$

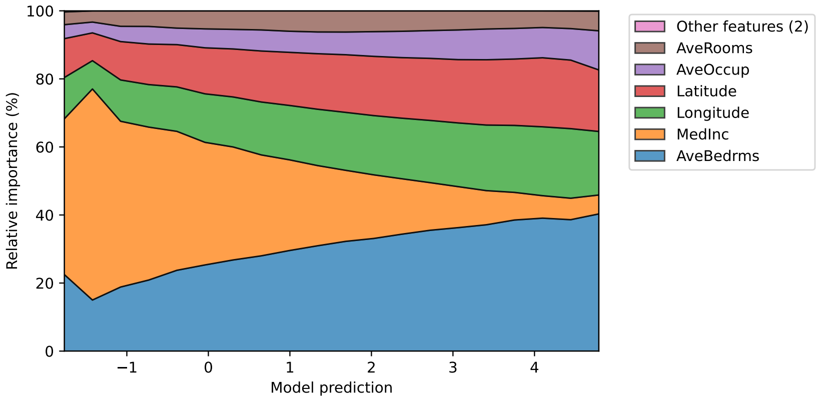
Average partial Effects

Feature importances with Average Partial Effects. This method attributes the importance to the i-th variable by calculating the average of the partial derivative w.r.t. i, evaluated for all data in the training set.



Normalized partial Effects

Feature importances with Normalized Partial Effects. To create this plot, first, the output interval is discretized. Then, for each interval, the partial effect of all samples in the training set that results in a prediction within the interval are calculated. Finally, they are normalized in order to make the total contribution by 100%.



Partial Effects at the Means

Partial Effects plots created by fixing the co-variables at the means and evaluating the model's output when only one variable changes. For simplicity, at most 5 variables are selected to create the plot (the 5 most important variables considering their Average Partial Effects).