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# Introduction

The HinMine algorithm is an algorithm designed to construct networ-analysis-based feature vectors for data instances that can be either nodes in a network or standard data instances with a fixed set of numeric features. In this implementation, the input for the algorithm is a set of data instances, and the output of the algorithm is a new data set with the same instances, but new features constructed out of them.

The algorithm works in two steps. In the first step, a network is constructed out of the input data, where the nodes of the network correspond to the data instances and the strength of the connection between two instances exponentially depends on the square of the Euclidean distance between the two instances. In the second step, network propositionalization is performed on the resulting network. Network propositionalization is a method for constructing feature vectors for each target node in the network using the personalized PageRank (P-PR) algorithm. The personalized PageRank of node *v* in a network is defined as the stationary distribution of the position of a random walker who starts the walk in node $v$ and then at each node either selects one of the outgoing connections or jumps back to node *v*. The probability (denoted *p*) of continuing the walk is a parameter of the personalized PageRank algorithm and is by default set to 0.85. Once calculated, the resulting PageRank vectors are normalized according to the Euclidean norm. The resulting vector contains information about the proximity of node *v* to each of the remaining nodes of the network. We consider the P-PR vectors of a node as a propositionalized feature vector of the node. Because two nodes with similar P-PR vectors will be in proximity of similar nodes a classifier should consider them as similar instances. The constructed feature vectors can be then used to analyze the nodes from which they were calculated, and therefore, the original data instances.

The algorithm has two parameters:

* *damping:* The variable *p* used in the construction of the P-PR vectors during propositionalization. The value of this variable can be any real number between 0 and 1. Smaller values of the damping factor ensure faster calculation of the feature vectors, however larger values of *p* mean that the algorithm is capable of performing longer walks, exploring more of the structure of the data.
* *normalize (True/False):* This variable determines whether the feature values of the input data instances should be normalized or not. If True, then the values of each feature are normalized to be between 0 and 1. This allows the algorithm to fairly compare two features measured with incomparable units. The value of this variable should be False if the difference in the size of the features carries inherent meaning.

## Algorithm inputs

In this document, we will present the results obtained on the well known iris data set. The input of the algorithm were 150 examples of plants belonging to one of three iris species. Each of the 150 examples is represented as a 4-dimensional real valued vector.

The algorithm was also tested on the MIP sample data set provided on the HBP Medical Github repository. In general, the input of the algorithm can be any data set containing instances with real-valued features.

## Algorithm output

As needed by the MIP, our algorithm’s output is a tabular data resource json file. As the full output of the algorithm contains several thousand lines, we provide only the beginning of the output in this report.

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| --- |
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# Tests

We have also prepared an integration test of the HinMine algorithm. The test runs the algorithm on the iris and sample data sets, both of which are available on the HBP Medical Github repository. To setup the testing environment, the following docker configuration was used:

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| --- |
| ---  version: '2'  services:  db:  image: postgres:9.6.5-alpine  hostname: db  environment:  POSTGRES\_PASSWORD: test  wait\_dbs:  image: "waisbrot/wait"  restart: "no"  environment:  TARGETS: "db:5432"  TIMEOUT: 60  create\_dbs:  image: "hbpmip/create-databases:1.0.0"  restart: "no"  environment:  DB\_HOST: db  DB\_PORT: 5432  DB\_ADMIN\_USER: postgres  DB\_ADMIN\_PASSWORD: test  DB1: features  USER1: features  PASSWORD1: featurespwd  DB2: woken  USER2: woken  PASSWORD2: wokenpwd  depends\_on:  - db  sample\_data\_db\_setup:  image: "hbpmip/sample-data-db-setup:0.5.0"  container\_name: "data-db-setup"  restart: "no"  environment:  FLYWAY\_DBMS: postgresql  FLYWAY\_HOST: db  FLYWAY\_PORT: 5432  FLYWAY\_DATABASE\_NAME: features  FLYWAY\_USER: postgres  FLYWAY\_PASSWORD: test  depends\_on:  - db  woken\_db\_setup:  image: "hbpmip/woken-db-setup:latest"  container\_name: "woken-db-setup"  restart: "no"  environment:  FLYWAY\_DBMS: postgresql  FLYWAY\_HOST: db  FLYWAY\_PORT: 5432  FLYWAY\_DATABASE\_NAME: woken  FLYWAY\_USER: postgres  FLYWAY\_PASSWORD: test  depends\_on:  - db  hinmine-iris:  image: "hbpmip/python-jsi-hinmine:latest"  container\_name: "python-jsi-hinmine"  restart: "no"  environment:  NODE: job\_test  JOB\_ID: 1  IN\_JDBC\_DRIVER: org.postgresql.Driver  IN\_JDBC\_URL: jdbc:postgresql://db:5432/features  IN\_JDBC\_USER: features  IN\_JDBC\_PASSWORD: featurespwd  OUT\_JDBC\_DRIVER: org.postgresql.Driver  OUT\_JDBC\_URL: jdbc:postgresql://db:5432/woken  OUT\_JDBC\_USER: woken  OUT\_JDBC\_PASSWORD: wokenpwd  PARAM\_variables: "name"  PARAM\_covariables: "sepal\_length,sepal\_width,petal\_length,petal\_width"  PARAM\_grouping: ""  PARAM\_query: "SELECT name,sepal\_length,sepal\_width,petal\_length,petal\_width FROM iris"  PARAM\_meta: "{\"name\":{\"code\":\"name\",\"type\":\"string\"},\"sepal\_length\":{\"code\":\"sepal\_length\",\"type\":\"real\"},\"sepal\_width\":{\"code\":\"sepal\_width\",\"type\":\"real\"},\"petal\_length\":{\"code\":\"petal\_length\",\"type\":\"real\"}, \"petal\_width\":{\"code\":\"petal\_width\",\"type\":\"real\"}}"  PARAM\_MODEL\_normalize: "True"  PARAM\_MODEL\_damping: 0.85  links:  - "db:db"  hinmine-sample:  image: "hbpmip/python-jsi-hinmine:latest"  container\_name: "python-jsi-hinmine"  restart: "no"  environment:  NODE: job\_test  JOB\_ID: 2  IN\_JDBC\_DRIVER: org.postgresql.Driver  IN\_JDBC\_URL: jdbc:postgresql://db:5432/features  IN\_JDBC\_USER: features  IN\_JDBC\_PASSWORD: featurespwd  OUT\_JDBC\_DRIVER: org.postgresql.Driver  OUT\_JDBC\_URL: jdbc:postgresql://db:5432/woken  OUT\_JDBC\_USER: woken  OUT\_JDBC\_PASSWORD: wokenpwd  PARAM\_variables: "score\_test1"  PARAM\_covariables: "stress\_before\_test1,iq"  PARAM\_grouping: ""  PARAM\_query: "SELECT stress\_before\_test1,score\_test1,iq,cognitive\_task2,practice\_task2,response\_time\_task2,college\_math,score\_math\_course1,score\_math\_course2 FROM SAMPLE\_DATA"  PARAM\_meta: "{\"score\_test1\":{\"code\":\"score\_test1\",\"type\":\"real\"},\"stress\_before\_test1\":{\"code\":\"stress\_before\_test1\",\"type\":\"real\"},\"iq\":{\"code\":\"iq\",\"type\":\"real\"},\"cognitive\_task2\":{\"code\":\"cognitive\_task2\",\"type\":\"real\"},\"practice\_task2\":{\"code\":\"practice\_task2\",\"type\":\"real\"},\"response\_time\_task2\":{\"code\":\"response\_time\_task2\",\"type\":\"real\"},\"college\_math\":{\"code\":\"college\_math\",\"type\":\"real\"},\"score\_math\_course1\":{\"code\":\"score\_math\_course1\",\"type\":\"real\"},\"score\_math\_course2\":{\"code\":\"score\_math\_course2\",\"type\":\"real\"}}"  links:  - "db:db" |

When we launch the test suite, the output is as follows.

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| Starting the databases...  Creating network "tests\_default" with the default driver  Creating tests\_db\_1  Waiting for db:5432 ... up!  Everything is up  PLAY [localhost] \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  TASK [Create the new database(s)"] \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  changed: [localhost] => (item={'password': 'featurespwd', 'db': 'features', 'user': 'features'})  changed: [localhost] => (item={'password': u'wokenpwd', 'db': u'woken', 'user': u'woken'})  TASK [Create user(s)] \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  changed: [localhost] => (item={'password': 'featurespwd', 'db': 'features', 'user': 'features'})  changed: [localhost] => (item={'password': u'wokenpwd', 'db': u'woken', 'user': u'woken'})  PLAY RECAP \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  localhost : ok=2 changed=2 unreachable=0 failed=0  Initialise the databases...  2018/03/08 12:49:36 Waiting for: tcp://db:5432  2018/03/08 12:49:36 Connected to tcp://db:5432  Flyway 4.2.0 by Boxfuse  Database: jdbc:postgresql://db:5432/features (PostgreSQL 9.6)  Successfully validated 8 migrations (execution time 00:00.057s)  Creating Metadata table: "public"."schema\_version"  Current version of schema "public": << Empty Schema >>  Migrating schema "public" to version 1.0 - create  Migrating schema "public" to version 1.1 - churn  Migrating schema "public" to version 1.2 - iris  Migrating schema "public" to version 1.3 - dummy ldsm  Migrating schema "public" to version 1.4 - dummy federation  Migrating schema "public" to version 1.5 - synthetic datasets  Migrating schema "public" with repeatable migration Create view  Migrating schema "public" with repeatable migration Setup datasets linreg\_sample,churn,iris,desd\_synth,nida\_synth,qqni\_synth  Mar 08, 2018 12:49:37 PM eu.humanbrainproject.mip.migrations.R\_\_SetupValues migrate  INFO: Migrating dataset linreg\_sample...  Mar 08, 2018 12:49:37 PM eu.humanbrainproject.mip.migrations.R\_\_SetupValues migrate  INFO: Migrating dataset churn...  Mar 08, 2018 12:49:38 PM eu.humanbrainproject.mip.migrations.R\_\_SetupValues migrate  INFO: Migrating dataset iris...  Mar 08, 2018 12:49:38 PM eu.humanbrainproject.mip.migrations.R\_\_SetupValues migrate  INFO: Migrating dataset desd\_synth...  Mar 08, 2018 12:49:39 PM eu.humanbrainproject.mip.migrations.R\_\_SetupValues migrate  INFO: Migrating dataset nida\_synth...  Mar 08, 2018 12:49:39 PM eu.humanbrainproject.mip.migrations.R\_\_SetupValues migrate  INFO: Migrating dataset qqni\_synth...  Successfully applied 8 migrations to schema "public" (execution time 00:03.778s).  2018/03/08 12:49:40 Command finished successfully.  2018/03/08 12:49:43 Waiting for: tcp://db:5432  2018/03/08 12:49:43 Connected to tcp://db:5432  Flyway 4.2.0 by Boxfuse  Database: jdbc:postgresql://db:5432/woken (PostgreSQL 9.6)  Successfully validated 1 migration (execution time 00:00.008s)  Creating Metadata table: "public"."schema\_version"  Current version of schema "public": << Empty Schema >>  Migrating schema "public" to version 1.0 - create  Successfully applied 1 migration to schema "public" (execution time 00:00.220s).  2018/03/08 12:49:44 Command finished successfully.  Run the Hinmine algorithm on the iris dataset...  INFO:root:<module 'cf\_netSDM' from '/usr/local/lib/python3.6/site-packages/cf\_netSDM-0.0.2-py3.6.egg/cf\_netSDM/\_\_init\_\_.py'>  INFO:root:Creating label matrix...  INFO:root:Finished 0  INFO:root:Finished 100  INFO:root:Creating google matrix...  INFO:root:Google matrix created.  Run the Hinmine algorithm on the sample dataset...  INFO:root:<module 'cf\_netSDM' from '/usr/local/lib/python3.6/site-packages/cf\_netSDM-0.0.2-py3.6.egg/cf\_netSDM/\_\_init\_\_.py'>  INFO:root:Using default value of parameter normalize: True  INFO:root:Using default value of parameter damping: 0.85  INFO:root:Creating label matrix...  INFO:root:Finished 0  INFO:root:Finished 100  INFO:root:Creating google matrix...  INFO:root:Google matrix created.  Stopping the containers...  Stopping tests\_db\_1 ... done  Removing tests\_hinmine-sample\_run\_1 ... done  Removing tests\_hinmine-iris\_run\_1 ... done  Removing tests\_woken\_db\_setup\_run\_1 ... done  Removing tests\_sample\_data\_db\_setup\_run\_1 ... done  Removing tests\_create\_dbs\_run\_1 ... done  Removing tests\_wait\_dbs\_run\_1 ... done  Removing tests\_db\_1 ... done  Removing network tests\_default  Stopping the containers...  Removing network tests\_default  WARNING: Network tests\_default not found. |