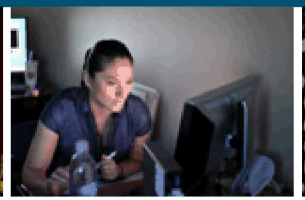
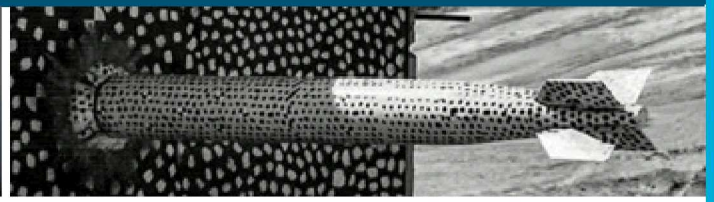
SAND2018-5105C

Smart Personalized Information Retrieval Environment





PRESENTED BY

Pengchu Zhang and John Herzer

National Laboratories Information Technology Summit 2018

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Enhancing Enterprise Search

SearchPoint Application Profile

- Deployed on Apache Solr search engine
- Migrating to LucidWorks Fusion
- 360,000 pages indexed
- Average of 13000 queries per day
- 8300 distinct customers submitted queries during the year

Recent Enhancements

- Applications that Listen
- Link popularity boosting

Exploring analytics to improve search results

- Click popularity boosting – Aggregate Behavior Model
- Word2Vec for synonym expansion
- Doc2Vec feature extraction for Related SAND reports
- General Reranker is a framework for evaluating these models

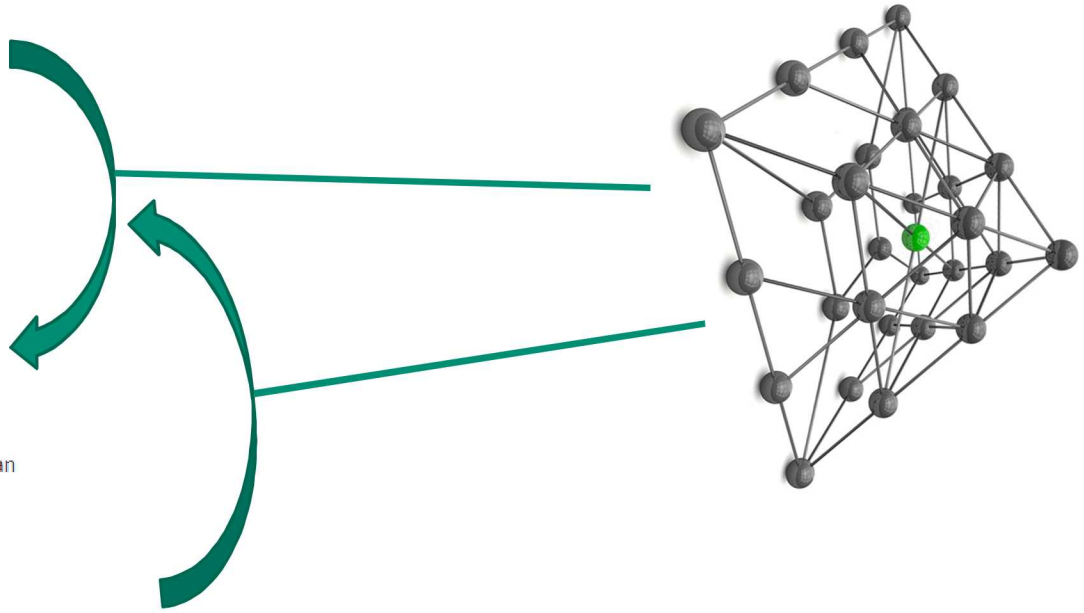
Showing 1 - 25 of 5184 results

Education **Outreach**
https://sharepoint.sandia.gov/sites/snlci/SitePages/Education.aspx
Education Outreach

Public Relations & Strategic Communication (PRSC) (SNL/CA)
http://info.sandia.gov/centers/8500/prsc
Design & Publishing Center, **Outreach**, Community **Outreach**, PRSC, Public Relations & Strategic Communication (PRSC), Media

Division Diversity Council (DDC) Home
https://sharepoint.sandia.gov/sites/ddcsnl/Pages/DDC-Groups-Summary.aspx
Connection, DDC, AAOC, APLC, CWNG, FNNG, GLBT, HLC SWC, MSC, WAG, Diversity, African American **Outreach** Committee, Asian Pacific Leadership

Pages - **Outreach**
https://sharepoint.sandia.gov/sites/BLCe/pages/outreach-.aspx
Site Contents **Outreach** Page Content For Technical Assistance:CCHD(505) 845-2243 corpInfo



Presenting personalized recommendations

Multiple components already provide ranking inputs

- Core search engine uses term frequency based ranking (TF/IDF algorithm)
- Rankings adjusted by URL popularity boosting

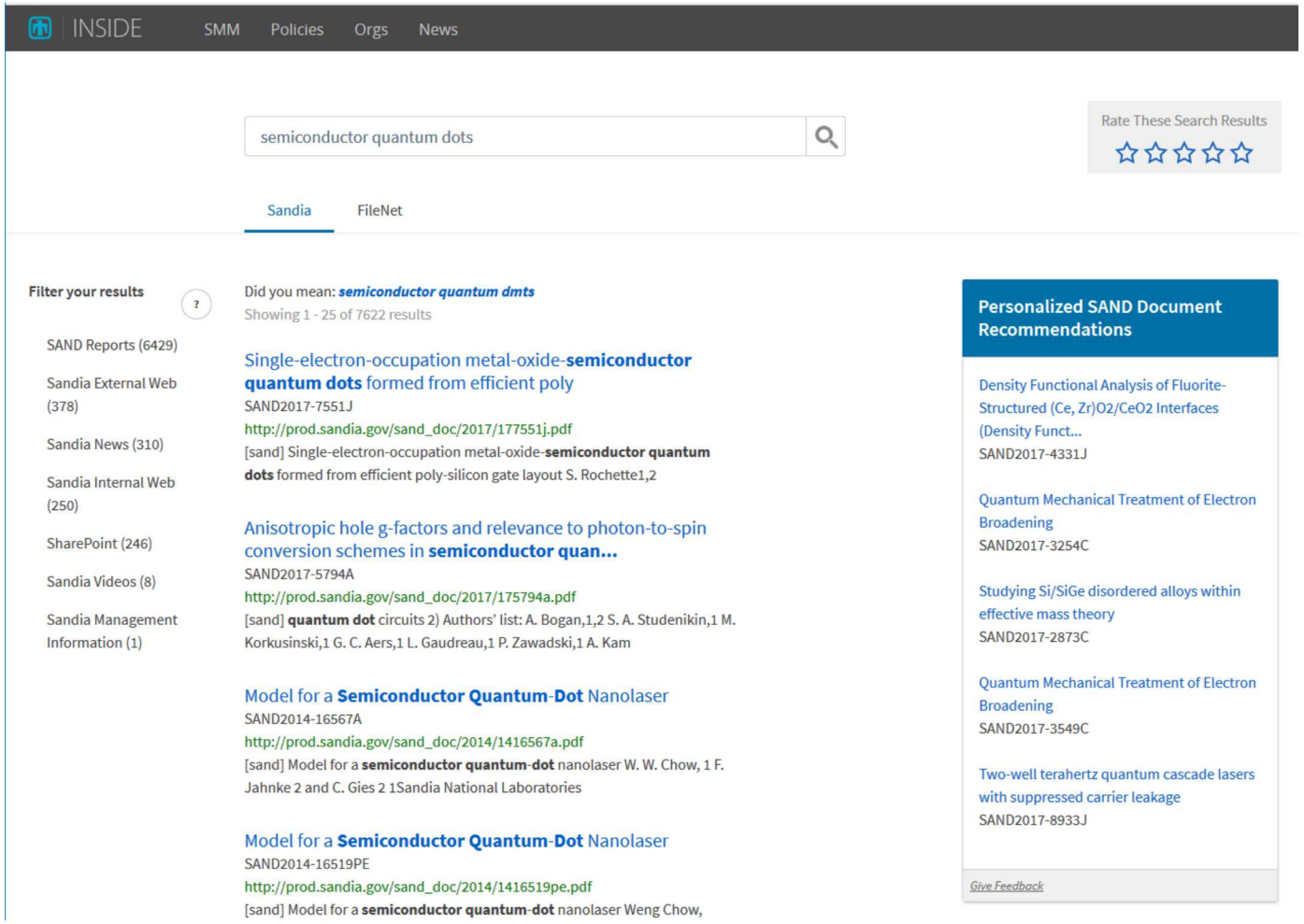
Worked with the UX team to determine best display options

Decided to display recommendations in a separate panel

- Didn't want another system competing to adjust rankings
- SPIRE recommendations are more course grained
- Want to distinguish them from pure content recommendations

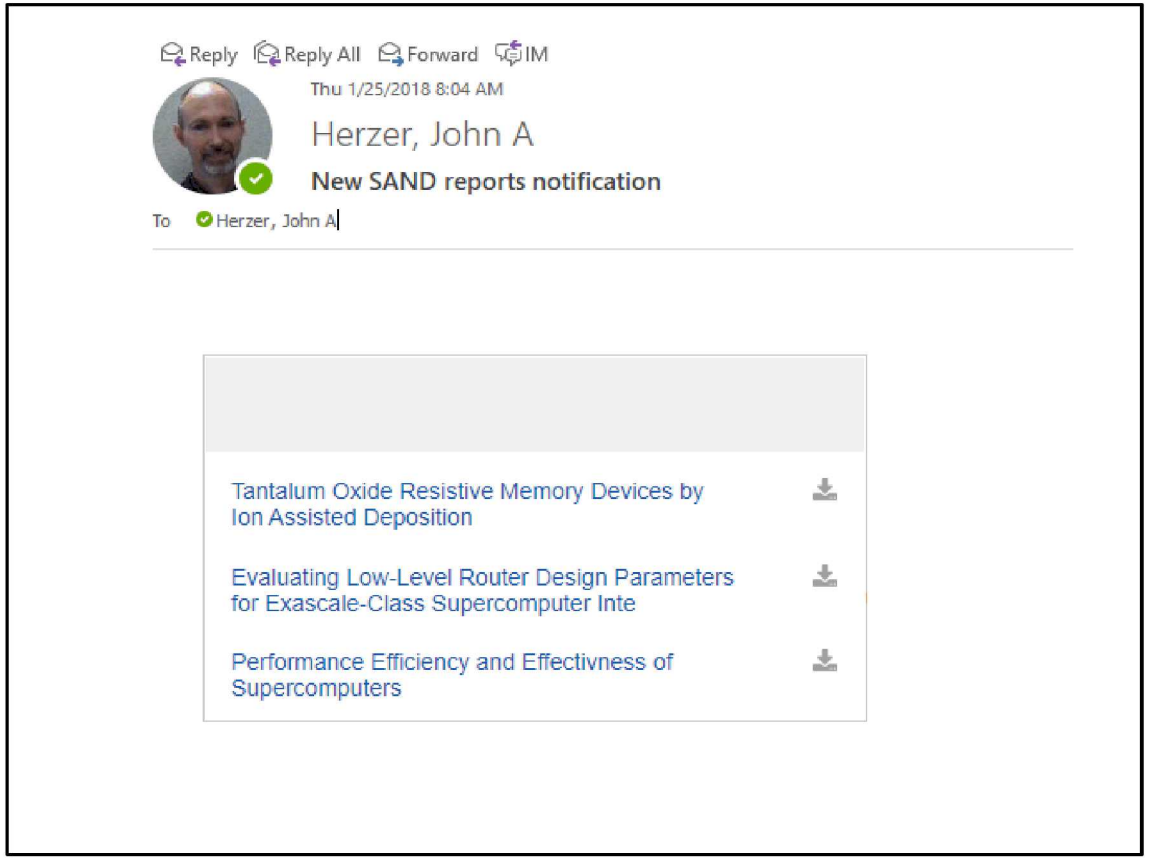
SAND Recommendation Layout

- SPIRE Recommendations apply to customer not search term
- Verify that results contain at least one SAND from topic of interest

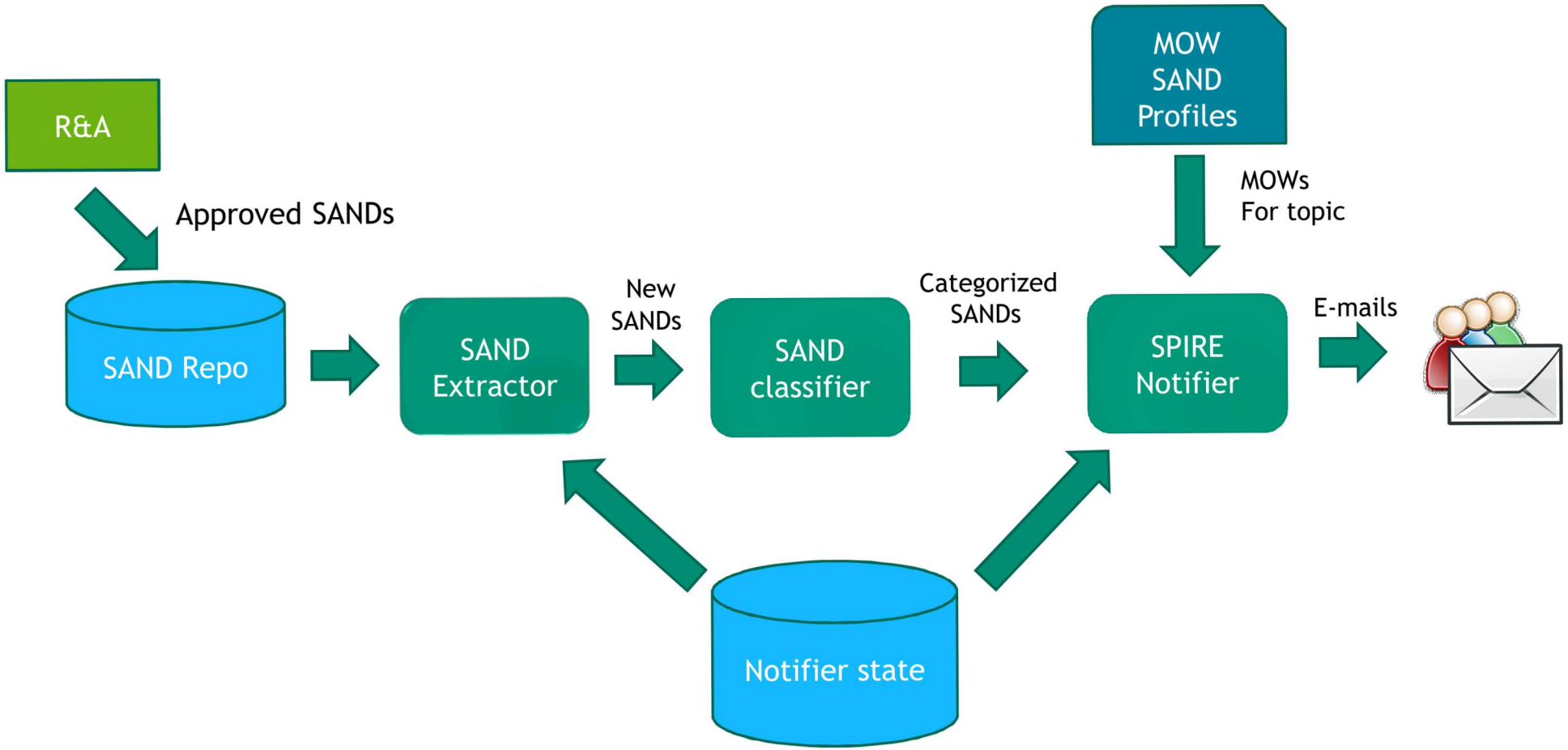


Pushing recommendations to the customer

- Email notifications are the push side of recommendations
- Need to prevent repeating previous recommendations
- Identify optimal frequency and provide opt-out capability

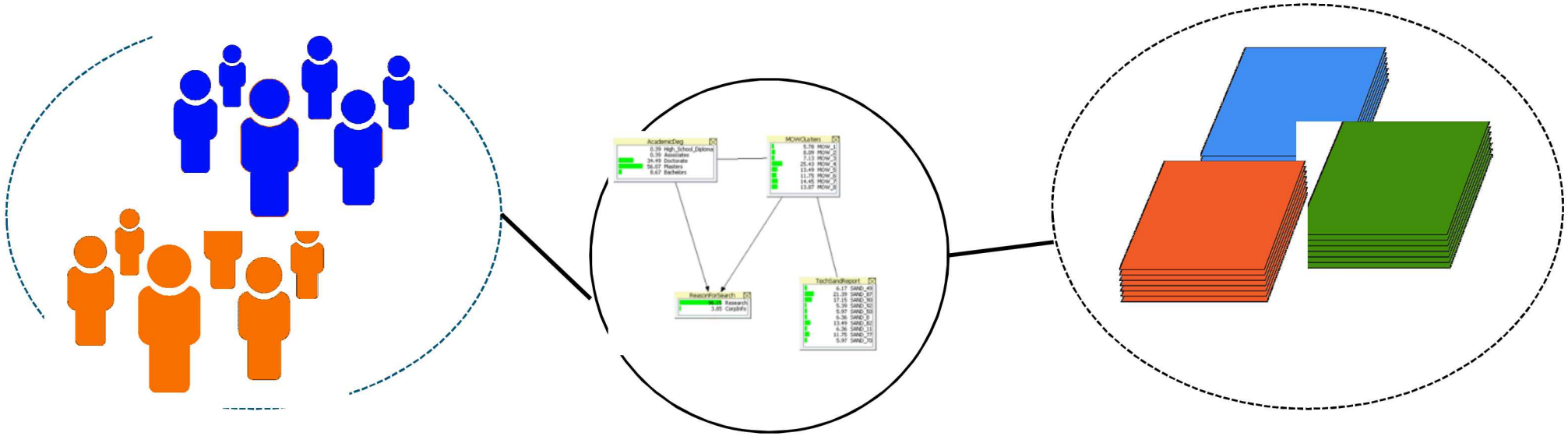


SPIRE Notification Process



Providing personalized content recommendations

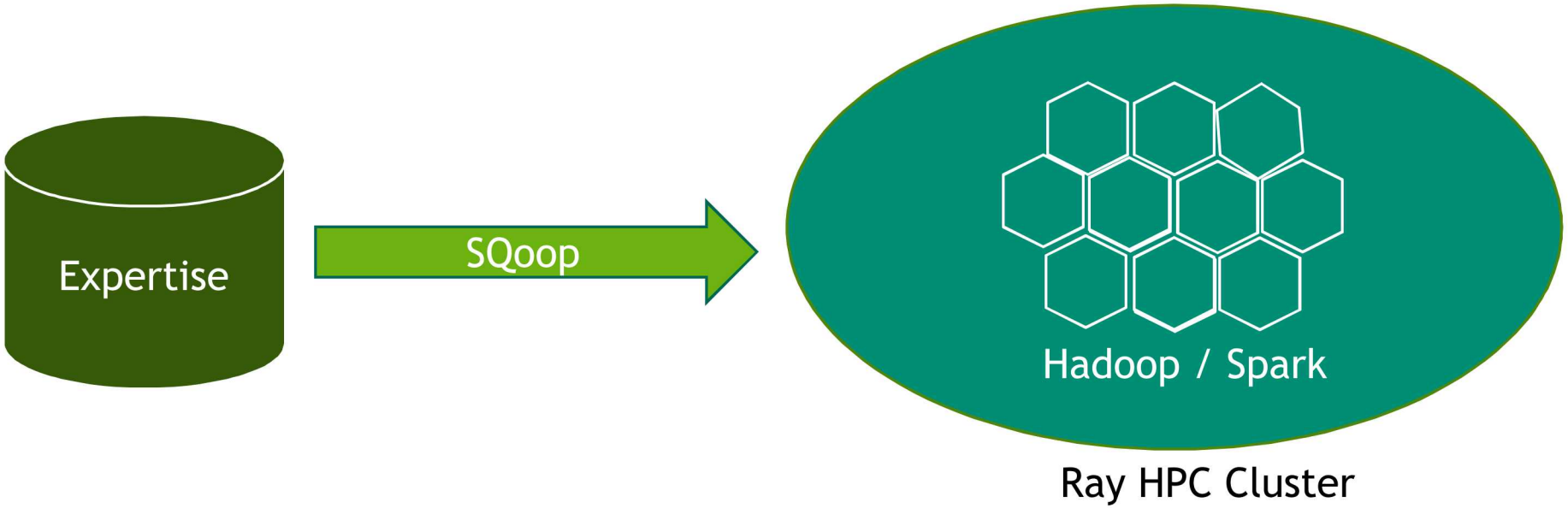
- SPIRE – Sandia Personalized Information Retrieval Environment
- Match customers with relevant content based on their information activities
- Group MOWs by their common interests
- Cluster related content by common term usage
- Develop predictive models that show who is likely to want which content



Profiling MOWs by activity

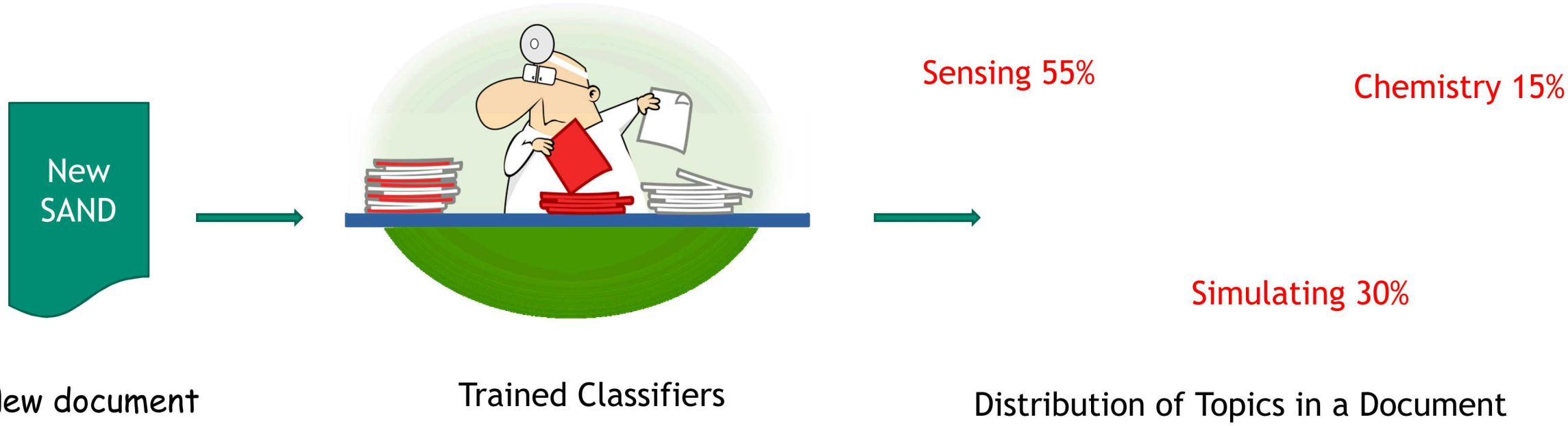
Customers are clustered based on their attributes and information usage

- Personal attributes: education, years at Sandia…
- Documents created: SAND reports, LDRDs, patents, PMF objectives …
- K-means used to cluster MOWs with K=30



Build SAND Report Classifiers

1. Classify documents into proper classes
2. Recognize the document class in various formats
3. Recognize the distribution of possible classes in a document



Procedures

- Collected ~100,000 SAND reports over last 50 years
- Data cleaned and indexed with Apache/Lucene
- Built "Taxonomy" for Sandia Category Guide (SCG)
- Selected the highly ranked documents with SCG taxonomy terms/phrases as the training sets
- Build a Word2Vec language model for embedding representatives of words
- Built a Convolutional Neural Network (CNN)
- Trained the network with various hyperparameters

Build "Taxonomy" based on Sandia Category Guide (SCG)

Category (Material Sciences)

Subcategories:

- Ceramics
- plastics
- seals and Adhesives

Obtain the terms/phrases for subcategories from:

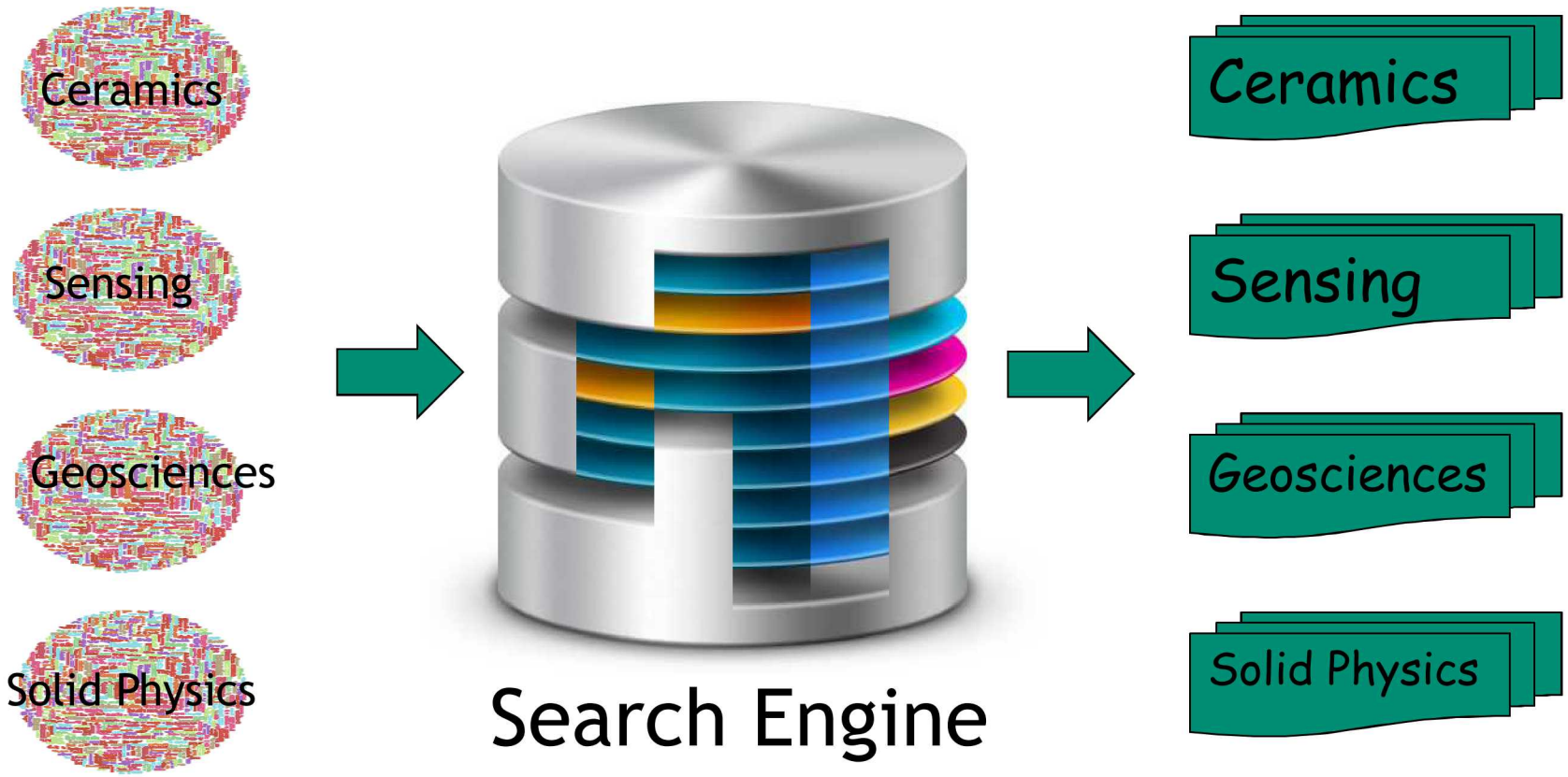
- Documents created by Sandia authors
- Wikipedia
- Word2Vec built on Sandia's documents
- Internal Organization webpages

Taxonomy Example for "Material Sciences/Composite Materials:

"carbon composite" "carbon fiber" "ceramal" "ceramic composite"
"ceramic matrix composite" "CFRP" "Chobham armour" "clad metals" "CMC"
"composite material" "concrete-plastic composite" "fiber reinforced composite"
"fiber reinforced polymer" "fiberglass" "formica" "FRP" "glasdpolyester"
"graphite" "GRP" "laminate" "Mallite" "metal composite" "metal matrix composite"…

NOTE: Taxonomy used here is simplified from Jessica Shaffer-Gant's version

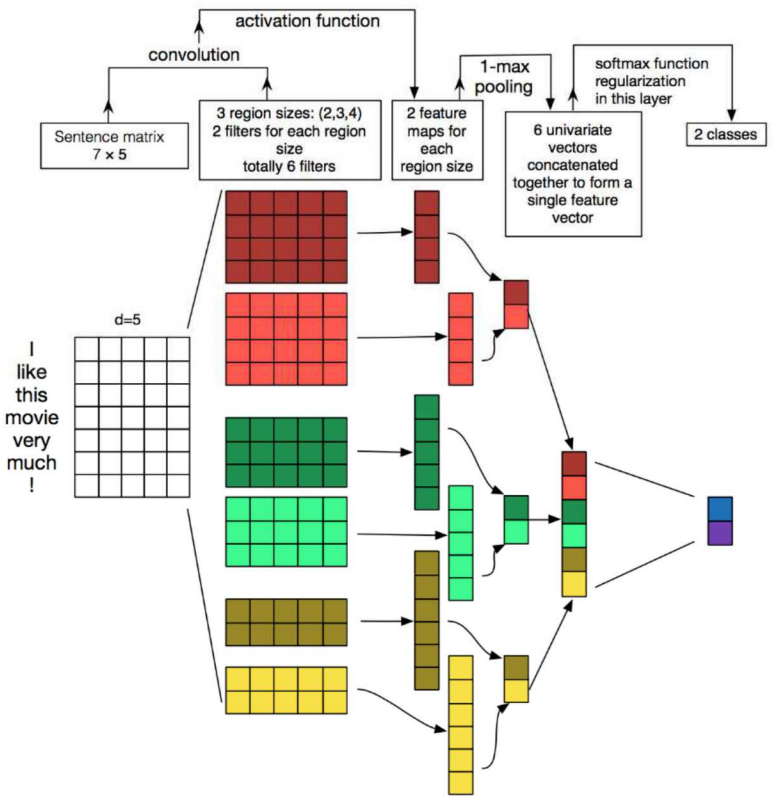
Collect Sets of Labeled Documents for Training



Terms/Phrases from Taxonomy

Labeled and Ranked Documents

Convolutional Neural Network for Text Classification




```
print('Training model.')

# train a 1D convnet with global maxpooling
sequence_input = Input(shape=(MAX_SEQUENCE_LENGTH,),
dtype='int32')
embedded_sequences = embedding_layer(sequence_input)
x = Conv1D(128, 5, activation='relu')(embedded_sequences)
x = MaxPooling1D(5)(x)
x = Dropout(0.5)(x)
x = Conv1D(128, 5, activation='relu')(x)
x = Dropout(0.5)(x)
x = MaxPooling1D(5)(x)
x = Conv1D(128, 5, activation='relu')(x)
x = Dropout(0.5)(x)
x = MaxPooling1D(35)(x)
x = Flatten()(x)
x = Dense(128, activation='relu')(x)
preds = Dense(len(labels_index), activation='softmax')(x)
model = Model(sequence_input, preds)
model.compile(loss='categorical_crossentropy',optimizer='rmsprop',
metrics=['acc'])
```

Modified from a Keras example

Examples of Classifiers for Classification

```
prediction = model.predict(data[146:150])
```

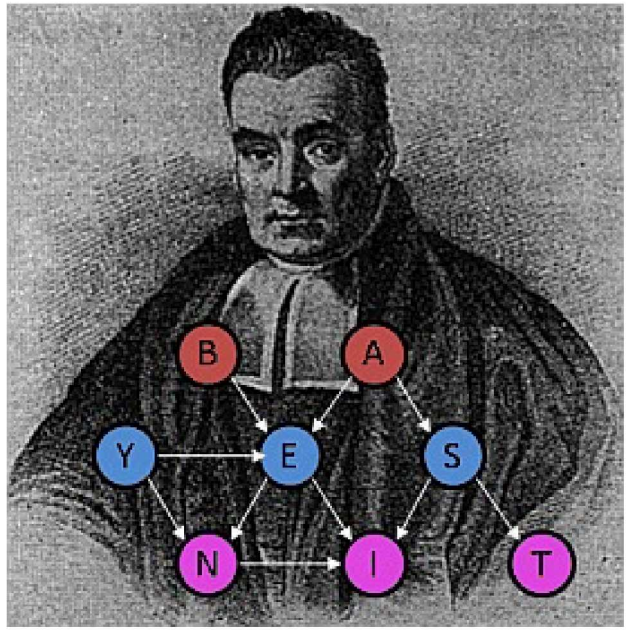
```
[37 1] [ 6.892 79.014] % SAND2000-0217.txt thermodynamics atmospheric sciences
[30 14] [ 6.755 91.043] % SAND2000-0218.txt particle physics electronics and electrical engineering
[16 31] [ 6.668 60.088] % SAND2000-0221.txt fluid mechanics plasma physics
[ 9 29] [ 29.797 52.055] % SAND2000-0222C.txt computer architecture optics
```

Class ID	Class Distribution	SAND ID	Class Names

Example of Classifying a Document

[37 1] [6.892 79.014] % SAND2000-0217.txt thermodynamics atmospheric sciences

Building a Graphic Model for Prediction



Prior probability

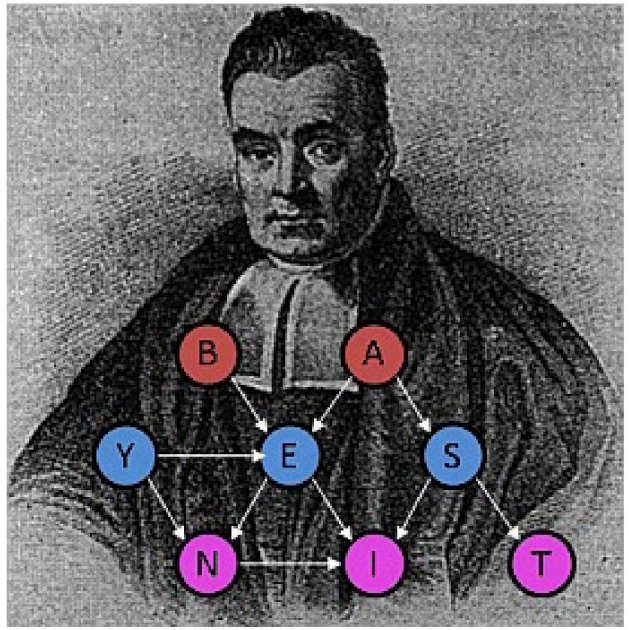
Likelihood of the evidence of ‘E’
If the hypothesis ‘x’ is true

$$\mathrm{P}(x|E) = \frac{P(x) * P(E|x)}{P(E)}$$

Posterior probability of ‘x’
given the evidence ‘E’

Prior probability that
the evidence itself is true

Building a Graphic Model for Prediction



Probability of Lung cancer patients among people

Probability of smokers among lung cancer patients

$$P(x|E) = \frac{P(x) * P(E|x)}{P(E)}$$

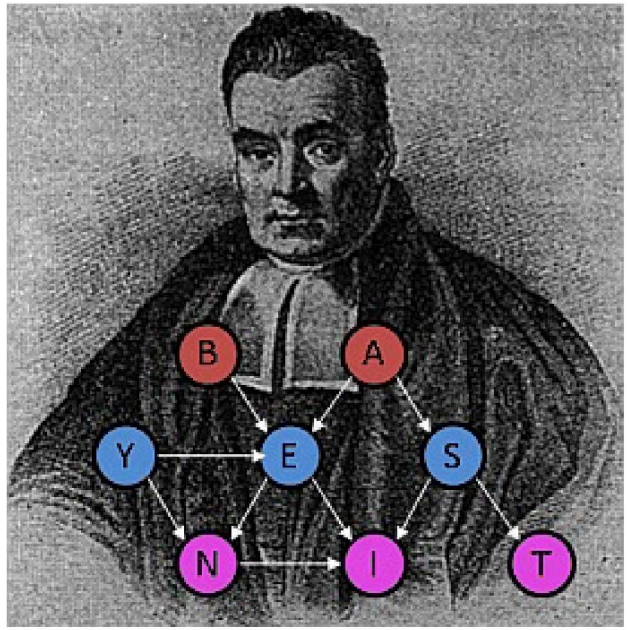
If one is a smoker, what is the probability he/she may have lung cancer

Probability of smokers among people

$$P(LC|S) = \frac{0.00006 * 0.7}{0.2} = 0.00021$$

$$\frac{0.00021}{0.00006} = 3.5 = 350\%$$

Building a Graphic Model for Prediction



P(computer)

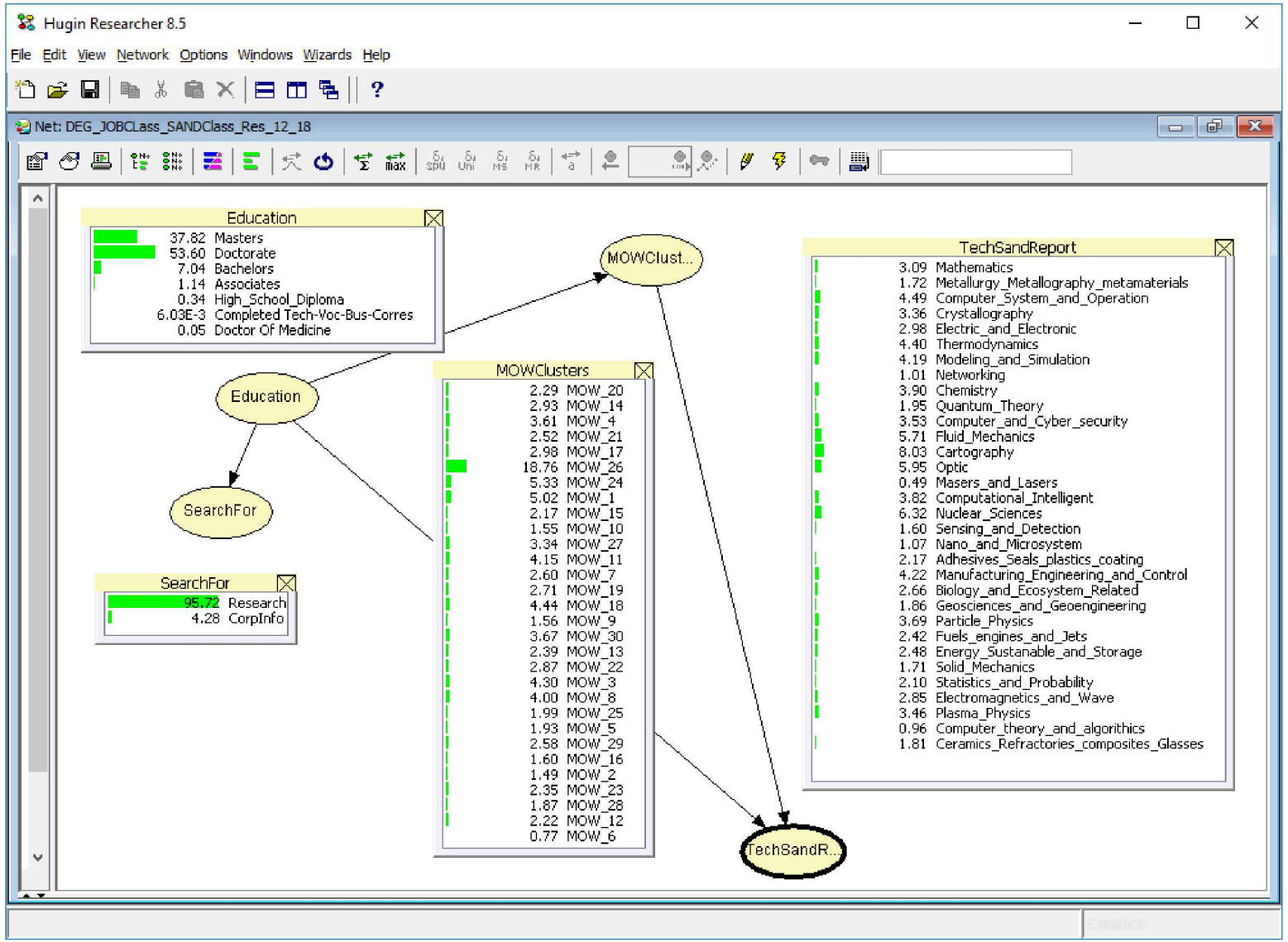
P(webDev/computer)

$$P(x|E) = \frac{P(x) * P(E|x)}{P(E)}$$

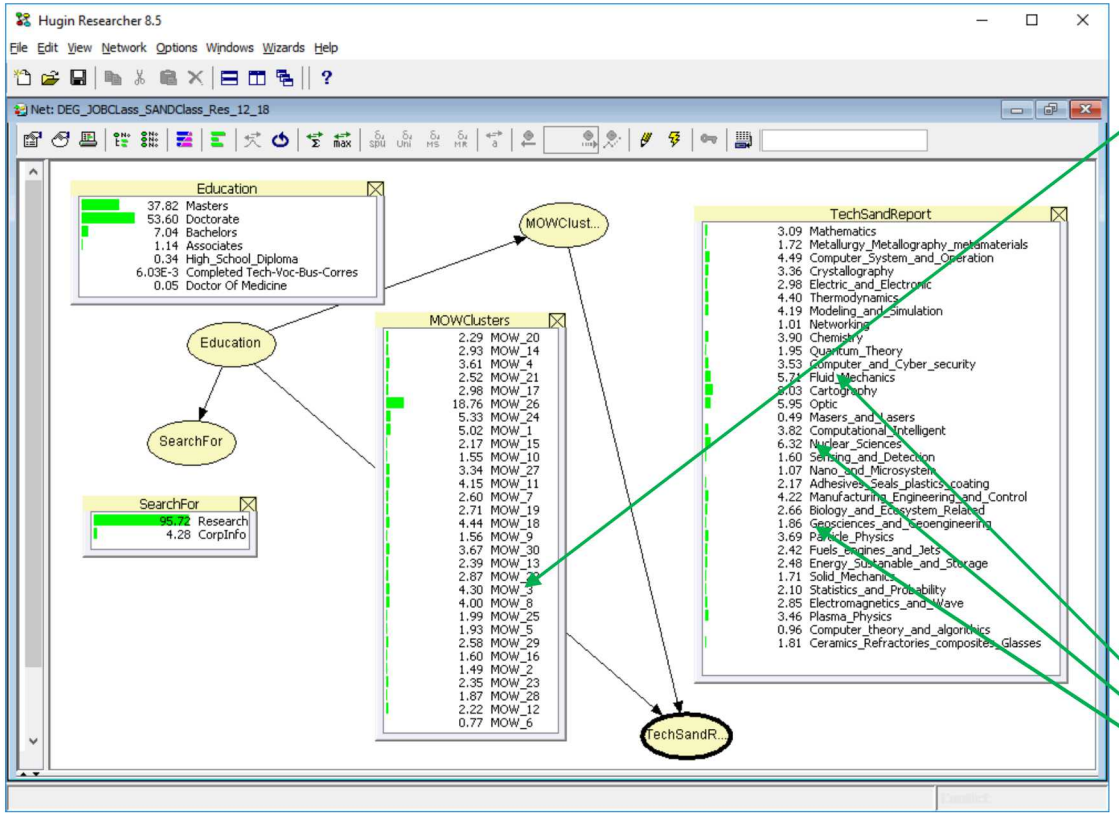
P(computer|webDev)

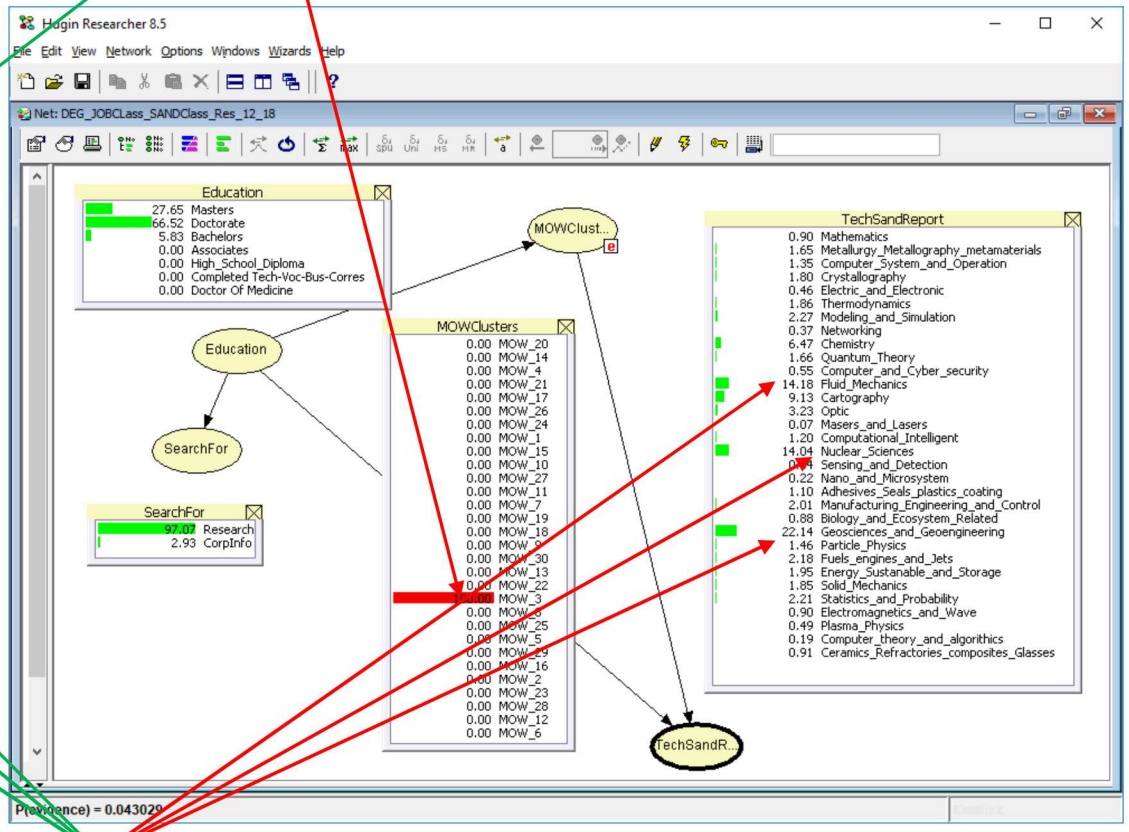
P(webDev)

Distribution of Sandia R&D S&E Clusters and Usage of SAND Reports



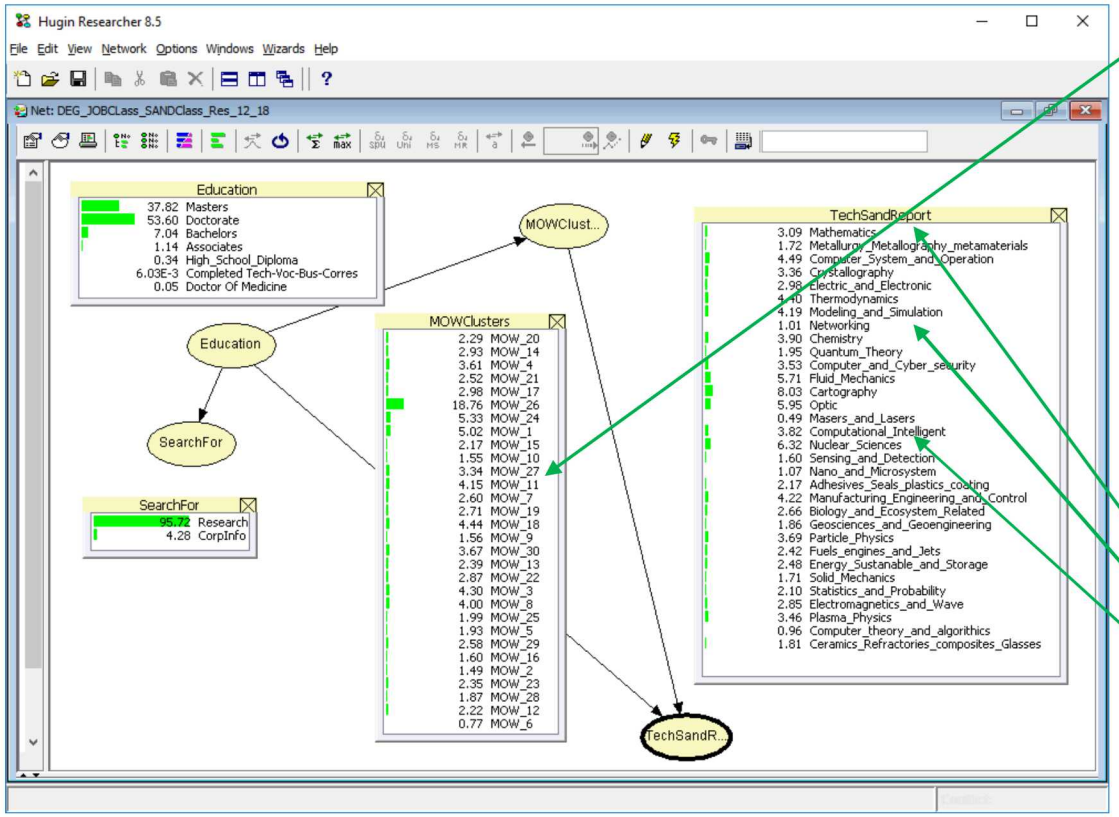
Comparison of SAND Reports Checked by Nuclear-Waste Management and Other Groups

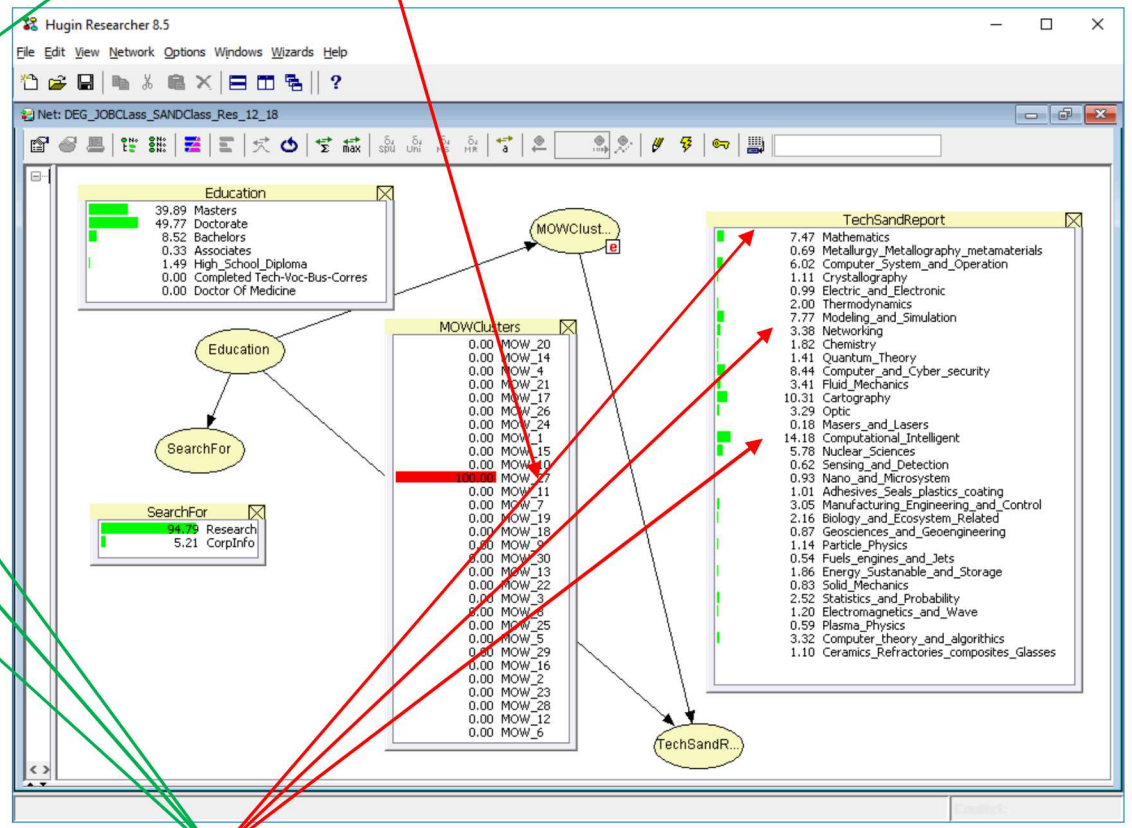




Geoscience	1.86% to 22.14%
Nuclear science	6.32% to 14.04%
Fluid mechanics	5.71% to 14.18%

Comparison of SAND Reports Checked by Machine-learning and Other Groups





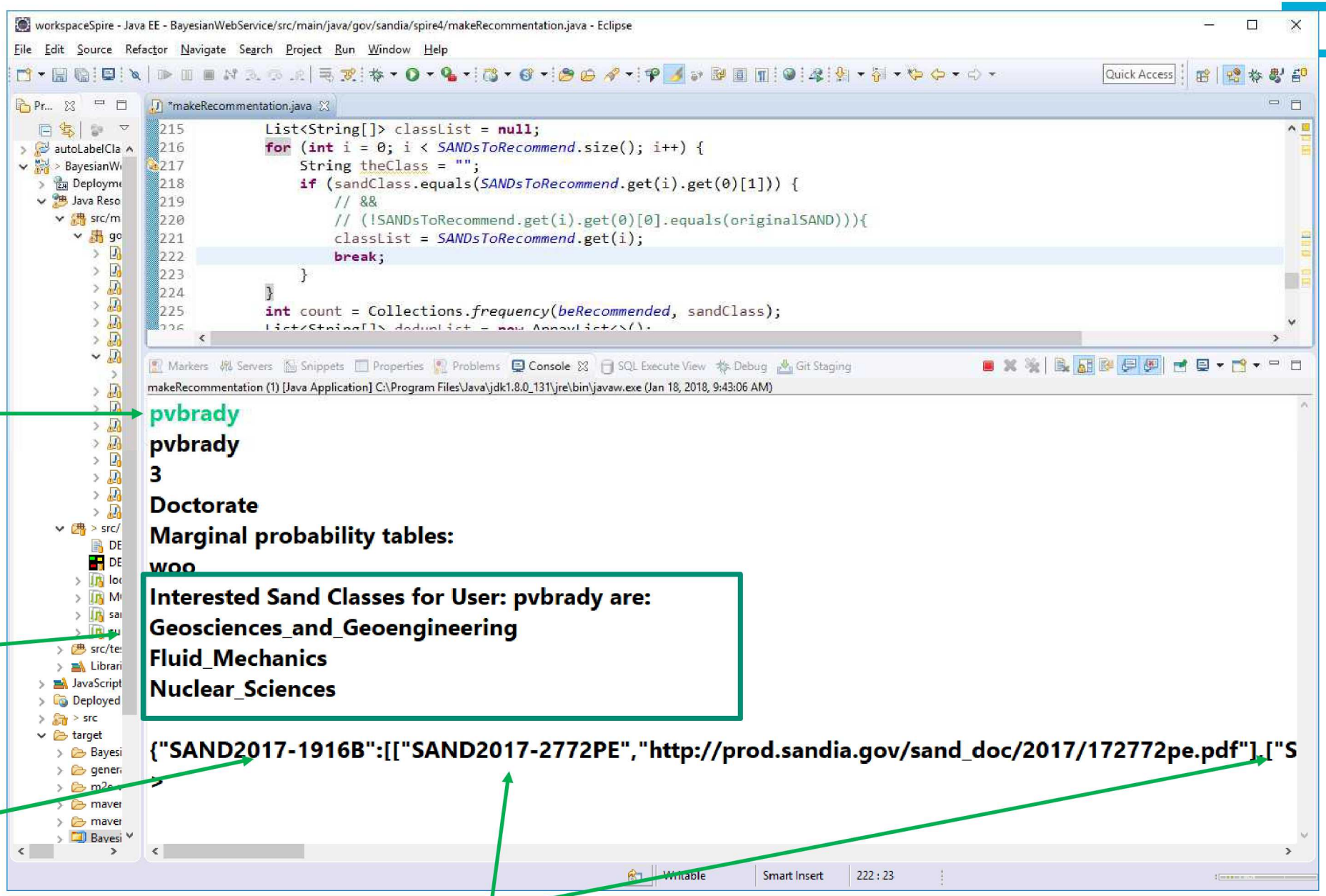
Computer intelligence	3.82% to 14.18%
Mathematics	3.09% to 7.47%
Modeling simulation	4.19% to 7.77%

How personalized recommendations are determined

The User

Sand classes interested

Queried SAND



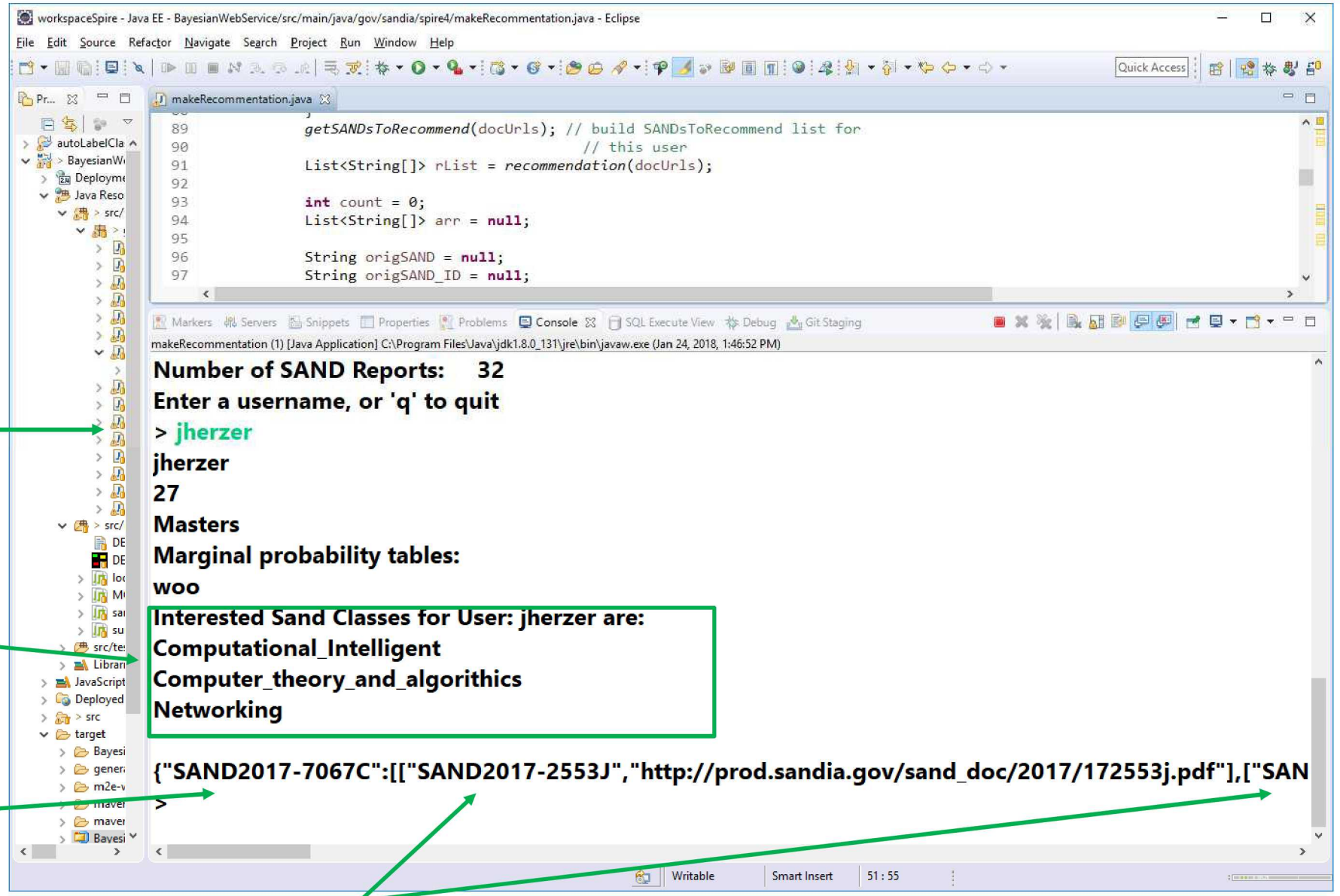
Recommended SANDS

How personalized recommendations are determined

The User

Sand classes interested

Queried SAND



Recommended SANDS

Quantum computing is and is not amazing
SAND2017-7067C

Searched SAND Report by jherzer

Heuristic approach to Satellite Range Scheduling with Bounds using Lagrangian Relaxation
SAND2017-2553J

Quantum Approximation Algorithms
SAND2017-7463C

Recommend to jherzer the SANDs related to his search by SPIRE

Approximate Constraint Satisfaction in the Quantum Setting
SAND2017-9140C

The Trilinos Project Exascale Roadmap
http://prod.sandia.gov/sand_doc/2017/178287pe.pdf
. Contributors: Mark Hoemmen, Siva Rajamanickam, Tobias Wiesner, Lois McInnes trilinos.github.io *SAND2017-8287PE*

A Hierarchical Low-rank Solver for Sparse Linear Systems
SAND2017-2694C

Achievements and Further Efforts

- Analytics provide the foundation to build up an intelligent information retrieval environment:
  - Understanding the similarities of employees through clustering
  - Collecting labeled documents for Machine Learning guided by Taxonomy
  - Classifying text documents with trained classifiers
- Probabilistic graphic model associates users and documents:
  - The model reasons and infers information needed by users
  - The model will be used to predict users' information needs
- More work needed to build a better taxonomy to select labeled documents for learning
  - This is always the issue for supervised learnings
- Expanding the Personalized Information Pull and Push mechanisms to cover more MOWs and other document types. Ideally, to all employees and to all data repositories

Questions