

SOP Consolidation to Save Lives and Property



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Context

SOP (Standard Operating Procedure) for 911 operators

- Contains a set of **instructions to handle specific situations**
- Categorized by **Call types / Event types**
- The same call type may have **different instructions by jurisdictions/agencies**
- 911 Call takers need to **find and follow the most appropriate SOP to respond to calls**

Examples of SOP file names:

- "NewYork - IC - Ice Cream.docx"
- "SanFrancisco -IC - Ice Cream.docx"
- "Washington - CA - Cake.docx"

Context

Call type (event type)

Situations

Agency

ICE CREAM - ICE CREAM CALLS

LA LA LAND POLICE DEPARTMENT

This SOP deals with the ICE CREAM – ice cream event type. Ice cream files are created in the following instances:

- When a person's ice cream has dropped
- When a person's ice cream is robbed

CALL TAKER

Ice cream drop

- Create a call if any of the following apply
 - The caller is a kid
 - The ice cream flavours include chocolate
- In all other cases
 - Advise the caller to pick it up and eat the good parts

Ice cream robbery

- If the caller is a kid and the robber is an adult
 - Create a call
 - Upgrade to Priority 2
- If both the caller and the robber are adults
 - Advise the caller to buy another ice-cream
- If both the caller and the robber are both kids
 - Refer to Animal Control

DISPATCHER

Ice cream drop

- Assign a member
- Advise the member to buy another ice cream for the caller

Ice cream robbery

- Assign a member if the call is a kid and is not accompanied by its parents

Pain points

LALALAND - IC - ICE CREAM.docx

Ice cream drop

- Create a call if any of the following apply
 - The caller is a kid
 - The ice cream flavours include chocolate
- In all other cases
 - Advise the caller to pick it up and eat the good parts

Ice cream robbery

- If the caller is a kid and the robber is an adult
 - Create a call
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- If both the caller and the robber are adults
 - Advise the caller to buy another ice-cream
- If both the caller and the robber are both kids
 - Refer to Animal Control

WONDERLAND - IC - ICE CREAM.docx

Ice cream drop

- Create a call if any of the following apply
 - The caller is a kid
 - The ice cream flavors include vanilla
- In all other cases
 - Refer to CLEANUP – clean up event type

Ice cream robbery

- If the caller is a kid and the robber is an adult
 - Create a call
 - Upgrade to Priority 2
- If both the caller and the robber are adults
 - Advise to by another ice-cream
- If both the caller and the robber are kids
 - Refer to Animal Control

Melted Ice Cream

- Create a call if any of the following apply
 - The caller is a kid
 - Melted Ice Cream is on the street
- In all other cases
 - Refer to CLEANUP - clean up event type

- Redundancy
- Small differences
- Difficult to learn
- Time consuming / Inefficient

Our objectives

1. Identify similarities and differences among SOPs
2. Summarize the above for potential consolidation
3. Explore and visualize common structures among SOPs

Data science methods

1. Document clustering

- a. Algorithms such as K-means, LDA, HDP, etc
- b. Various coherence scores

2. Flowchart

- a. Functions to map out the hierarchical structure
- b. Flatten conditions and filter levels

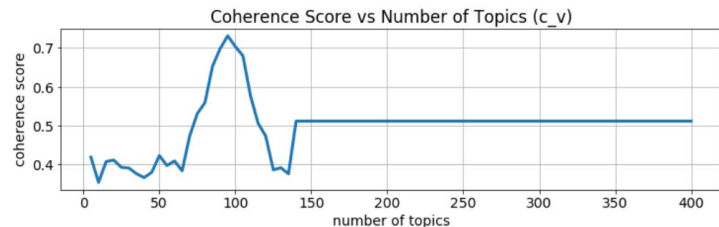
Preprocessing and word vectorization

- Preprocessing
 - Remove stop words
 - Keep allowable POS
 - Lemmatization
- Word vectorization
 - TFIDF

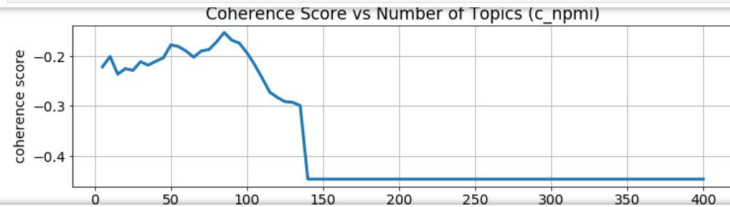
Document clustering - LDA

- Documents with the same topic are grouped under the same cluster
- Hyperparameters:
 - alpha: distribution of topics
 - num_topics: number of topics
- Objective measure: coherence score
 - Whether the topics make sense

```
[14]: plot_coh(situation_lda_tfidf, 'c_v')
```



```
[16]: plot_coh(situation_lda_tfidf, 'c_npmi')
```



Document clustering - Hierarchical Dirichlet Process

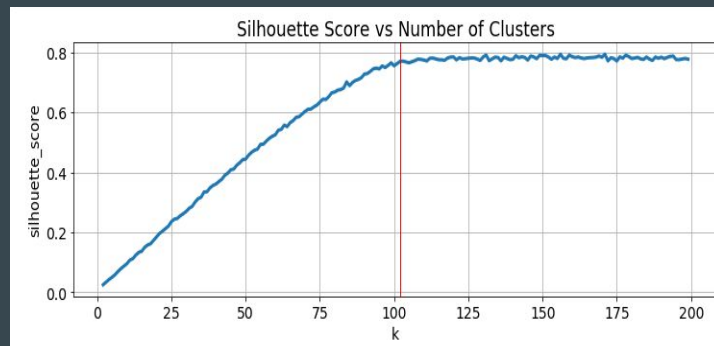
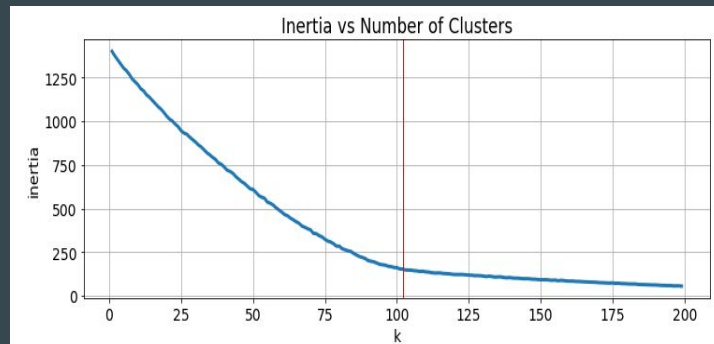
- An extension on LDA
 - Number of topics is inferred
- Hyperparameters:
 - alpha: document level distribution of topics
 - gamma: corpus level distribution of topics
 - T: upper bound of the number of topics
 - K: upper bound of the number of words

```
len(situ_topics_hdp_tfidf['topic_id'].unique())
```

```
263
```

Document clustering - KMeans

- Hyperparameter
 - `n_clusters`: the number of clusters
- Objective measure
 - inertia
 - Silhouette score



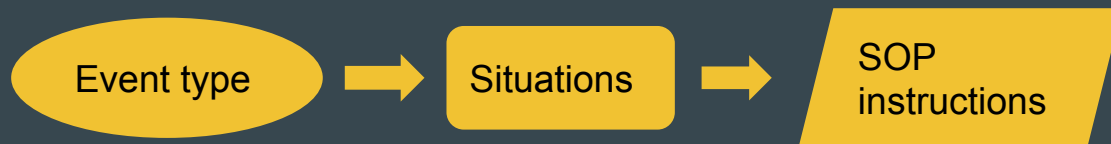
Result of clustering

- KMeans is chosen
 - Based on human interpretation
- Cross-type clustering
 - Breaks the boundary of event types
- Cross-situation clustering
 - Breaks the boundary of event types and situations

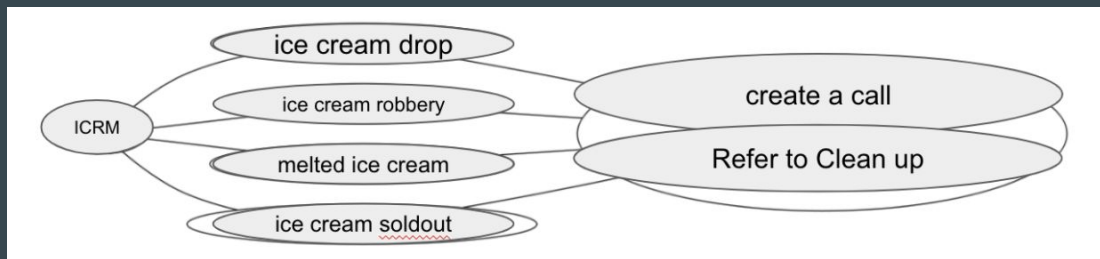
filename	cluster
UD.docx	0
found or zed.docx	0
found or zed.docx	0
found or zed.docx	0
found or zed.docx	0
...	...
1AL.docx	188
1AL.docx	188
ncy.docx	189

Procedure Flowchart

- Represent the hierarchy of call process
 - Simplified knowledge map



- Merge similar nodes
 - TFIDF
 - Cosine similarity

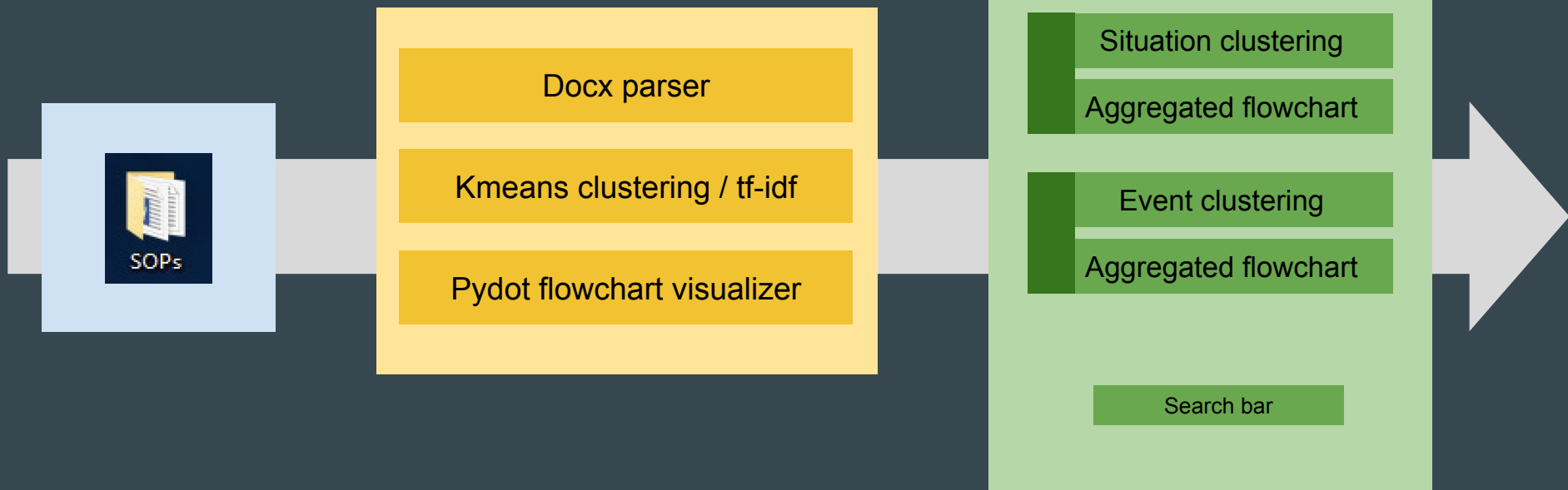


Data product

SOP documents

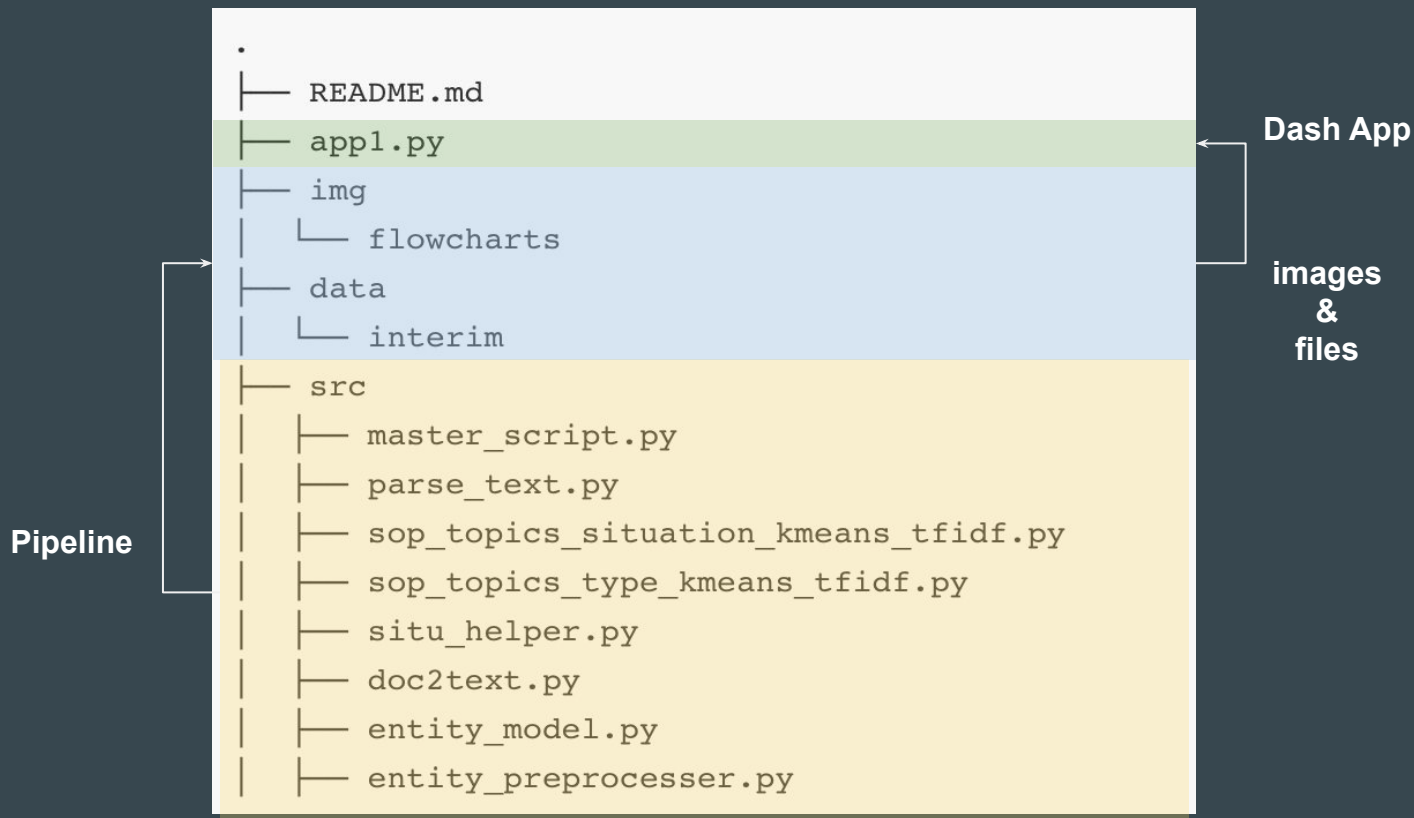
Pipeline

Dashboard



Data product

File structure



Data product

Pipeline

Pipeline


Docx parser

Kmeans clustering / tf-idf


Pydot flowchart visualizer



master_script.py

Acts as a makefile


parse_text.py


Parse docx document to dataframe


sop_topics_situation_k
means_tfidf.py


sop_topics_type_
kmeans_tfidf.py

KMeans clustering
on tf-idf document
vectors


situ_flowchart.py


type_flowchart.py

Generate flowchart
with pydot

Data product Dashboard (Censored)

Dashboard

Situation clustering

Aggregated flowchart

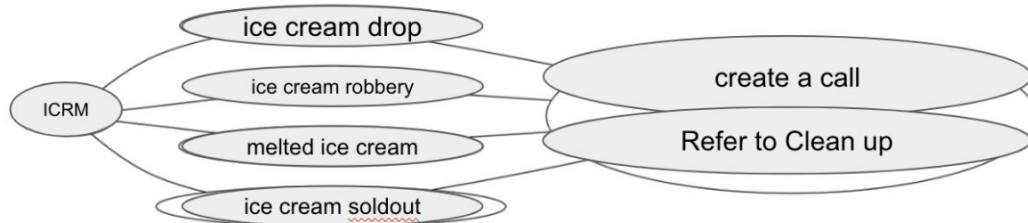
Event clustering

Aggregated flowchart

Search feature

SOP clustering and searching for call takers

Clusters across situations



Choose cluster:

27

Type	Juri	Situation	Sop	filename	cluster
ICRM	LL	ice cream drop	create a call	ICRM-LL.docx	27
ICRM	WL	ice cream robbery	create a call	ICRM-WL.docx	27
ICRM	DL	melted ice cream	refer to clean up	ICRM-DL.docx	27
ICRM	SL	ice cream soldout	refer to clean up	ICRM-SL.docx	27

Data product Dashboard (Censored)

Dashboard

Situation clustering

Aggregated flowchart

Event clustering

Aggregated flowchart

Search feature

Search for call taker SOPs



type	juri	role	situation	sop	filename	cluster
ICRM	LL	Call taker	Missing ice cream	Upgrade to priority 2	LL-ICRM-Ice Cream.docx	100
TOY	WL	Call taker	Missing toy	Buy a new one	WL-TOY-Toy.docx	10
HAT	DL	Call taker	Missing hat	Help the caller to find it	DL-HAT-Hat.docx	50

Search in SOPs

type	juri	role	filename	cluster
LNF	LL	Call taker	LL-LNF-Lost and Found missing object.docx	100

Discussion & limitation

Challenges & Constraints

1. Data

- Word document file (.docx)
- Inconsistency in filenames and format

2. Virtual machine / Remote Offline Desktop

- Restrictions
 - No internet: Difficulty in package installation
 - No administrative authority: cannot change filenames, environment variables, etc.
 - Limited front-end support/resources: no Javascript
- Slow hardware

3. Communication

- COVID-19

Discussion & limitation

Limitations

- Clustering results
 - Interpretability:
some clusters don't make a lot of sense
- Unable to parse SOP instructions
 - Structural inconsistency between/within SOPs

ICE CREAM - ICE CREAM CALLS

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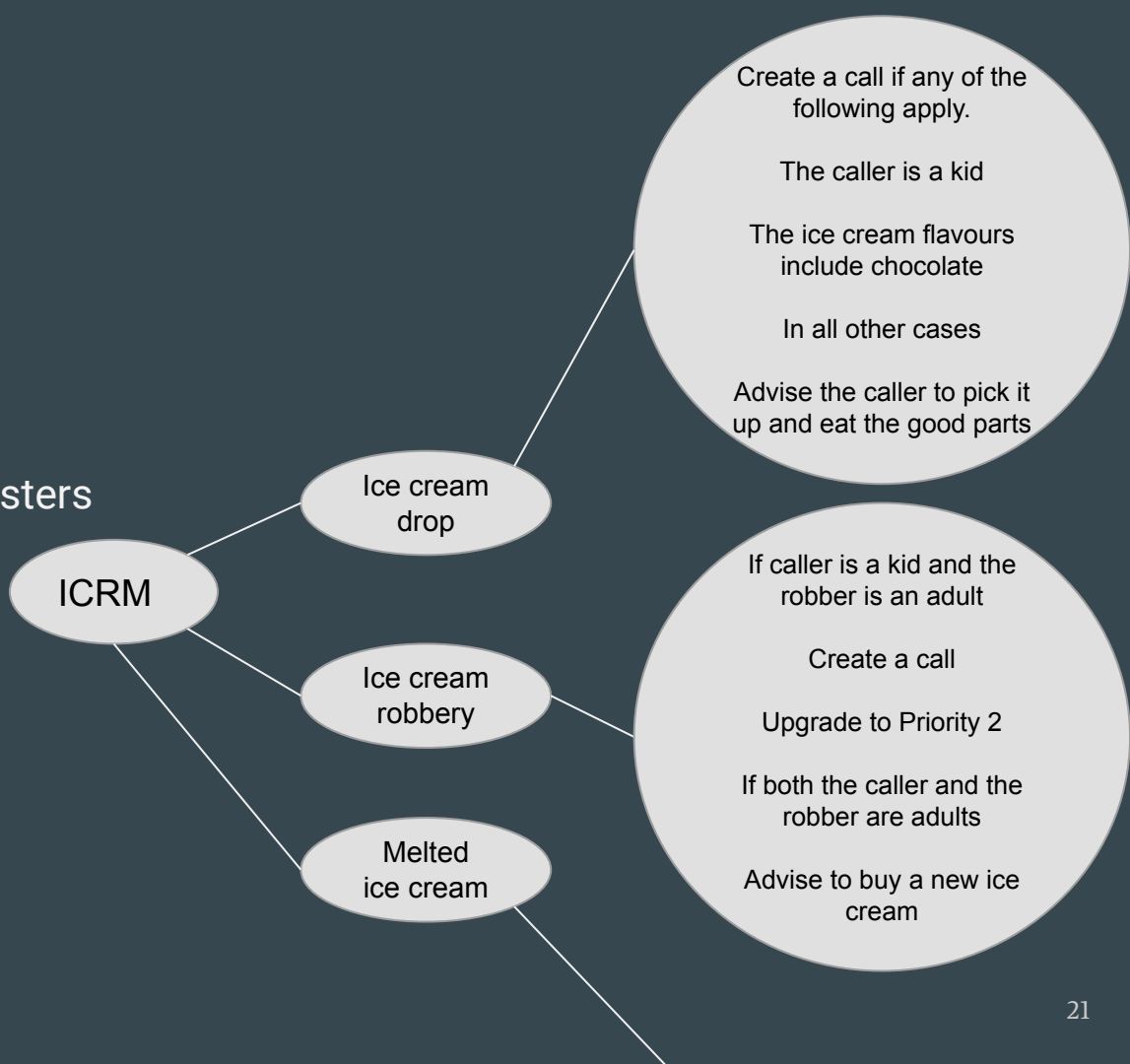
<Structural inconsistency within SOP>

Discussion & limitation

Limitations

- Flowchart

- Lack of visibility for large clusters
- Large nodes



Recommendation / Improvement

1. Improve Search Algorithm

- Use Entity Extraction on Documents for better search results

2. Parsing Instructions

- Breakdown large nodes for better visualization and consolidation

Thank you