Word Spotting in Silent Lip Videos

Supplementary

(Best viewed in 'Presentation mode')

Overview

We divide the discussion into four parts:

- Dependency of word spotting pipeline on quality of feature extractor: Tells about the performance of the proposed pipeline if a better feature extractor is used.
- 2. **Dependency of word spotting pipeline on the quality of input video:** Tells about the limitation of the proposed pipeline
- 3. Word level evaluation of recognition-free retrieval
- 4. Qualitative results

- A detailed analysis of our pipeline with different quality of feature extractors can give us the performance trend of the word spotting pipeline.
- We can further extrapolate the results to know if the recognition-free retrieval will perform better than recognition-based counterpart in case we find a feature extractor.

Experiment:

- We train our CMT lipreader[3] till different validation accuracies, ranging from ~10% to ~70% word accuracy on Lipreading in Wild (LRW) dataset [1].
- This acts as a proxy for using different quality lipreader as feature extractor in our word spotting pipeline.

Results:



Figure 1: Dependency of word spotting pipeline on quality of feature extractor(lipreader): (a) shows change in mean average precision(mAP), (b) shows change in precision at 10 (P@10), and (c) shows the change in recall at 10 (R@10) for different quality of lipreader (x-axis). Blue line-dot is the empirical data for recognition-based(RB) recognition also the baseline(BL), translucent blue line is its 2nd order polynomial extrapolation. Similarly red is for our proposed recognition-free pipeline.

Observation based on experiment:

- The recognition-free retrieval always gives better performance than recognition-based retrieval for different quality of lipreaders used as feature extractors.
- **Robust for different quality of feature extractors:** A 2nd order polynomial extrapolation (Trend line, Figure 1) of the different performance curves shows that our proposed recognition-free word spotting pipeline may perform better than its recognition-based counterpart in case we find a better lipreader.

- In real life scenario, videos taken are not face centric and region of interest (ROI) can be small or blurred.
- We show the performance of our proposed recognition-free pipeline against recognition-based counterpart for different quality of input videos.

Experiment:

- We blur the frames of input video using **3x3 averaging kernel** [2].
- To degrade the quality of input video we perform this blurring operation multiple times.
- We feed this blurred video to our proposed pipeline and compute recognition free performance which we compare with our baseline recognition-based retrieval.

Blurring operation:





Figure 2: Blurring operation: (top) shows blurring of the region of interest (ROI) of a frame of the input video clip, (bottom) shows successive blurring operation on the ROI of the input video clip. (bottom) The number below the ROI of the frames show the number of times blurring filter/kernel has been applied on the original input video.

Results:



Figure 3: Dependency of word spotting pipeline on quality of input video: (a) shows change in mean average precision (mAP), (b) shows change in precision at 10 (P@10) and (c) shows change in recall at 10 (R@10) for different quality of input video(x-axis), subjected to successive blurring as discussed in Figure 2.

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Observation based on experiment:

• Recognition-free performance is steadily better than recognition-based counterpart for different passes of averaging kernel on input video.

drop in mAP (our) = **22.49%**

drop in mAP (BL) = 28.11 % after successive 9 blur.

- **Robust for different quality of input video:** Our proposed pipeline outperforms the baseline even when the input video quality gets severely degraded (successive 9 blurs, Figure 3(a,b,c))
- **Real life application:** Our pipeline may be useful for spotting lips for distant speaker or for surveillance purposes.

Word level evaluation

Word level evaluation

Mean average precision per word:

Figure 4

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its mAP value, with respect to the reference color bar on the right.

Please zoom-in for better clarity.

									Mean	average p	recision pe	class								
	ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	ALLEGATION
	ALLOW	ALLOWED	ALMOST	ALREADY	ALWAYS	AMERICA	AMERICAN	AMONG	AMOUNT	ANNOUNCED	ANOTHER	ANSWER	ANYTHING	AREAS	AROUND	ARRESTED	ASKED	ASKING	ATTACK	ATTACKS
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	GIVING	GLOBAL	GOING	SOVERNMEN	T GREAT	GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH	HEARD	HEART	HEAVY	HIGHER
	HISTORY	HOMES	HOSPITAL	HOURS	HOUSE	HOUSING	HUMAN	HUNDREDS	IMMIGRATIO	ІМРАСТ	IMPORTANT	INCREASE I	NDEPENDEN ⁻	r INDUSTRY	INFLATION	NFORMATION	NQUIRY	INSIDE	INTEREST	INVESTMEN
	INVOLVED	IRELAND	ISLAMIC	ISSUE	ISSUES	ITSELF	JAMES	JUDGE	JUSTICE	KILLED	KNOWN	LABOUR	LARGE	LATER	LATEST	LEADER	LEADERS	LEADERSHIP	LEAST	LEAVE
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	UNITED	UNTIL	USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
v	VESTMINSTE	R WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT	WOMEN	WORDS	WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	YEARS	YESTERDAY	YOUNG
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Word level evaluation

Precision and Recall at k



Figure 5: Precision and Recall at K on LRW dataset(all words): (a) is precision at k (y-axis) for different values of k(x-axis), similarly (b) is recall at k (y-axis) for different values of k(x-axis)

Word level evaluation Precision at k per word (k=1)

Figure 6(a)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Precision at 1** value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Note: Refer Figure 5 for overall precision and recall at k

									Precision @	1 per clas	s								
ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	ALLEGATIONS
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WESTMINSTER	R WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT	WOMEN	WORDS	WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	YEARS	YESTERDAY	YOUNG

0.8

0.7

Word level evaluation Precision at k per word (k=5)

Figure 6(b)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Precision at 5** value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Note: Refer Figure 5 for overall precision and recall at k

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BUDGET	BUILD	BUILDING	BUSINESS	BUSINESSES	CALLED	CAMERON	CAMPAIGN	CANCER	CANNOT	CAPITAL	CASES	CENTRAL	CERTAINLY	CHALLENGE	CHANCE	CHANGE	CHANGES	CHARGE	CHARGES
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Precision @ 5 per class

Word level evaluation Precision at k per word (k=10)

Figure 6(c)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Precision at 10** value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

								Р	recision @	10 per clas	55								
ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	ALLEGATIONS
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GIVING	GLOBAL	GOING	GOVERNMEN	T GREAT	GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH	HEARD	HEART	HEAVY	HIGHER
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LEGAL	LEVEL	LEVELS	LIKELY	UTTLE	LIVES	LIVING	LOCAL	LONDON	LONGER	LOOKING	MAJOR	MAJORITY	MAKES	MAKING	MANCHESTER	MARKET	MASSIVE	MATTER	MAYBE
MEANS	MEASURES	MEDIA	MEDICAL	MEETING	MEMBER	MEMBERS	MESSAGE	MIDDLE	MIGHT	MIGRANTS	MILITARY	MILLION	MILLIONS	MINISTER	MINISTERS	MINUTES	MISSING	MOMENT	MONEY
MONTH	MONTHS	MORNING	MOVING	MURDER	NATIONAL	NEEDS	NEVER	NIGHT	NORTH	NORTHERN	NOTHING	NUMBER	NUMBERS	OBAMA	OFFICE	OFFICERS	OFFICIALS	OFTEN	OPERATION
OPPOSITION	ORDER	OTHER	OTHERS	OUTSIDE	PARENTS	PARLIAMENT	PARTIES	PARTS	PARTY	PATIENTS	PAYING	PEOPLE	PERHAPS	PERIOD	PERSON	PERSONAL	PHONE	PLACE	PLACES -
PLANS	POINT	POLICE	POLICY	POLITICAL	POLITICIANS	POLITICS	POSITION	POSSIBLE	POTENTIAL	POWER	POWERS	PRESIDENT	PRESS	PRESSURE	PRETTY	PRICE	PRICES	PRIME	PRISON
PRIVATE	PROBABLY	PROBLEM	PROBLEMS	PROCESS	PROTECT	PROVIDE	PUBLIC	QUESTION	QUESTIONS	QUITE	RATES	RATHER	REALLY	REASON	RECENT	RECORD	REFERENDU	REMEMBER	REPORT
REPORTS	RESPONSE	RESULT	RETURN	RIGHT	RIGHTS	RULES	RUNNING	RUSSIA	RUSSIAN	SAYING	SCHOOL	SCHOOLS	SCOTLAND	SCOTTISH	SECOND	SECRETARY	SECTOR	SECURITY	SEEMS
SENIOR	SENSE	SERIES	SERIOUS	SERVICE	SERVICES	SEVEN	SEVERAL	SHORT	SHOULD	SIDES	SIGNIFICANT	SIMPLY	SINCE	SINGLE	SITUATION	SMALL	SOCIAL	SOCIETY	SOMEONE
SOMETHING	SOUTH	SOUTHERN	SPEAKING	SPECIAL	SPEECH	SPEND	SPENDING	SPENT	STAFF	STAGE	STAND	START	STARTED	STATE		STATES	STILL	STORY	STREET -
STRONG	SUNDAY	SUNSHINE	SUPPORT	SYRIA	SYRIAN	SYSTEM	TAKEN	TAKING	TALKING	TALKS T	EMPERATUR	IS TERMS	THEIR	THEMSELVES	THERE	THESE	THING	THINGS	THINK
THIRD	THOSE	THOUGHT	THOUSANDS	THREAT	THREE	THROUGH	TIMES	TODAY	TOGETHER	TOMORROW	TONIGHT	TOWARDS	TRADE	TRIAL	TRUST	TRYING	UNDER	UNDERSTAND	UNION
UNITED	UNTIL	USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
VESTMINSTE	R WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT	WOMEN	WORDS	WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	YEARS	YESTERDAY	YOUNG

Word level evaluation Precision at k per word (k=20)

Figure 6(d)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its Precision at 20 value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

								P	recision @	20 per clas	55								
ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	ALLEGATIONS
ALLOW	ALLOWED	ALMOST	ALREADY	ALWAYS	AMERICA	AMERICAN	AMONG	AMOUNT	ANNOUNCED	ANOTHER	ANSWER	ANYTHING	AREAS	AROUND	ARRESTED	ASKED	ASKING	ATTACK	ATTACKS
AUTHORITIES	BANKS	BECAUSE	BECOME	BEFORE	BEHIND	BEING	BELIEVE	BENEFIT	BENEFITS	BETTER	BETWEEN	BIGGEST	BILLION	BLACK	BORDER	BRING	BRITAIN	BRITISH	BROUGHT
BUDGET	BUILD	BUILDING	BUSINESS	BUSINESSES	CALLED	CAMERON		CANCER	CANNOT	CAPITAL	CASES	CENTRAL	CERTAINLY	CHALLENGE	CHANCE	CHANGE	CHANGES	CHARGE	CHARGES
OHEF	CHILD	CHILDREN	CHINA	CLAIMS	CLEAR	CLOSE	CLOUD	COMES	COMING	COMMUNITY	COMPANIES	COMPANY	CONCERNS	CONFERENCE	CONFLICT C	ONSERVATIN	ECONTINUE	CONTROL	COULD
COUNCIL	COUNTRIES	COUNTRY	COUPLE	COURSE	COURT	CRIME	CRISIS	CURRENT	CUSTOMERS	DAVID	DEATH	DEBATE	DECIDED	DECISION	DEFICIT	DEGREES	DESCRIBED	DESPITE	DETAILS
DIFFERENCE	DIFFERENT	DIFFICULT	DOING	DURING	EARLY	EASTERN	ECONOMIC	ECONOMY	EDITOR	EDUCATION	ELECTION	EMERGENCY	ENERGY	ENGLAND	ENOUGH	EUROPE	EUROPEAN	EVENING	EVENTS
EVERY	EVERYBODY	EVERYONE	EVERYTHING	EVIDENCE	EXACTLY	EXAMPLE	EXPECT	EXPECTED	EXTRA	FACING	FAMILIES	FAMILY	FIGHT	FIGHTING	FIGURES	FINAL	FINANCIAL	FIRST	FOCUS
FOLLOWING	FOOTBALL	FORCE	FORCES	FOREIGN	FORMER	FORWARD	FOUND	FRANCE	FRENCH	FRIDAY	FRONT	FURTHER	FUTURE	GAMES	GENERAL	GEORGE	GERMANY	GETTING	GIVEN
GIVING	GLOBAL	GOING	GOVERNMEN	T GREAT	GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH	HEARD	HEART	HEAVY	HIGHER
HISTORY	HOMES	HOSPITAL	HOURS	HOUSE	HOUSING	HUMAN	HUNDREDS	IMMIGRATION	і імраст	IMPORTANT	INCREASE	NDEPENDEN"	T INDUSTRY	INFLATION	NFORMATION	NQUIRY	INSIDE	INTEREST	INVESTMENT
INVOLVED			ISSUE	ISSUES	ITSELF	JAMES	JUDGE	JUSTICE	KILLED	KNOWN	LABOUR	LARGE	LATER	LATEST	LEADER	LEADERS	LEADERSHIP	LEAST	LEAVE
LEGAL	LEVEL	LEVELS	LIKELY	UTTLE	LIVES	LIVING	LOCAL	LONDON	LONGER	LOOKING	MAJOR	MAJORITY	MAKES	MAKING	MANCHESTER	MARKET	MASSIVE	MATTER	МАҮВЕ
MEANS	MEASURES	MEDIA	MEDICAL	MEETING	MEMBER	MEMBERS	MESSAGE	MIDDLE	MIGHT	MIGRANTS	MILITARY	MILLION	MILLIONS	MINISTER	MINISTERS	MINUTES	MISSING	MOMENT	MONEY
MONTH	MONTHS	MORNING	MOVING	MURDER	NATIONAL	NEEDS	NEVER	NIGHT	NORTH	NORTHERN	NOTHING	NUMBER	NUMBERS	OBAMA	OFFICE	OFFICERS	OFFICIALS	OFTEN	OPERATION
OPPOSITION	ORDER	OTHER	OTHERS	OUTSIDE	PARENTS	PARLIAMENT	PARTIES	PARTS	PARTY	PATIENTS	PAYING	PEOPLE	PERHAPS	PERIOD	PERSON	PERSONAL	PHONE	PLACE	PLACES -
PLANS	POINT	POLICE	POLICY	POLITICAL	POLITICIANS	POLITICS	POSITION	POSSIBLE	POTENTIAL	POWER	POWERS	PRESIDENT	PRESS	PRESSURE	PRETTY	PRICE	PRICES	PRIME	PRISON
PRIVATE	PROBABLY	PROBLEM	PROBLEMS	PROCESS	PROTECT	PROVIDE	PUBLIC	QUESTION	QUESTIONS	QUITE	RATES	RATHER	REALLY	REASON	RECENT	RECORD	REFERENDUM	REMEMBER	REPORT
REPORTS	RESPONSE	RESULT	RETURN	RIGHT	RIGHTS	RULES	RUNNING	RUSSIA	RUSSIAN	SAYING	SCHOOL	SCHOOLS	SCOTLAND	SCOTTISH	SECOND	SECRETARY	SECTOR	SECURITY	SEEMS
SENIOR	SENSE	SERIES	SERIOUS	SERVICE	SERVICES	SEVEN	SEVERAL	SHORT	SHOULD	SIDES	SIGNIFICANT	SIMPLY	SINCE	SINGLE	SITUATION	SMALL	SOCIAL	SOCIETY	SOMEONE
SOMETHING	SOUTH	SOUTHERN	SPEAKING	SPECIAL	SPEECH	SPEND	SPENDING	SPENT	STAFF	STAGE	STAND	START	STARTED	STATE	STATEMENT	STATES	STILL	STORY	STREET -
STRONG	SUNDAY	SUNSHINE	SUPPORT	SYRIA	SYRIAN	SYSTEM	TAKEN	TAKING	TALKING	TALKS T	EMPERATURE	S TERMS	THEIR	THEMSELVES		THESE	THING	THINGS	THINK
THIRD	THOSE	THOUGHT	THOUSANDS	THREAT	THREE	THROUGH	TIMES	TODAY	TOGETHER	TOMORROW	TONIGHT	TOWARDS	TRADE	TRIAL	TRUST	TRYING	UNDER	UNDERSTANE	
UNITED	UNTIL	USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
WESTMINSTE	R WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT	WOMEN	WORDS	WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	YEARS	YESTERDAY	YOUNG

Word level evaluation Precision at k per word (k=30)

Figure 6(e)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its Precision at 30 value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

								P	recision @	so per cia:	55								
ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	
ALLOW	ALLOWED	ALMOST	ALREADY	ALWAYS	AMERICA	AMERICAN	AMONG	AMOUNT	ANNOUNCED	ANOTHER	ANSWER	ANYTHING	AREAS	AROUND	ARRESTED	ASKED	ASKING	ATTACK	ATTACKS
AUTHORITIES	BANKS	BECAUSE	BECOME	BEFORE	BEHIND	BEING	BELIEVE	BENEFIT	BENEFITS	BETTER	BETWEEN	BIGGEST	BILLION	BLACK	BORDER	BRING	BRITAIN	BRITISH	BROUGHT
BUDGET	BUILD	BUILDING	BUSINESS	BUSINESSES	CALLED	CAMERON		CANCER	CANNOT	CAPITAL	CASES	CENTRAL	CERTAINLY	CHALLENGE	CHANCE	CHANGE	CHANGES	CHARGE	CHARGES
CHIEF	CHILD	CHILDREN	CHINA	CLAIMS	CLEAR	CLOSE	CLOUD	COMES	COMING	COMMUNITY	COMPANIES	COMPANY	CONCERNS	CONFERENCE	CONFLICT	ONSERVATIV	E CONTINUE	CONTROL	COULD
- COUNCIL	COUNTRIES	COUNTRY	COUPLE	COURSE	COURT	CRIME	CRISIS	CURRENT	CUSTOMERS	DAVID	DEATH	DEBATE	DECIDED	DECISION	DEFICIT	DEGREES	DESCRIBED	DESPITE	DETAILS -
DIFFERENCE	DIFFERENT	DIFFICULT	DOING	DURING	EARLY	EASTERN	ECONOMIC	ECONOMY	EDITOR	EDUCATION	ELECTION	EMERGENCY	ENERGY	ENGLAND	ENOUGH	EUROPE	EUROPEAN	EVENING	EVENTS
EVERY	EVERYBODY	EVERYONE	EVERYTHING	EVIDENCE	EXACTLY	EXAMPLE	EXPECT	EXPECTED	EXTRA	FACING	FAMILIES	FAMILY	FIGHT	FIGHTING	FIGURES	FINAL	FINANCIAL	FIRST	FOCUS
FOLLOWING	FOOTBALL	FORCE	FORCES	FOREIGN	FORMER	FORWARD	FOUND	FRANCE	FRENCH	FRIDAY	FRONT	FURTHER	FUTURE	GAMES	GENERAL	GEORGE	GERMANY	GETTING	GIVEN
GIVING	GLOBAL	GOING	GOVERNMEN	T GREAT	GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH	HEARD	HEART	HEAVY	HIGHER
HISTORY	HOMES	HOSPITAL	HOURS	HOUSE	HOUSING	HUMAN		IMMIGRATION	IMPACT	IMPORTANT	INCREASE I	NDEPENDEN	T INDUSTRY	INFLATION	NFORMATION		INSIDE	INTEREST	INVESTMENT
INVOLVED	IRELAND		ISSUE	ISSUES	ITSELF	JAMES	JUDGE	JUSTICE	KILLED	KNOWN	LABOUR	LARGE	LATER	LATEST	LEADER	LEADERS	LEADERSHIP	LEAST	LEAVE
LEGAL	LEVEL	LEVELS	LIKELY	UTTLE	LIVES	LIVING	LOCAL	LONDON	LONGER	LOOKING	MAJOR	MAJORITY	MAKES	MAKING	MANCHESTER	MARKET	MASSIVE	MATTER	MAYBE
MEANS	MEASURES	MEDIA	MEDICAL	MEETING	MEMBER	MEMBERS	MESSAGE	MIDDLE	MIGHT	MIGRANTS	MILITARY	MILLION	MILLIONS	MINISTER	MINISTERS	MINUTES	MISSING	MOMENT	MONEY
MONTH	MONTHS	MORNING	MOVING	MURDER	NATIONAL	NEEDS	NEVER	NIGHT	NORTH	NORTHERN	NOTHING	NUMBER	NUMBERS	OBAMA	OFFICE	OFFICERS	OFFICIALS	OFTEN	OPERATION
OPPOSITION	ORDER	OTHER	OTHERS	OUTSIDE	PARENTS	PARLIAMENT	PARTIES	PARTS	PARTY	PATIENTS	PAYING	PEOPLE	PERHAPS	PERIOD	PERSON	PERSONAL	PHONE	PLACE	PLACES -
PLANS	POINT	POLICE	POLICY	POLITICAL	POLITICIANS	POLITICS	POSITION	POSSIBLE	POTENTIAL	POWER	POWERS	PRESIDENT	PRESS	PRESSURE	PRETTY	PRICE	PRICES	PRIME	PRISON
PRIVATE	PROBABLY	PROBLEM	PROBLEMS	PROCESS	PROTECT	PROVIDE	PUBLIC	QUESTION	QUESTIONS	QUITE	RATES	RATHER	REALLY	REASON	RECENT	RECORD	REFERENDUN	REMEMBER	REPORT
REPORTS	RESPONSE	RESULT	RETURN	RIGHT	RIGHTS	RULES	RUNNING	RUSSIA	RUSSIAN	SAYING	SCHOOL	SCHOOLS	SCOTLAND	SCOTTISH	SECOND	SECRETARY	SECTOR	SECURITY	SEEMS
SENIOR	SENSE	SERIES	SERIOUS	SERVICE	SERVICES	SEVEN	SEVERAL	SHORT	SHOULD	SIDES	SIGNIFICANT	SIMPLY	SINCE	SINGLE	SITUATION	SMALL	SOCIAL	SOCIETY	SOMEONE
SOMETHING	SOUTH	SOUTHERN	SPEAKING	SPECIAL	SPEECH	SPEND	SPENDING	SPENT	STAFF	STAGE	STAND	START	STARTED	STATE	STATEMENT	STATES	STILL	STORY	STREET -
STRONG	SUNDAY	SUNSHINE	SUPPORT	SYRIA	SYRIAN	SYSTEM	TAKEN	TAKING	TALKING	TALKS T	EMPERATURE	ES TERMS	THEIR	THEMSELVES	THERE	THESE	THING	THINGS	THINK
THIRD	THOSE	THOUGHT	THOUSANDS	THREAT	THREE	THROUGH	TIMES	TODAY	TOGETHER	TOMORROW	TONIGHT	TOWARDS	TRADE	TRIAL	TRUST	TRYING	UNDER	UNDERSTAND	UNION
UNITED	UNTIL	USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
WESTMINSTE	R WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT		WORDS	WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	YEARS	YESTERDAY	YOUNG

Word level evaluation Precision at k per word (k=40)

Figure 6(f)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Precision at** 40 value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Note: Refer Figure 5 for overall precision and recall at k

									1	Precision @	40 per clas	55								
ALMA ALMA<	ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER		AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	
Marka and and and and and and and and and an	ALLOW	ALLOWED	ALMOST	ALREADY	ALWAYS	AMERICA	AMERICAN	AMONG	AMOUNT	ANNOUNCED	ANOTHER	ANSWER	ANYTHING	AREAS	AROUND	ARRESTED	ASKED	ASKING	ATTACK	ATTACKS
	UTHORITIES	BANKS	BECAUSE	BECOME	BEFORE	BEHIND	BEING	BELIEVE	BENEFIT	BENEFITS	BETTER	BETWEEN	BIGGEST	BILLION	BLACK	BORDER	BRING	BRITAIN	BRITISH	BROUGHT
	BUDGET	BUILD	BUILDING	BUSINESS	BUSINESSES	CALLED	CAMERON	CAMPAIGN	CANCER	CANNOT	CAPITAL	CASES	CENTRAL	CERTAINLY	CHALLENGE	CHANCE	CHANGE	CHANGES	CHARGE	CHARGES
Control Contro Control Control	CHIEF	CHILD	CHILDREN	CHINA	CLAIMS	CLEAR	CLOSE	CLOUD	COMES	COMING		COMPANIES	COMPANY	CONCERNS	CONFERENC	E CONFLICT O	ONSERVATIN	E CONTINUE	CONTROL	COULD
Here Net Sole <t< th=""><th>COUNCIL</th><th>COUNTRIES</th><th>COUNTRY</th><th>COUPLE</th><th>COURSE</th><th>COURT</th><th>CRIME</th><th>CRISIS</th><th>CURRENT</th><th>CUSTOMERS</th><th>DAVID</th><th>DEATH</th><th>DEBATE</th><th>DECIDED</th><th>DECISION</th><th>DEFICIT</th><th>DEGREES</th><th>DESCRIBED</th><th>DESPITE</th><th>DETAILS</th></t<>	COUNCIL	COUNTRIES	COUNTRY	COUPLE	COURSE	COURT	CRIME	CRISIS	CURRENT	CUSTOMERS	DAVID	DEATH	DEBATE	DECIDED	DECISION	DEFICIT	DEGREES	DESCRIBED	DESPITE	DETAILS
NAME <	DIFFERENCE	DIFFERENT	DIFFICULT	DOING	DURING	EARLY	EASTERN	ECONOMIC	ECONOMY	EDITOR	EDUCATION	ELECTION	EMERGENCY	ENERGY	ENGLAND	ENOUGH	EUROPE	EUROPEAN	EVENING	EVENTS
Alterna Alte	EVERY	EVERYBODY	EVERYONE	EVERYTHING	EVIDENCE	EXACTLY	EXAMPLE	EXPECT	EXPECTED	EXTRA	FACING	FAMILIES	FAMILY	FIGHT	FIGHTING	FIGURES	FINAL	FINANCIAL	FIRST	FOCUS
ONN ONN<	FOLLOWING	FOOTBALL	FORCE	FORCES	FOREIGN	FORMER	FORWARD	FOUND	FRANCE	FRENCH	FRIDAY	FRONT	FURTHER	FUTURE	GAMES	GENERAL	GEORGE	GERMANY	GETTING	GIVEN
NATION NAT	GIVING	GLOBAL	GOING	GOVERNMEN	T GREAT	GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH	HEARD	HEART	HEAVY	HIGHER
NAME LAME SAME SAME SAME SAME MAME MAME<	HISTORY	HOMES	HOSPITAL	HOURS	HOUSE	HOUSING	HUMAN	HUNDREDS	IMMIGRATIO	N IMPACT	IMPORTANT	INCREASE	INDEPENDEN	T INDUSTRY	INFLATION	INFORMATION	NQUIRY	INSIDE	INTEREST	NVESTMEN
LEAK LEVE <thleve< th=""> LEVE LEVE LEVE <t< th=""><th>INVOLVED</th><th>IRELAND</th><th></th><th>ISSUE</th><th>ISSUES</th><th>ITSELF</th><th>JAMES</th><th>JUDGE</th><th>JUSTICE</th><th>KILLED</th><th>KNOWN</th><th>LABOUR</th><th>LARGE</th><th>LATER</th><th>LATEST</th><th>LEADER</th><th>LEADERS</th><th>LEADERSHIP</th><th>LEAST</th><th>LEAVE</th></t<></thleve<>	INVOLVED	IRELAND		ISSUE	ISSUES	ITSELF	JAMES	JUDGE	JUSTICE	KILLED	KNOWN	LABOUR	LARGE	LATER	LATEST	LEADER	LEADERS	LEADERSHIP	LEAST	LEAVE
MEMS MEGA MEDIA MEDIA MEMBA M	LEGAL	LEVEL	LEVELS	UKELY	LITTLE	LIVES	LIVING	LOCAL	LONDON	LONGER	LOOKING	MAJOR	MAJORITY	MAKES	MAKING	MANCHESTER	MARKET	MASSIVE	MATTER	MAYBE
MMHH MMHHH MMHH MURDER MURDER MITHON MURDER MURDER <	MEANS	MEASURES	MEDIA	MEDICAL	MEETING	MEMBER	MEMBERS	MESSAGE	MIDDLE	MIGHT	MIGRANTS	MILITARY	MILLION	MILLIONS	MINISTER	MINISTERS	MINUTES	MISSING	MOMENT	MONEY
ORDER ORDER <th< th=""><th>MONTH</th><th>MONTHS</th><th>MORNING</th><th>MOVING</th><th>MURDER</th><th>NATIONAL</th><th>NEEDS</th><th>NEVER</th><th>NIGHT</th><th>NORTH</th><th>NORTHERN</th><th>NOTHING</th><th>NUMBER</th><th>NUMBERS</th><th>OBAMA</th><th>OFFICE</th><th>OFFICERS</th><th>OFFICIALS</th><th>OFTEN</th><th>OPERATION</th></th<>	MONTH	MONTHS	MORNING	MOVING	MURDER	NATIONAL	NEEDS	NEVER	NIGHT	NORTH	NORTHERN	NOTHING	NUMBER	NUMBERS	OBAMA	OFFICE	OFFICERS	OFFICIALS	OFTEN	OPERATION
Point Point <th< th=""><th>OPPOSITION</th><th>ORDER</th><th>OTHER</th><th>OTHERS</th><th>OUTSIDE</th><th>PARENTS</th><th>PARLIAMENT</th><th>PARTIES</th><th>PARTS</th><th>PARTY</th><th>PATIENTS</th><th>PAYING</th><th>PEOPLE</th><th>PERHAPS</th><th>PERIOD</th><th>PERSON</th><th>PERSONAL</th><th>PHONE</th><th>PLACE</th><th>PLACES</th></th<>	OPPOSITION	ORDER	OTHER	OTHERS	OUTSIDE	PARENTS	PARLIAMENT	PARTIES	PARTS	PARTY	PATIENTS	PAYING	PEOPLE	PERHAPS	PERIOD	PERSON	PERSONAL	PHONE	PLACE	PLACES
PROBALLY PROBALLY PROBLEMS PRODECKS PROTECT PROVINCE QUESTONS	PLANS	POINT	POLICE	POLICY	POLITICAL	POLITICIANS	POLITICS	POSITION	POSSIBLE	POTENTIAL	POWER	POWERS	PRESIDENT	PRESS	PRESSURE	PRETTY	PRICE	PRICES	PRIME	PRISON
REPORTS RESULT RETURN RECURN REGURN RULES	PRIVATE	PROBABLY	PROBLEM	PROBLEMS	PROCESS	PROTECT	PROVIDE	PUBLIC	QUESTION	QUESTIONS	QUITE	RATES	RATHER	REALLY	REASON	RECENT	RECORD	REFERENDU	N REMEMBER	REPORT
SENOR SENE SERIES SERIOUS SERVICE SERVICE SEVEN SEVEN SEVEN SHOLD SHOLD SDEE SUBBRIAL SHOLE SHALE	REPORTS	RESPONSE	RESULT	RETURN	RIGHT	RIGHTS	RULES	RUNNING	RUSSIA	RUSSIAN	SAYING	SCHOOL	SCHOOLS		SCOTTISH	SECOND	SECRETARY	SECTOR	SECURITY	SEEMS
OMETHING SOUTHERN SPEAKING SPECIAL SPEEND SPEND STAFF STAFF STARE STARE STATE STATEM	SENIOR	SENSE	SERIES	SERIOUS	SERVICE	SERVICES	SEVEN	SEVERAL	SHORT	SHOULD	SIDES	SIGNIFICANT	SIMPLY	SINCE	SINGLE	SITUATION	SMALL	SOCIAL	SOCIETY	SOMEONE
STROM SUMARY SUPPORT STRUM STRUM STSTEM TAKIN TAKIN TALKIN	SOMETHING	SOUTH	SOUTHERN	SPEAKING	SPECIAL	SPEECH	SPEND	SPENDING	SPENT	STAFF	STAGE	STAND	START	STARTED	STATE	STATEMENT	STATES	STILL	STORY	STREET
THOSE THOUGHT THOUGHD THREAT THREAD THRE	STRONG	SUNDAY	SUNSHINE	SUPPORT	SYRIA	SYRIAN	SYSTEM	TAKEN	TAKING	TALKING	TALKS T		ES TERMS	THEIR	THEMSELVE	THERE	THESE	THING	THINGS	THINK
UNITED UNITE USING WEITHE USING WEITHE UNICE VOTERS WAITING WALES WAITED	THIRD	THOSE	THOUGHT	THOUSANDS	THREAT	THREE	THROUGH	TIMES	TODAY	TOGETHER	TOMORROW	TONIGHT	TOWARDS	TRADE	TRIAL	TRUST	TRYING	UNDER	UNDERSTANE	UNION
STMINISTER WHERE WHETHER WHICH WHILE WHOLE WINDS WITHIN WITHOUT WOMEN WORDS WORKERS WORKING WORLD WORST WOULD WRONG YEARS YESTERDAY YOU	UNITED	UNTIL	USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
	ESTMINSTE	R WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT	WOMEN	WORDS	WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	YEARS	YESTERDAY	YOUNG

0.8

0.7

- 0.6

Word level evaluation Precision at k per word (k=50)

Figure 6(g)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Precision at 50** value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Note: Refer Figure 5 for overall precision and recall at k

								F	Precision @	50 per clas	s								
ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	ALLEGATIONS
ALLOW	ALLOWED	ALMOST	ALREADY	ALWAYS	AMERICA	AMERICAN	AMONG	AMOUNT	ANNOUNCED	ANOTHER	ANSWER	ANYTHING	AREAS	AROUND	ARRESTED	ASKED	ASKING	ATTACK	ATTACKS
AUTHORITIES	BANKS	BECAUSE	BECOME	BEFORE	BEHIND	BEING	BELIEVE	BENEFIT	BENEFITS	BETTER	BETWEEN	BIGGEST	BILLION	BLACK	BORDER	BRING	BRITAIN	BRITISH	BROUGHT
BUDGET	BUILD	BUILDING	BUSINESS	BUSINESSES	CALLED	CAMERON	CAMPAIGN	CANCER	CANNOT	CAPITAL	CASES	CENTRAL	CERTAINLY	CHALLENGE	CHANCE	CHANGE	CHANGES	CHARGE	CHARGES
CHIEF	CHILD	CHILDREN	CHINA	CLAIMS	CLEAR	CLOSE	CLOUD	COMES	COMING	COMMUNITY	COMPANIES	COMPANY	CONCERNS	CONFERENCE		ONSERVATIV	ECONTINUE	CONTROL	COULD
- COUNCIL	COUNTRIES	COUNTRY	COUPLE	COURSE	COURT	CRIME	CRISIS	CURRENT	CUSTOMERS	DAVID	DEATH	DEBATE	DECIDED	DECISION	DEFICIT	DEGREES	DESCRIBED	DESPITE	DETAILS
DIFFERENCE	DIFFERENT	DIFFICULT	DOING	DURING	EARLY	EASTERN	ECONOMIC	ECONOMY	EDITOR	EDUCATION	ELECTION	EMERGENCY	ENERGY	ENGLAND	ENOUGH	EUROPE	EUROPEAN	EVENING	EVENTS
EVERY	EVERYBODY	EVERYONE	EVERYTHING	EVIDENCE	EXACTLY	EXAMPLE	EXPECT	EXPECTED	EXTRA	FACING	FAMILIES	FAMILY	FIGHT	FIGHTING	FIGURES	FINAL	FINANCIAL	FIRST	FOCUS
FOLLOWING	FOOTBALL	FORCE	FORCES	FOREIGN	FORMER	FORWARD	FOUND	FRANCE	FRENCH	FRIDAY	FRONT	FURTHER	FUTURE	GAMES	GENERAL	GEORGE	GERMANY	GETTING	GIVEN
GIVING	GLOBAL	GOING	GOVERNMEN	T GREAT	GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH	HEARD	HEART	HEAVY	HIGHER
HISTORY	HOMES	HOSPITAL	HOURS	HOUSE	HOUSING	HUMAN	HUNDREDS	IMMIGRATIO	N IMPACT	IMPORTANT	INCREASE	INDEPENDEN	T INDUSTRY	INFLATION	NFORMATION	NUN	INSIDE	INTEREST	INVESTMENT
INVOLVED	IRELAND	ISLAMIC	ISSUE	ISSUES	ITSELF	JAMES	JUDGE	JUSTICE	KILLED	KNOWN	LABOUR	LARGE	LATER	LATEST	LEADER	LEADERS	LEADERSHIP	LEAST	LEAVE
LEGAL	LEVEL	LEVELS	UKELY	LITTLE	LIVES	LIVING	LOCAL	LONDON	LONGER	LOOKING	MAJOR	MAJORITY	MAKES	MAKING	MANCHESTER	MARKET	MASSIVE	MATTER	MAYBE
MEANS	MEASURES	MEDIA	MEDICAL	MEETING	MEMBER	MEMBERS	MESSAGE	MIDDLE	MIGHT	MIGRANTS	MILITARY	MILLION	MILLIONS	MINISTER	MINISTERS	MINUTES	MISSING	MOMENT	MONEY
MONTH	MONTHS	MORNING	MOVING	MURDER	NATIONAL	NEEDS	NEVER	NIGHT	NORTH	NORTHERN	NOTHING	NUMBER	NUMBERS	OBAMA	OFFICE	OFFICERS	OFFICIALS	OFTEN	OPERATION
OPPOSITION	ORDER	OTHER	OTHERS	OUTSIDE	PARENTS	PARLIAMENT	PARTIES	PARTS	PARTY	PATIENTS	PAYING	PEOPLE	PERHAPS	PERIOD	PERSON	PERSONAL	PHONE	PLACE	PLACES
PLANS	POINT	POLICE	POLICY	POLITICAL	POLITICIANS	POLITICS	POSITION	POSSIBLE	POTENTIAL	POWER	POWERS	PRESIDENT	PRESS	PRESSURE	PRETTY	PRICE	PRICES	PRIME	PRISON
PRIVATE	PROBABLY	PROBLEM	PROBLEMS	PROCESS	PROTECT	PROVIDE	PUBLIC	QUESTION	QUESTIONS	QUITE	RATES	RATHER	REALLY	REASON	RECENT	RECORD	REFERENDUM	REMEMBER	REPORT
REPORTS	RESPONSE	RESULT	RETURN	RIGHT	RIGHTS	RULES	RUNNING	RUSSIA	RUSSIAN	SAYING	SCHOOL	SCHOOLS	SCOTLAND	SCOTTISH	SECOND	SECRETARY	SECTOR	SECURITY	SEEMS
SENIOR	SENSE	SERIES	SERIOUS	SERVICE	SERVICES	SEVEN	SEVERAL	SHORT	SHOULD	SIDES	SIGNIFICANT	SIMPLY	SINCE	SINGLE	SITUATION	SMALL	SOCIAL	SOCIETY	SOMEONE
SOMETHING	SOUTH	SOUTHERN	SPEAKING	SPECIAL	SPEECH	SPEND	SPENDING	SPENT	STAFF	STAGE	STAND	START	STARTED	STATE	STATEMENT	STATES	STILL	STORY	STREET
STRONG	SUNDAY	SUNSHINE	SUPPORT	SYRIA	SYRIAN	SYSTEM	TAKEN	TAKING	TALKING	TALKS T		S TERMS	THEIR	THEMSELVES	THERE	THESE	THING	THINGS	THINK
THIRD	THOSE		THOUSANDS	THREAT	THREE	THROUGH	TIMES	TODAY	TOGETHER	TOMORROW	TONIGHT	TOWARDS	TRADE	TRIAL	TRUST	TRYING	UNDER	UNDERSTAND	UNION
UNITED		USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
UNITED	MAJER	MULETUER	Metici:	MAILE	WHOLE	MINIDE	MATHIN	WITHOUT	WANTS	MORDS	WORKERS	MORKING	MODUC	MORET	WOLLD	WEEKS	VEADO	VECTERDAY	VOLUME
WEST MINSTER	WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT	WOMEN	WORDS	WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	TEARS	TESTERDAY	TOUNG

0.8

0.7

0.6

0.5

03

0.2

Word level evaluation Recall at k per class (k=1)

Figure 7(a)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Recall at 1** value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Note: Refer Figure 5 for overall precision and recall at k

									ALLEISATIONS
									ATACKS
									BROUGHT
									CHARGES
									COULD
									OPDALS -
									EVENTS
									Pocus
									GVEN
									FIGHER
									INVESTMENT
									LEAVE
									MAYBE
									MONEY
									CIPERATION
									PLACES
									PHISON
									REPORT
									SEEMS
									SOMEONE
									STREET
									телек
									D. UNION
									WESTERN
									YOUNG

Word level evaluation Recall at k per class (k=5)

Figure 7(b)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Recall at 5** value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Word level evaluation Recall at k per class (k=10)

Figure 7(c)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its Recall at 10 value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

ABOLT	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	ALLEGATIONS
ALLOW																		ATTACKS
AUTHORITIES																		BROUGHT
BUDGET						CAMPAIGN												CHARGES
CHIEF																		COULD
COUNCIL																		DETAILS
DIFFERENCE																		EVENTS
EVERY																		FOCUS
FOLLOWING																		GIVEN
GIVING																		HIGHER
HISTORY														NFORMATION	INQUIRY			INVESTMENT
INVOLVED																		LEAVE
LEGAL.																		MAYBE
MEANS									MIGRANTS									MONEY
MONTH																		OPERATION
OPPOSITION																		PLACES
PLANS																	PRIME	PRISON
PRIVATE																		REPORT
REPORTS																		SEEMS
SENIOR																		SOMEONE
SOMETHING																		STREET
STRONG		SUPPORT																THENK
THIRD																		
UNITED																		WESTERN
WESTMINSTER																		YOUNG

Word level evaluation Recall at k per class (k=20)

Figure 7(d)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Recall at 20** value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Note: Refer Figure 5 for overall precision and recall at k

ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS		ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN		AGREE	AGREEMENT	AHEAD	ALLEGATIONS
ALLOW	ALLOWED	ALMOST	ALREADY	ALWAYS	AMERICA	AMERICAN	AMONG	AMOUNT	ANNOUNCED	ANOTHER	ANSWER	ANYTHING	AREAS	AROUND	ARRESTED		ASKING	ATTACK	ATTACKS
AUTHORITIES	BANKS	BECAUSE	BECOME	BEFORE	BEHIND	BEING	BELIEVE	BENEFIT	BENEFITS		BETWEEN	BIGGEST	BILLION	BLACK	BORDER		BRITAIN	BRITISH	BROUGHT
BUDGET		BUILDING	BUSINESS	BUSINESSES		CAMERON	CAMPAIGN	CANCER	CANNOT	CAPITAL	CASES	CENTRAL	CERTAINLY	CHALLENGE			CHANGES	CHARGE	CHARGES
CHIEF		CHILDREN	CHINA	CLAIMS	CLEAR	CLOSE	CLOUD	COMES	COMING	COMMUNITY	COMPANIES	COMPANY	CONCERNS	CONFERENCE	CONFLICT C	ONSERVATIV	ECONTINUE	CONTROL	COULD
COUNCIL	COUNTRIES	COUNTRY	COUPLE			CRIME	CRISIS	CURRENT	CUSTOMERS	DAVID	DEATH	DEBATE	DECIDED	DECISION	DEFICIT	DEGREES	DESCRIBED	DESPITE	DETAILS
DIFFERENCE		DIFFICULT		DURING	EARLY	EASTERN	ECONOMIC	ECONOMY	EDITOR	EDUCATION	ELECTION	EMERGENCY	ENERGY	ENGLAND	ENOUGH	EUROPE	EUROPEAN	EVENING	EVENTS
EVERY	EVERYBODY	EVERYONE	EVERYTHING	EVIDENCE	EXACTLY	EXAMPLE	EXPECT	EXPECTED	EXTRA	FACING	FAMILIES	FAMILY		FIGHTING	FIGURES	FINAL	FINANCIAL		FOCUS
FOLLOWING	FOOTBALL	FORCE	FORCES	FOREIGN	FORMER	FORWARD	FOUND	FRANCE	FRENCH	FRIDAY	FRONT	FURTHER	FUTURE	GAMES	GENERAL	GEORGE	GERMANY		GIVEN
GIVING	GLOBAL		SOVERNMEN [®]		GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH		HEART	HEAVY	HIGHER
HISTORY	HOMES	HOSPITAL	HOURS	HOUSE	HOUSING	HUMAN	HUNDREDS	IMMIGRATION	MPACT	IMPORTANT	INCREASE I	NDEPENDEN	T INDUSTRY	INFLATION I	NFORMATION	I INQUIRY	INSIDE	INTEREST	INVESTMENT
INVOLVED	IRELAND	ISLAMIC	ISSUE	ISSUES	ITSELF	JAMES	JUDGE	JUSTICE	KILLED	KNOWN	LABOUR	LARGE	LATER	LATEST	LEADER	LEADERS	LEADERSHIP		LEAVE
LEGAL		LEVELS	LIKELY		LIVES		LOCAL		LONGER	LOOKING	MAJOR	MAJORITY	MAKES	MAKING	MANCHESTER	MARKET	MASSIVE	MATTER	MAYBE
MEANS	MEASURES	MEDIA	MEDICAL	MEETING	MEMBER	MEMBERS	MESSAGE			MIGRANTS	MILITARY	MILLION	MILLIONS	MINISTER	MINISTERS	MINUTES	MISSING	MOMENT	MONEY
MONTH	MONTHS	MORNING	MOVING	MURDER	NATIONAL	NEEDS		NIGHT	NORTH	NORTHERN	NOTHING	NUMBER	NUMBERS	OBAMA	OFFICE	OFFICERS	OFFICIALS	OFTEN	OPERATION
OPPOSITION			OTHERS	OUTSIDE	PARENTS	PARLIAMENT	PARTIES	PARTS	PARTY	PATIENTS	PAYING	PEOPLE	PERHAPS	PERIOD		PERSONAL	PHONE	PLACE	PLACES -
PLANS	POINT	POLICE	POLICY	POLITICAL	POLITICIANS	POLITICS	POSITION	POSSIBLE	POTENTIAL	POWER	POWERS	PRESIDENT		PRESSURE	PRETTY	PRICE	PRICES	PRIME	PRISON
PRIVATE	PROBABLY	PROBLEM	PROBLEMS	PROCESS	PROTECT	PROVIDE	PUBLIC	QUESTION	QUESTIONS	QUITE	RATES	RATHER	REALLY	REASON	RECENT	RECORD	REFERENDUM	REMEMBER	REPORT
REPORTS	RESPONSE	RESULT	RETURN	RIGHT	RIGHTS	RULES	RUNNING	RUSSIA	RUSSIAN	SAYING	SCHOOL	SCHOOLS	SCOTLAND	SCOTTISH	SECOND	SECRETARY	SECTOR	SECURITY	SEEMS
SENIOR	SENSE	SERIES	SERIOUS	SERVICE	SERVICES	SEVEN	SEVERAL.	SHORT	SHOULD	SIDES	SIGNIFICANT	SIMPLY	SINCE	SINGLE	SITUATION	SMALL	SOCIAL	SOCIETY	SOMEONE
SOMETHING	SOUTH	SOUTHERN	SPEAKING	SPECIAL	SPEECH	SPEND	SPENDING		STAFF	STAGE	STAND	START		STATE	STATEMENT			STORY	STREET -
STRONG	SUNDAY	SUNSHINE	SUPPORT	SYRIA	SYRIAN	SYSTEM	TAKEN		TALKING	TALKS T	EMPERATURE	S TERMS		THEMSELVES				THINGS	THINK
THIRD			THOUSANDS	THREAT	THREE	THROUGH	TIMES		TOGETHER	TOMORROW	TONIGHT	TOWARDS	TRADE	TRIAL	TRUST		UNDER	JNDERSTAND	UNION
UNITED		USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
ESTMINSTER	WHERE	WHETHER	WHICH		WHOLE	WINDS	WITHIN	WITHOUT	WOMEN		WORKERS	WORKING	WORLD	WORST	WOULD	WRONG		YESTERDAY	YOUNG

0.8

0.7

- 0.6

0.4

0.3

0.2

Word level evaluation Recall at k per class (k=30)

Figure 7(e)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its Recall at 30 value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Note: Refer Figure 5 for overall precision and recall at k

ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN		AGREE	AGREEMENT	AHEAD .	ALLEGATIONS
ALLOW	ALLOWED	ALMOST	ALREADY	ALWAY5	AMERICA	AMERICAN	AMONG	AMOUNT	ANNOUNCED	ANOTHER	ANSWER	ANYTHING	AREAS	AROUND	ARRESTED	ASKED	ASKING	ATTACK	ATTACKS
AUTHORITIES	BANKS	BECAUSE	BECOME	BEFORE	BEHIND	BEING	BELIEVE	BENEFIT	BENEFITS	BETTER	BETWEEN	BIGGEST	BILLION	BLACK	BORDER	BRING	BRITAIN	BRITISH	BROUGHT
BUDGET	BUILD	BUILDING	BUSINESS	BUSINESSES	CALLED	CAMERON	CAMPAIGN	CANCER	CANNOT	CAPITAL	CASES	CENTRAL	CERTAINLY	CHALLENGE	CHANCE	CHANGE	CHANGES	CHARGE	CHARGES
CHIEF	CHILD	CHILDREN	CHINA	CLAIMS	CLEAR	CLOSE	CLOUD	COMES	COMING	COMMUNITY	COMPANIES	COMPANY	CONCERNS	CONFERENCE	CONFLICT	CONSERVATION	VECONTINUE	CONTROL	COULD
COUNCIL	COUNTRIES	COUNTRY	COUPLE	COURSE	COURT	CRIME	CRISIS	CURRENT	CUSTOMERS	DAVID	DEATH	DEBATE	DECIDED	DECISION	DEFICIT	DEGREES	DESCRIBED	DESPITE	DETAILS -
DIFFERENCE	DIFFERENT	DIFFICULT	DOING	DURING	EARLY	EASTERN	ECONOMIC	ECONOMY	EDITOR	EDUCATION	ELECTION	EMERGENCY	ENERGY	ENGLAND	ENOUGH	EUROPE	EUROPEAN	EVENING	EVENTS
EVERY	EVERYBODY	EVERYONE	EVERYTHING	EVIDENCE	EXACTLY	EXAMPLE	EXPECT	EXPECTED	EXTRA	FACING	FAMILIES	FAMILY	FIGHT	FIGHTING	FIGURES	FINAL	FINANCIAL	FIRST	FOCUS
FOLLOWING	FOOTBALL	FORCE	FORCES	FOREIGN	FORMER	FORWARD	FOUND	FRANCE	FRENCH	FRIDAY	FRONT	FURTHER	FUTURE	GAMES	GENERAL	GEORGE	GERMANY	GETTING	GIVEN
GIVING	GLOBAL	GOING	GOVERNMEN	GREAT	GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH	HEARD	HEART	HEAVY	HIGHER
HISTORY	HOMES	HOSPITAL	HOURS	HOUSE	HOUSING	HUMAN	HUNDREDS	IMMIGRATION	I IMPACT	IMPORTANT	INCREASE	NDEPENDEN	T INDUSTRY	INFLATION I	INFORMATION	N INQUIRY	INSIDE	INTEREST	INVESTMENT
INVOLVED	IRELAND	ISLAMIC	ISSUE	ISSUES	ITSELF	JAMES	JUDGE	JUSTICE	KILLED	KNOWN	LABOUR	LARGE	LATER	LATEST	LEADER	LEADERS	LEADERSHIP	LEAST	LEAVE
LEGAL	LEVEL	LEVELS	LIKELY	UTTLE	UVES	LIVING	LOCAL	LONDON	LONGER	LOOKING	MAJOR	MAJORITY	MAKES	MAKING	MANCHESTEF	R MARKET	MASSIVE	MATTER	MAYBE
MEANS	MEASURES	MEDIA	MEDICAL	MEETING	MEMBER	MEMBERS	MESSAGE	MIDDLE	MIGHT	MIGRANTS	MILITARY	MILLION	MILLIONS	MINISTER	MINISTERS	MINUTES	MISSING	MOMENT	MONEY
MONTH	MONTHS	MORNING	MOVING	MURDER	NATIONAL	NEEDS	NEVER	NIGHT	NORTH	NORTHERN	NOTHING	NUMBER	NUMBERS	OBAMA	OFFICE	OFFICERS	OFFICIALS	OFTEN	OPERATION
OPPOSITION	ORDER	OTHER	OTHERS	OUTSIDE	PARENTS	PARLIAMENT	PARTIES	PARTS	PARTY	PATIENTS	PAYING	PEOPLE	PERHAPS	PERIOD	PERSON	PERSONAL	PHONE	PLACE	PLACES -
PLANS	POINT	POLICE	POLICY	POLITICAL	POLITICIANS	POLITICS	POSITION	POSSIBLE	POTENTIAL	POWER	POWERS	PRESIDENT	PRESS	PRESSURE	PRETTY	PRICE	PRICES	PRIME	PRISON
PRIVATE	PROBABLY	PROBLEM	PROBLEMS	PROCESS	PROTECT	PROVIDE	PUBLIC	QUESTION	QUESTIONS	QUITE	RATES	RATHER	REALLY	REASON	RECENT	RECORD	REFERENDUM	REMEMBER	REPORT
REPORTS	RESPONSE	RESULT	RETURN	RIGHT	RIGHTS	RULES	RUNNING	RUSSIA	RUSSIAN	SAYING	SCHOOL	SCHOOLS	SCOTLAND	SCOTTISH	SECOND	SECRETARY	SECTOR	SECURITY	SEEMS
SENIOR	SENSE	SERIES	SERIOUS	SERVICE	SERVICES	SEVEN	SEVERAL	SHORT	SHOULD	SIDES	SIGNIFICANT	SIMPLY	SINCE	SINGLE	SITUATION	SMALL	SOCIAL	SOCIETY	SOMEONE
SOMETHING	SOUTH	SOUTHERN	SPEAKING	SPECIAL	SPEECH	SPEND	SPENDING	SPENT	STAFF	STAGE	STAND	START		STATE	STATEMENT	STATES	STILL	STORY	STREET -
STRONG	SUNDAY	SUNSHINE	SUPPORT	SYRIA	SYRIAN	SYSTEM	TAKEN	TAKING	TALKING	TALKS T	EMPERATURE	S TERMS	THEIR	THEMSELVES	THERE			THINGS	THINK
THIRD		THOUGHT	THOUSANDS	THREAT	THREE	THROUGH	TIMES	TODAY	TOGETHER	TOMORROW	TONIGHT	TOWARDS	TRADE	TRIAL	TRUST	TRYING	UNDER	UNDERSTAND	UNION
UNITED	UNTIL	USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
WESTMINSTER	WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT	WOMEN		WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	YEARS	YESTERDAY	YOUNG

0.9

0.8

Word level evaluation Recall at k per class (k=40)

Figure 7(f)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Recall at 40** value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Note: Refer Figure 5 for overall precision and recall at k

ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	ALLEGATIONS
ALLOW	ALLOWED	ALMOST	ALREADY	ALWAYS	AMERICA	AMERICAN	AMONG	AMOUNT	ANNOUNCED	ANOTHER	ANSWER	ANYTHING	AREAS	AROUND	ARRESTED	ASKED	ASKING	ATTACK	ATTACKS
AUTHORITIES	BANKS	BECAUSE	BECOME	BEFORE	BEHIND	BEING	BELIEVE	BENEFIT	BENEFITS	BETTER	BETWEEN	BIGGEST	BILLION	BLACK	BORDER	BRING	BRITAIN	BRITISH	BROUGHT
BUDGET	BUILD	BUILDING	BUSINESS	BUSINESSES	CALLED	CAMERON	CAMPAIGN	CANCER	CANNOT	CAPITAL	CASES	CENTRAL	CERTAINLY	CHALLENGE	CHANCE	CHANGE	CHANGES	CHARGE	CHARGES
CHIEF	CHILD	CHILDREN	CHINA	CLAIMS	CLEAR	CLOSE	CLOUD	COMES	COMING	COMMUNITY	COMPANIES	COMPANY	CONCERNS	CONFERENCE	CONFLICT	ONSERVATIN	ECONTINUE	CONTROL	COULD
- COUNCIL	COUNTRIES	COUNTRY	COUPLE	COURSE	COURT	CRIME	CRISIS	CURRENT	CUSTOMERS	DAVID	DEATH	DEBATE	DECIDED	DECISION	DEFICIT	DEGREES	DESCRIBED	DESPITE	DETAILS -
DIFFERENCE	DIFFERENT	DIFFICULT	DOING	DURING	EARLY	EASTERN	ECONOMIC	ECONOMY	EDITOR	EDUCATION	ELECTION	EMERGENCY	ENERGY	ENGLAND	ENOUGH	EUROPE	EUROPEAN	EVENING	EVENTS
EVERY	EVERYBODY	EVERYONE	EVERYTHING	EVIDENCE	EXACTLY	EXAMPLE	EXPECT	EXPECTED	EXTRA	FACING	FAMILIES	FAMILY	FIGHT	FIGHTING	FIGURES	FINAL	FINANCIAL	FIRST	FOCUS
FOLLOWING	FOOTBALL	FORCE	FORCES	FOREIGN	FORMER	FORWARD	FOUND	FRANCE	FRENCH	FRIDAY	FRONT	FURTHER	FUTURE	GAMES	GENERAL	GEORGE	GERMANY	GETTING	GIVEN
GIVING	GLOBAL	GOING	GOVERNMEN	GREAT	GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH	HEARD	HEART	HEAVY	HIGHER
HISTORY	HOMES	HOSPITAL	HOURS	HOUSE	HOUSING	HUMAN	HUNDREDS	IMMIGRATION	M IMPACT	IMPORTANT	INCREASE	NDEPENDEN	T INDUSTRY	INFLATION I	NFORMATION	INQUIRY	INSIDE	INTEREST	INVESTMENT
INVOLVED	IRELAND	ISLAMIC	ISSUE	ISSUES	ITSELF	JAMES	JUDGE	JUSTICE	KILLED	KNOWN	LABOUR	LARGE	LATER	LATEST	LEADER	LEADERS	LEADERSHIP	LEAST	LEAVE
LEGAL	LEVEL	LEVELS	LIKELY	UTTLE	LIVES	LIVING	LOCAL	LONDON	LONGER	LOOKING	MAJOR	MAJORITY	MAKES	MAKING	MANCHESTER	MARKET	MASSIVE	MATTER	MAYBE
MEANS	MEASURES	MEDIA	MEDICAL	MEETING	MEMBER	MEMBERS	MESSAGE	MIDDLE	MIGHT	MIGRANTS	MILITARY	MILLION	MILLIONS	MINISTER	MINISTERS	MINUTES	MISSING	MOMENT	MONEY
MONTH	MONTHS	MORNING	MOVING	MURDER	NATIONAL	NEEDS	NEVER	NIGHT	NORTH	NORTHERN	NOTHING	NUMBER	NUMBERS	OBAMA	OFFICE	OFFICERS	OFFICIALS	OFTEN	OPERATION
OPPOSITION	ORDER	OTHER	OTHERS	OUTSIDE	PARENTS	PARLIAMENT	PARTIES	PARTS	PARTY	PATIENTS	PAYING	PEOPLE	PERHAPS	PERIOD	PERSON	PERSONAL	PHONE	PLACE	PLACES -
PLANS	POINT	POLICE	POLICY	POLITICAL	POLITICIANS	POLITICS	POSITION	POSSIBLE	POTENTIAL	POWER	POWERS	PRESIDENT	PRESS	PRESSURE	PRETTY	PRICE	PRICES	PRIME	PRISON
PRIVATE	PROBABLY	PROBLEM	PROBLEMS	PROCESS	PROTECT	PROVIDE	PUBLIC	QUESTION	QUESTIONS	QUITE	RATES	RATHER	REALLY	REASON	RECENT	RECORD	REFERENDUM	REMEMBER	REPORT
REPORTS	RESPONSE	RESULT	RETURN	RIGHT	RIGHTS	RULES	RUNNING	RUSSIA	RUSSIAN	SAYING	SCHOOL	SCHOOLS	SCOTLAND	SCOTTISH	SECOND	SECRETARY	SECTOR	SECURITY	SEEMS
SENIOR	SENSE	SERIES	SERIOUS	SERVICE	SERVICES	SEVEN	SEVERAL	SHORT	SHOULD	SIDES	SIGNIFICANT	SIMPLY	SINCE	SINGLE	SITUATION	SMALL	SOCIAL	SOCIETY	SOMEONE
SOMETHING	SOUTH	SOUTHERN	SPEAKING	SPECIAL	SPEECH	SPEND	SPENDING	SPENT	STAFF	STAGE	STAND	START	STARTED	STATE	STATEMENT	STATES	STILL	STORY	STREET -
STRONG	SUNDAY	SUNSHINE	SUPPORT	SYRIA	SYRIAN	SYSTEM	TAKEN	TAKING	TALKING	TALKS 1	EMPERATURE	S TERMS	THER	THEMSELVES	THERE		THING	THINGS	THINK
THIRD		THOUGHT	THOUSANDS	THREAT	THREE	THROUGH	TIMES	TODAY	TOGETHER	TOMORROW	TONIGHT	TOWARDS	TRADE	TRIAL	TRUST	TRYING	UNDER	JNDERSTAN	UNION
UNITED	UNTIL	USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
WESTMINSTER	WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT	WOMEN	WORDS	WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	YEARS	YESTERDAY	YOUNG

0.9

Word level evaluation Recall at k per class (k=50)

Figure 7(g)

- Each cell contain a word from LRW dataset's vocabulary.
- The color of the cell depicts its **Recall at 50** value, with respect to the reference color bar on the right.
- Please zoom-in for better clarity.

Note: Refer Figure 5 for overall precision and recall at k

ABOUT	ABSOLUTELY	ABUSE	ACCESS	ACCORDING	ACCUSED	ACROSS	ACTION	ACTUALLY	AFFAIRS	AFFECTED	AFRICA	AFTER	AFTERNOON	AGAIN	AGAINST	AGREE	AGREEMENT	AHEAD	ALLEGATIONS
ALLOW	ALLOWED	ALMOST	ALREADY	ALWAYS	AMERICA	AMERICAN	AMONG	AMOUNT	ANNOUNCED	ANOTHER	ANSWER	ANYTHING	AREAS	AROUND	ARRESTED	ASKED	ASKING	ATTACK	ATTACKS
AUTHORITIES	BANKS	BECAUSE	BECOME	BEFORE	BEHIND	BEING	BELIEVE	BENEFIT	BENEFITS	BETTER	BETWEEN	BIGGEST	BILLION	BLACK	BORDER	BRING	BRITAIN	BRITISH	BROUGHT
BUDGET	BUILD	BUILDING	BUSINESS	BUSINESSES	CALLED	CAMERON	CAMPAIGN	CANCER	CANNOT	CAPITAL	CASES	CENTRAL	CERTAINLY	CHALLENGE	CHANCE	CHANGE	CHANGES	CHARGE	CHARGES
CHIEF	CHILD	CHILDREN	CHINA	CLAIMS	CLEAR	CLOSE	CLOUD	COMES	COMING	COMMUNITY	COMPANIES	COMPANY	CONCERNS	CONFERENCE	CONFLICT	ONSERVATIV	ECONTINUE	CONTROL	COULD
COUNCIL	COUNTRIES	COUNTRY	COUPLE	COURSE	COURT	CRIME	CRISIS	CURRENT	CUSTOMERS	DAVID	DEATH	DEBATE	DECIDED	DECISION	DEFICIT	DEGREES	DESCRIBED	DESPITE	DETAILS -
DIFFERENCE	DIFFERENT	DIFFICULT	DOING	DURING	EARLY	EASTERN	ECONOMIC	ECONOMY	EDITOR	EDUCATION	ELECTION	EMERGENCY	ENERGY	ENGLAND	ENOUGH	EUROPE	EUROPEAN	EVENING	EVENTS
EVERY	EVERYBODY	EVERYONE	EVERYTHING	EVIDENCE	EXACTLY	EXAMPLE	EXPECT	EXPECTED	EXTRA	FACING	FAMILIES	FAMILY	FIGHT	FIGHTING	FIGURES	FINAL	FINANCIAL	FIRST	FOCUS
FOLLOWING	FOOTBALL	FORCE	FORCES	FOREIGN	FORMER	FORWARD	FOUND	FRANCE	FRENCH	FRIDAY	FRONT	FURTHER	FUTURE	GAMES	GENERAL	GEORGE	GERMANY	GETTING	GIVEN
GIVING	GLOBAL	GOING	GOVERNMEN	GREAT	GREECE	GROUND	GROUP	GROWING	GROWTH	GUILTY	HAPPEN	HAPPENED	HAPPENING	HAVING	HEALTH	HEARD	HEART	HEAVY	HIGHER
HISTORY	HOMES	HOSPITAL	HOURS	HOUSE	HOUSING	HUMAN	HUNDREDS	MMIGRATION	IMPACT	IMPORTANT	INCREASE	INDEPENDEN"	r Industry	INFLATION I	NFORMATION	NQUIRY	INSIDE	INTEREST	INVESTMENT
INVOLVED	IRELAND	ISLAMIC	ISSUE	ISSUES	ITSELF	JAMES	JUDGE	JUSTICE	KILLED	KNOWN	LABOUR	LARGE	LATER	LATEST	LEADER	LEADERS	LEADERSHIP	LEAST	LEAVE
LEGAL	LEVEL	LEVELS	LIKELY	UTTLE	LIVES	LIVING	LOCAL	LONDON	LONGER	LOOKING	MAJOR	MAJORITY	MAKES	MAKING	MANCHESTER	MARKET	MASSIVE	MATTER	MAYBE
MEANS	MEASURES	MEDIA	MEDICAL	MEETING	MEMBER	MEMBERS	MESSAGE	MIDDLE	MIGHT	MIGRANTS	MILITARY	MILLION	MILLIONS	MINISTER	MINISTERS	MINUTES	MISSING	MOMENT	MONEY
MONTH	MONTHS	MORNING	MOVING	MURDER	NATIONAL	NEEDS	NEVER	NIGHT	NORTH	NORTHERN	NOTHING	NUMBER	NUMBERS	OBAMA	OFFICE	OFFICERS	OFFICIALS	OFTEN	OPERATION
OPPOSITION	ORDER	OTHER	OTHERS	OUTSIDE	PARENTS	PARLIAMENT	PARTIES	PARTS	PARTY	PATIENTS	PAYING	PEOPLE	PERHAPS	PERIOD	PERSON	PERSONAL	PHONE	PLACE	PLACES -
PLANS	POINT	POLICE	POLICY	POLITICAL	POLITICIANS	POLITICS	POSITION	POSSIBLE	POTENTIAL	POWER	POWERS	PRESIDENT	PRESS	PRESSURE	PRETTY	PRICE	PRICES	PRIME	PRISON
PRIVATE	PROBABLY	PROBLEM	PROBLEMS	PROCESS	PROTECT	PROVIDE	PUBLIC	QUESTION	QUESTIONS	QUITE	RATES	RATHER	REALLY	REASON	RECENT	RECORD	REFERENDUM	REMEMBER	REPORT
REPORTS	RESPONSE	RESULT	RETURN	RIGHT	RIGHTS	RULES	RUNNING	RUSSIA	RUSSIAN	SAYING	SCHOOL	SCHOOLS	SCOTLAND	SCOTTISH	SECOND	SECRETARY	SECTOR	SECURITY	SEEMS
SENIOR	SENSE	SERIES	SERIOUS	SERVICE	SERVICES	SEVEN	SEVERAL	SHORT	SHOULD	SIDES	SIGNIFICANT	SIMPLY	SINCE	SINGLE	SITUATION	SMALL	SOCIAL	SOCIETY	SOMEONE
SOMETHING	SOUTH	SOUTHERN	SPEAKING	SPECIAL	SPEECH		SPENDING	SPENT	STAFF	STAGE	STAND	START	STARTED	STATE	STATEMENT	STATES	STILL	STORY	STREET -
STRONG	SUNDAY		SUPPORT	SYRIA	SYRIAN	SYSTEM	TAKEN	TAKING	TALKING	TALKS T	EMPERATURE	S TERMS		THEMSELVES				THINGS	THINK
THIRD	THOSE	THOUGHT	THOUSANDS	THREAT	THREE	THROUGH	TIMES	TODAY	TOGETHER	TOMORROW	TONIGHT	TOWARDS	TRADE	TRIAL	TRUST	TRYING	UNDER	UNDERSTANE	UNION
UNITED	UNTIL	USING	VICTIMS	VIOLENCE	VOTERS	WAITING	WALES	WANTED	WANTS	WARNING	WATCHING	WATER	WEAPONS	WEATHER	WEEKEND	WEEKS	WELCOME	WELFARE	WESTERN
WESTMINSTE	R WHERE	WHETHER	WHICH	WHILE	WHOLE	WINDS	WITHIN	WITHOUT	WOMEN	WORDS	WORKERS	WORKING	WORLD	WORST	WOULD	WRONG	YEARS	YESTERDAY	YOUNG

0.8

0.7

0.6

0.4

0.3





Figure 8 (a): Qualitative results on LRW dataset: for each image (top) depicts a randomly sampled frame the query video clip and its lip ROI; (middle) blue boxes are the ground truths with (.) denoting number of the top-10 candidates in the retrieval set having the same label as the ground truth(GT) of the input query exemplar; (bottom) green boxes are correct predictions while the red ones are incorrect predictions, with (.) denoting number of the top-10 candidates in the retrieval set having the predicted label. Label is propagated to a query based on the majority label present in the top-10 retrieval candidates.



Figure 8 (b): Qualitative results on LRW dataset: for each image (top) depicts a randomly sampled frame the query video clip and its lip ROI; (middle) blue boxes are the ground truths with (.) denoting number of the top-10 candidates in the retrieval set having the same label as the ground truth(GT) of the input query exemplar; (bottom) green boxes are correct predictions while the red ones are incorrect predictions, with (.) denoting number of the top-10 candidates in the retrieval set having the predicted label. Label is propagated to a query based on the majority label present in the top-10 retrieval candidates.



Figure 8 (c): Qualitative results on LRW dataset: for each image (top) depicts a randomly sampled frame the query video clip and its lip ROI; (middle) blue boxes are the ground truths with (.) denoting number of the top-10 candidates in the retrieval set having the same label as the ground truth(GT) of the input query exemplar; (bottom) green boxes are correct predictions while the red ones are incorrect predictions, with (.) denoting number of the top-10 candidates in the retrieval set having the predicted label. Label is propagated to a query based on the majority label present in the top-10 retrieval candidates.



Figure 8 (d): Qualitative results on LRW dataset: for each image (top) depicts a randomly sampled frame the query video clip and its lip ROI; (middle) blue boxes are the ground truths with (.) denoting number of the top-10 candidates in the retrieval set having the same label as the ground truth(GT) of the input query exemplar; (bottom) green boxes are correct predictions while the red ones are incorrect predictions, with (.) denoting number of the top-10 candidates in the retrieval set having the predicted label. Label is propagated to a query based on the majority label present in the top-10 retrieval candidates.

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