

# Text Summarization

By

Noah Dcruz

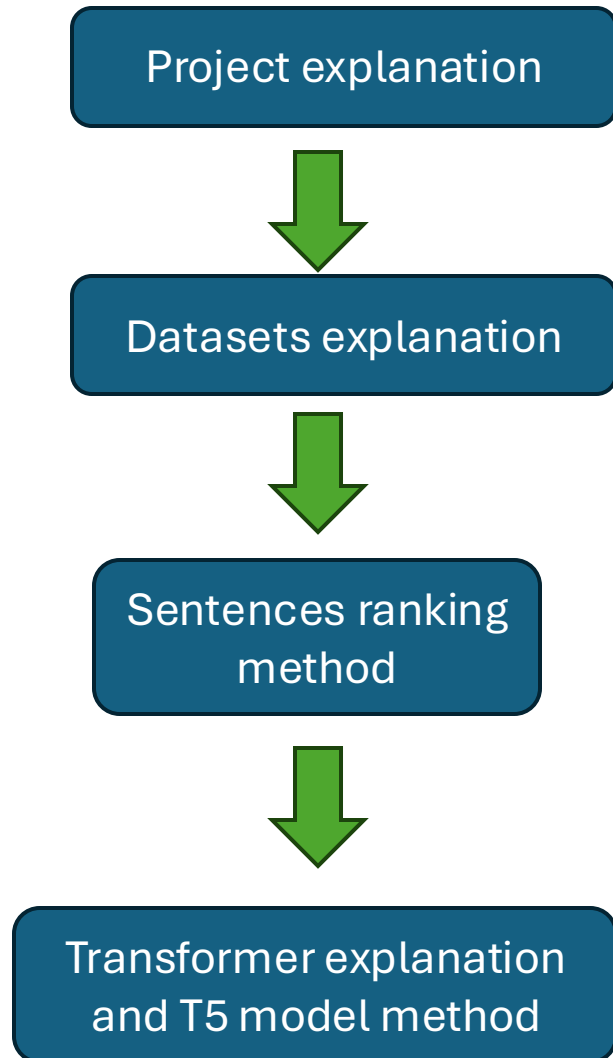
Liuyi Cui

Mingzhi Hu

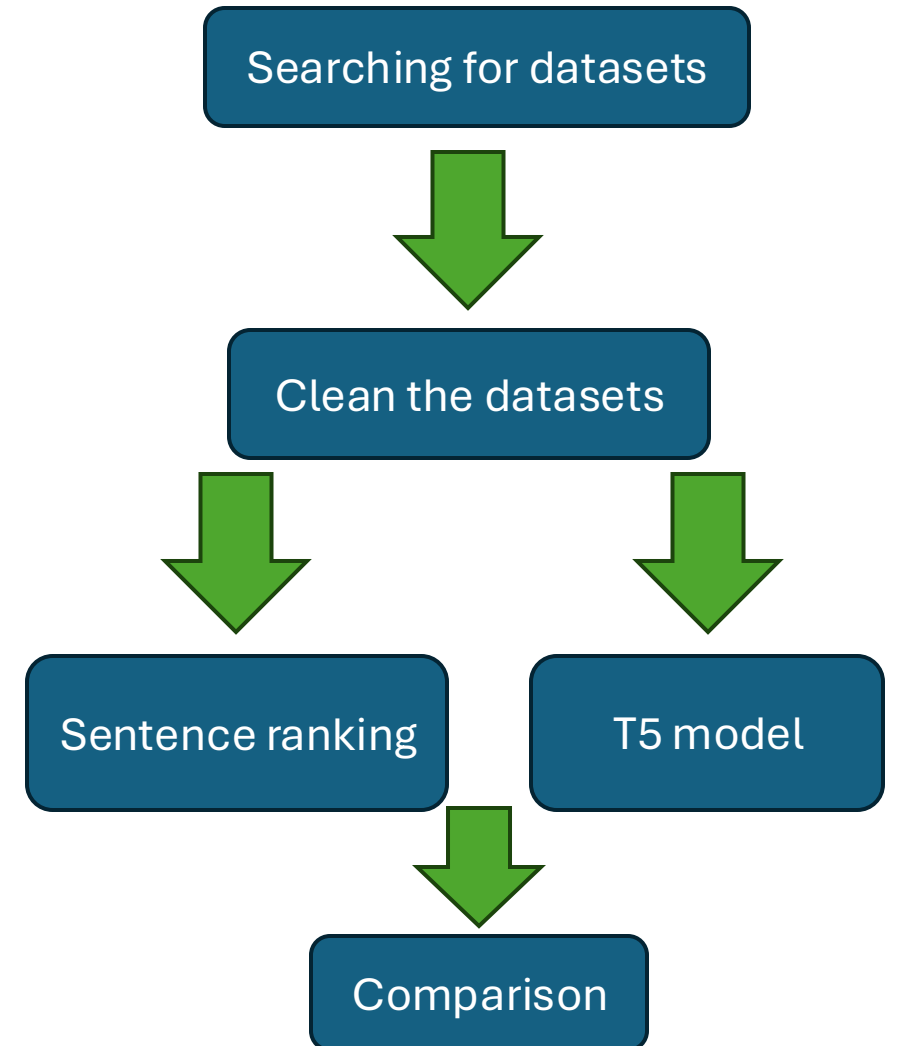
Hoaen Huang

# General summary

## Report procedure



## Work flow



# Dataset

- **Structure and Content:** It contains over 300,000 news articles, each paired with multi-sentence summaries, giving us a rich training ground for our model.
- **Variety and Volume:** The dataset spans various topics, providing our model with a broad understanding of language and context, crucial for producing relevant summaries.
- **Train-test split:** We split the data with 280000 pair for training, 10000 for validation, 10000 for testing.

Subset (3) 1.0.0 · 312k rows		Split (3) train · 287k rows	
<div>Q Search this dataset</div>			
<div><div>article</div><div>string · lengths</div><div><div></div><div>1.64k-3.22k 32.8%</div></div></div>		<div><div>highlights</div><div>string · lengths</div><div><div></div><div>14-752 99.5%</div></div></div>	
LONDON, England (Reuters) -- Harry Potter star Daniel Radcliffe gains access to a reported £20 million (\$41.1 million) fortune as he turns...		Harry Potter star Daniel Radcliffe gets £20M fortune as he turns 18 Monday . Young actor says he has no plans to fritter his cash away ...	
Editor's note: In our Behind the Scenes series, CNN correspondents share their experiences in covering news and analyze the stories...		Mentally ill inmates in Miami are housed on the "forgotten floor" Judge Steven Leifman says most are there as a result of "avoidable...	
MINNEAPOLIS, Minnesota (CNN) -- Drivers who were on the Minneapolis bridge when it collapsed told harrowing tales of survival. "The whole...		NEW: "I thought I was going to die," driver says . Man says pickup truck was folded in half; he just has cut on face . Driver: "I...	
WASHINGTON (CNN) -- Doctors removed five small polyps from President Bush's colon on Saturday, and "none appeared worrisome," a White Hous...		Five small polyps found during procedure; "none worrisome," spokesman says . President reclaims powers transferred to vice president . Bush...	
(CNN) -- The National Football League has indefinitely suspended Atlanta Falcons quarterback Michael Vick without pay, officials with...		NEW: NFL chief, Atlanta Falcons owner critical of Michael Vick's conduct . NFL suspends Falcons quarterback indefinitely without pay ...	
BAGHDAD, Iraq (CNN) -- Dressed in a Superman shirt, 5-year-old Youssif held his sister's hand Friday, seemingly unaware that millions of...		Parents beam with pride, can't stop from smiling from outpouring of support . Mom: "I was so happy I didn't know what to do" Burn center...	
BAGHDAD, Iraq (CNN) -- The women are too afraid and ashamed to show their faces or have their real names used. They have been driven to...		Aid workers: Violence, increased cost of living drive women to prostitution . Group is working to raise awareness of the problem wit...	
BOGOTA, Colombia (CNN) -- A key rebel commander and fugitive from a U.S. drug trafficking indictment was killed over the weekend in an ai...		Tomas Medina Caracas was a fugitive from a U.S. drug trafficking indictment . "El Negro Acacio" allegedly helped manage extensive...	
WASHINGTON (CNN) -- White House press secretary Tony Snow, who is undergoing treatment for cancer, will step down from his post...		President Bush says Tony Snow "will battle cancer and win" Job of press secretary "has been a dream for me," Snow says Snow leaving on...	
(CNN) -- Police and FBI agents are investigating the discovery of an empty rocket launcher tube on the front lawn of a Jersey City, New...		Empty anti-tank weapon turns up in front of New Jersey home . Device handed over to Army ordnance disposal unit . Weapon not capable of...	
WASHINGTON (CNN) -- As he awaits a crucial progress report on Iraq, President Bush will try to put a twist on comparisons of the war to...		President Bush to address the Veterans of Foreign Wars on Wednesday . Bush to say that withdrawing from Vietnam emboldened today's...	
LONDON, England (CNN) -- A chronology of bombings and attempted bomb attacks in the mainland UK since the 1970s: . Police close off street...		Two cars loaded with gasoline and nails found abandoned in London Friday . 52 people killed on July 7, 2005 after bombs exploded on...	
BREMEN, Germany -- Carlos Alberto, who scored in FC Porto's Champions League final victory against Monaco in 2004, has joined Bundesliga...		Werder Bremen pay a club record \$10.7 million for Carlos Alberto . The Brazilian midfielder won the Champions League with FC Porto in 2004 ...	
WASHINGTON (CNN) -- Vice President Dick Cheney will serve as acting president briefly Saturday while President Bush is anesthetized for a...		President Bush will have a routine colonoscopy Saturday . While he's anesthetized, his powers will be transferred to the vice president ...	

# Sentences ranking method

# Goal: Find the sentences that matters most

Chris Ramsey will attempt to tame a monster of his own creation on Saturday, but fears talents such as Harry Kane will remain rare so long as clubs and fans apply fickle judgements to their homegrown players. The QPR manager was instrumental in his 10 years at Tottenham in the rise and breakthrough of Kane, but on Friday recalled the sort of attitudes that mean the 24-goal striker remains something of an exception in this country. 'We played him towards the end of the season last year and the fans weren't having him,' Ramsey said.

'They were trying to get the galacticos on the pitch.

We stuck to our guns and got a lot of flak for it. Harry Kane battles with Ki Sung-Yueng during Tottenham's clash with Swansea on Wednesday night. Chris Ramsey says that he is not surprised by Kane's remarkable rise to prominence at Tottenham. Kane breaks away from the challenge of Gary Cahill during the Capital One Cup final at Wembley last week. 'Clubs have to stick their necks out to get English players playing in the Premier League, and getting them judged in the same way as players who cost a lot of money and don't produce.' In Kane's case, the bravery of Tim Sherwood and Mauricio Pochettino, his White Hart Lane successor, has been central to the 21-year-old proving he can thrive in the higher reaches of the Premier League. The same can be said of players such as Ryan Mason, Nabil Bentaleb and Danny Rose, who have all excelled at times this season. But Ramsey added: 'I know quite a lot of Spurs fans. I used to tell them about the players coming in. I said to a friend of mine that Ryan Mason is probably the best footballer at the club. Ramsey (right) was part of Tim Sherwood's backroom staff when Kane broke through to the first team. Many Tottenham fans were unhappy when Kane began to play in the first team (he is pictured on his debut in August 2011) but Ramsey says they stuck with him and were rewarded. Football data analysts BSports predict that a Spurs win at QPR is the most likely outcome on Saturday.

'They don't know what goes on in the background and they were like, "We need this person from this country and we need that guy from that country". To Tottenham's credit and the manager's (Pochettino) credit, he has come in and has been very brave. All credit to him for being very unbiased to expensive players and actually seeing the players who are on form.

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# The more repeated, the more important

Work flow

Split it into words

Harry Potter star Daniel Radcliffe gains access to a reported £20 million.



'Harry', 'Potter', 'star', 'Daniel',  
'Radcliffe', 'gains', 'access', 'to', 'a',  
'reported', '£', '20', 'million'

Delete meaning less words

~~Punctuations: ', ', '\n'~~

~~Stop words: 'Is', 'and',  
'his'.~~

Get the words' frequency



Calculate the score of each sentence




Pick the highest ranking ones

# Limitations of the Sentence ranking

- The results are all from the original text.
- Rephrasing distracts the repeatition.
- Several sentences describes the same core.



A large yellow and black Transformer robot, Bumblebee, stands in the center of a city that has been destroyed. Smoke rises from the ground, and the background shows damaged skyscrapers. The robot has a blue face and glowing blue eyes. The title "Transformers and T5 model" is overlaid in white text with a horizontal line underneath it.

# Transformers and T5 model

by MICHAEL BAY  
**TRANSFORMERS**  
DARK OF THE MOON



# Transformer

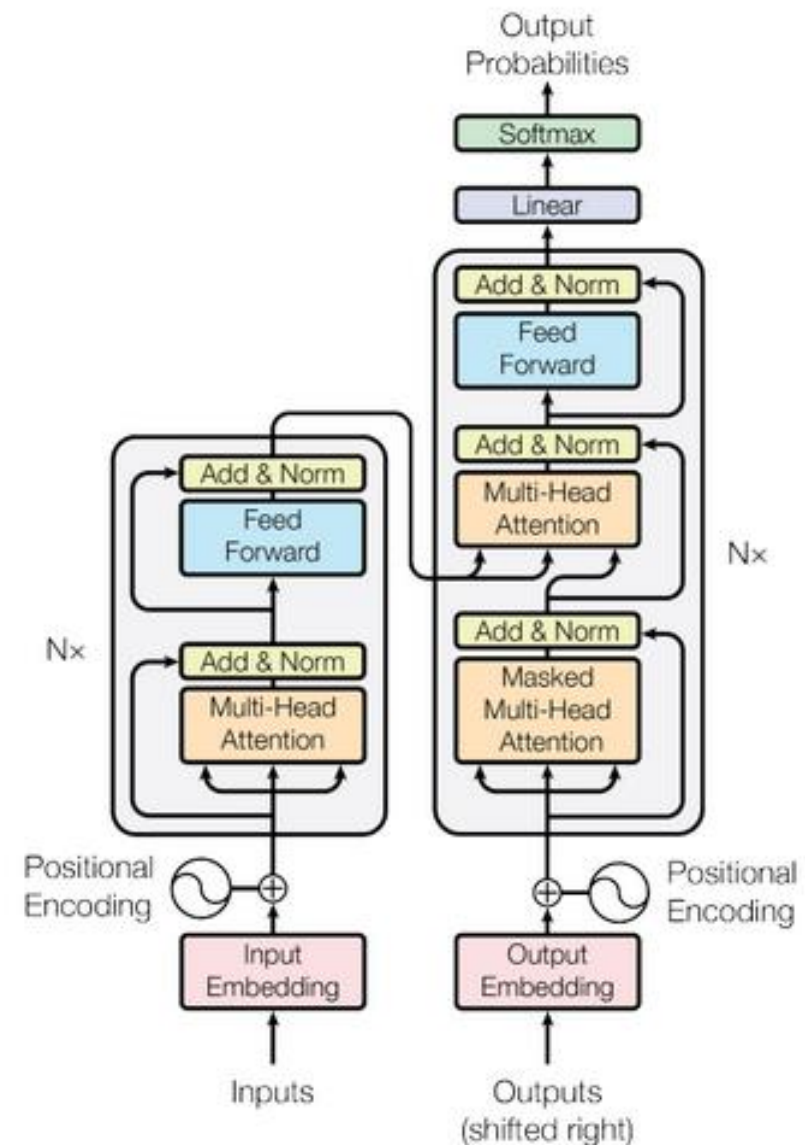
- The Transformer model is a deep learning model that employs an attentional mechanism that assigns different weights to various parts of the input data according to their importance
- Right now, the transformer model become the first choice to deal NLP problem, Also development of pre-trained systems like BERT and GPTS

# Transformer background

- Before the Transformer model, most state-of-the-art NLP systems relied on gated RNN models such as LSTM, Gated Recurrent Units (GRUs), and other gated RNN models to which attention mechanisms were added.
- There are limitations of RNNs and LSTMs in processing long sequences
- “Attention is All You Need” tell us the attention mechanism itself is powerful enough, we don't need to use RNN model.

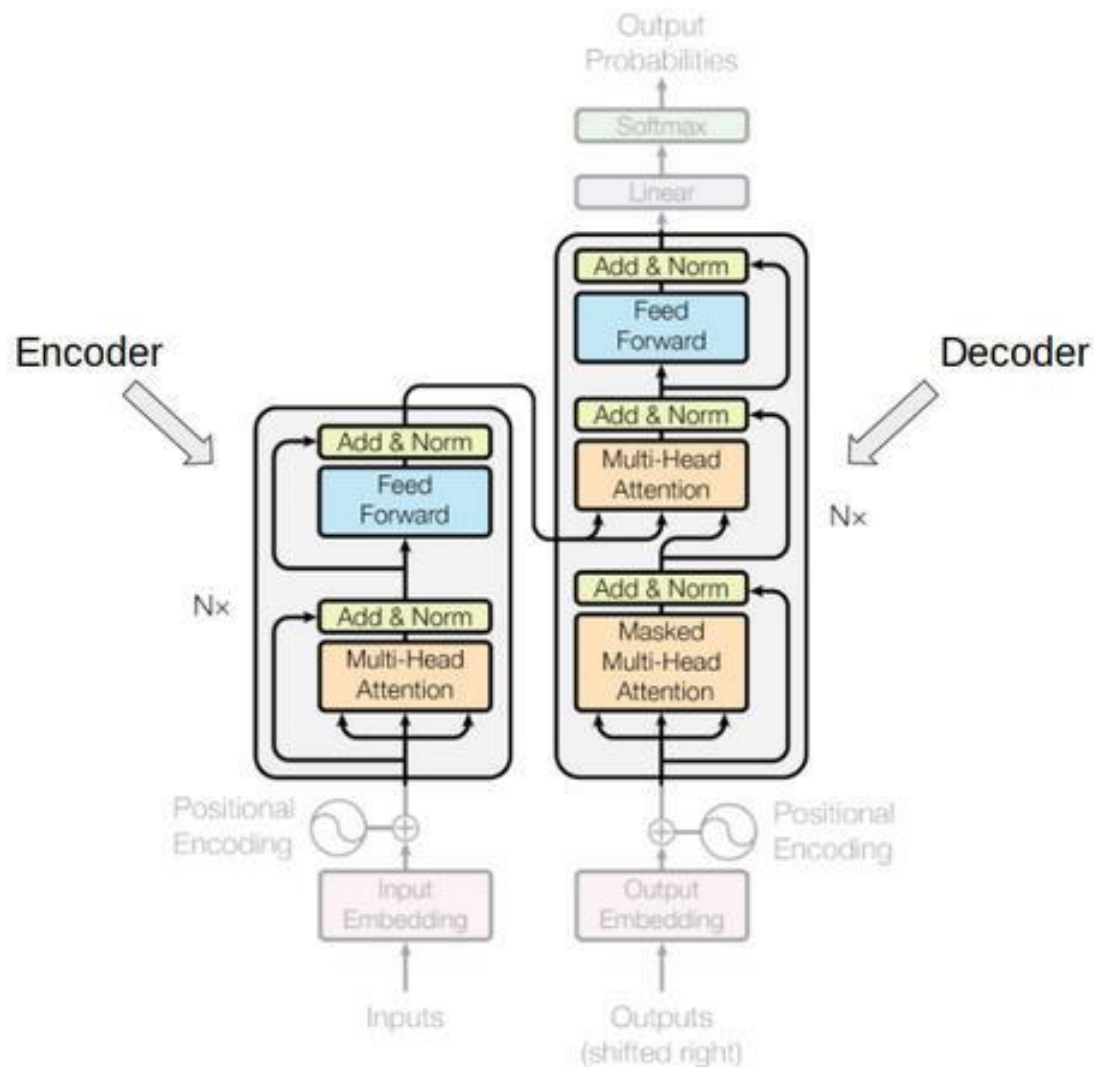
# Transformer Architecture

- Multi-Head Attention
- Positional Encoding



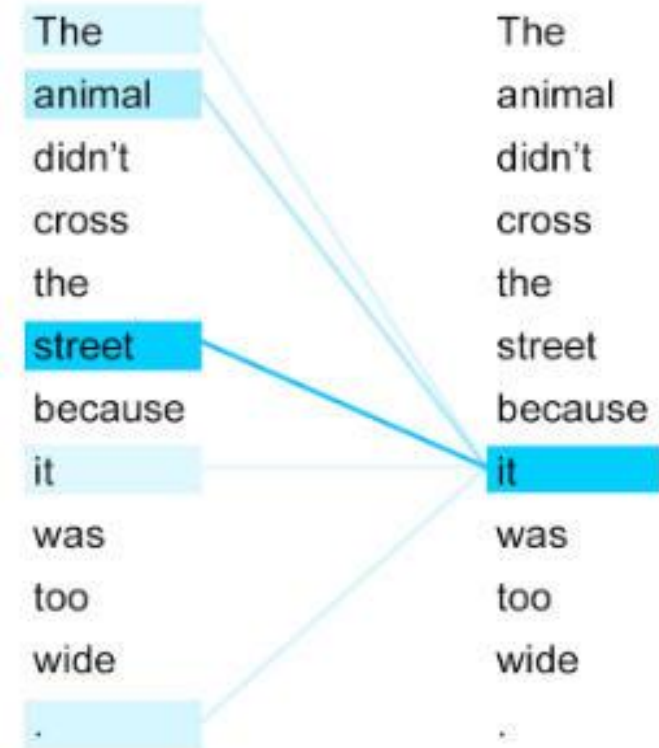
# Encoder-Decoder Architecture

- A Transformer usually consists of an encoder and a decoder.
- Encoder: encoding the input sequence into a series of hidden representations.
- Decoder: encoding the input sequence into a series of hidden representations



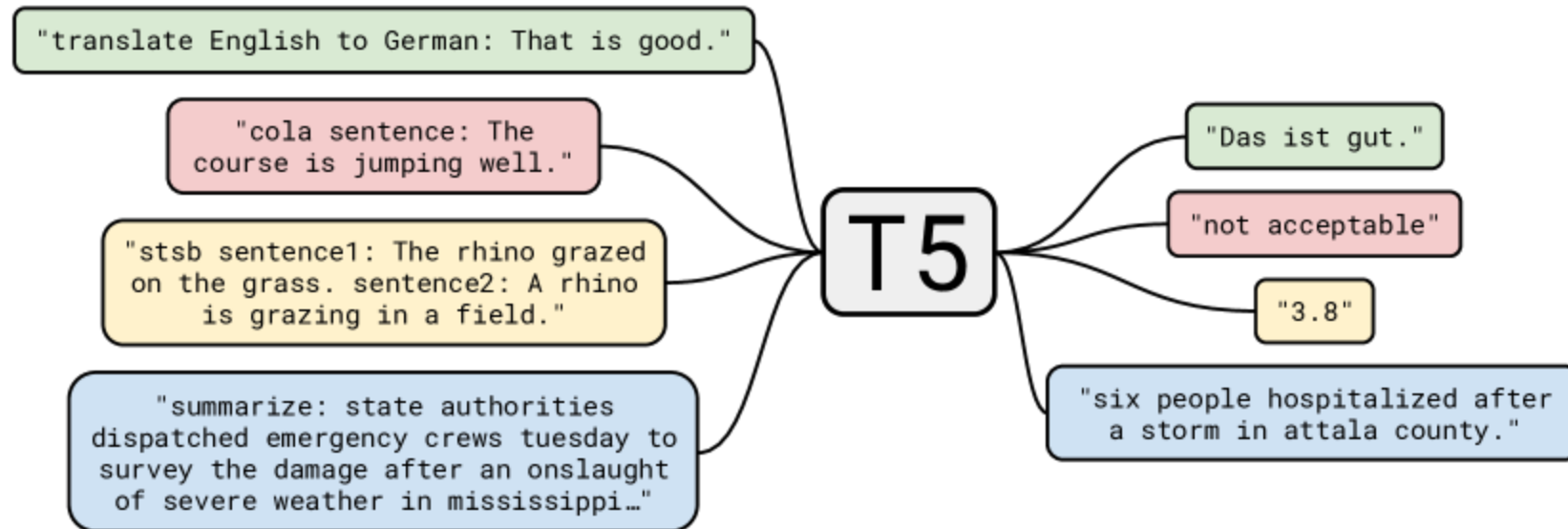
# Core concept

- Self-Attention: Transformer uses Self-Attention to capture the relationships between positions in the input sequence. This allows the model to consider the entire input sequence at the same time.



# T-5 (Text-To-Text Transfer Transformer)

- T5 uses unsupervised learning objectives (e.g., language modeling or masked language modeling) to pre-train on large-scale textual data.
- Pre-training and Fine-tuning and text to text approach



# Test method: Rouge-L

- ROUGE-L is one of the ROUGE (Recall-Oriented Understudy for Gisting Evaluation).
- Evaluating the similarity between generated summary and target abstract.

$$R_{lcs} = \frac{\sum_{i=1}^u LCS_{\cup}(r_i, C)}{m} \quad (5)$$

$$P_{lcs} = \frac{\sum_{i=1}^u LCS_{\cup}(r_i, C)}{n} \quad (6)$$

$$F_{lcs} = \frac{(1 + \beta^2) R_{lcs} P_{lcs}}{R_{lcs} + \beta^2 P_{lcs}} \quad (7)$$



# Limitations of the Transformer

- Attention can only deal with fixed-length text strings.
- This chunking of text causes context fragmentation.
- High computational cost and extensive training data requirements.

# Results and comparison

-----article-----

(CNN)A Russian property developer, a Chinese outfit operating shell companies and Venezuelan officials ripping off the state-owned oil companies -- all of them are accused of coming to a bank in the European principality of Andorra to "wash" their money. Now the U.S. Treasury is casting a spotlight on the alleged misdeeds of senior managers at the Banca Privada d'Andorra (BPA), several of whom have been arrested in the past few days. The Treasury Department has alleged that "high-level managers [at BPA] accepted payments and other benefits from their criminal clients." The Andorran authorities took over the running of the bank after the Treasury revelations, and the director general of the Banca Privada, Joan Pau Miquel Prats, was arrested late Friday. Two more bank officials were arrested Sunday. Tiny Andorra, nestled in the rugged Pyrenees mountains, has two big neighbors. One is France. And the scandal has spread to its other neighbor, Spain, where corruption among public officials is a hot-button political issue. Prats had driven BPA's expansion into Spain, through its acquisition of Banco Madrid, in 2011. Banco Madrid caters to wealthy private clients and came under investigation by Spanish financial authorities last year. Since the BPA scandal broke, the commission that investigates illicit financial activity, Sepblac, has raised questions about accounts held by influential Spanish political and business figures at the Banco Madrid. They have not been named. The Central Bank has taken control of Banco Madrid and sent in two inspectors to examine accounts there. The bank's board, which included Prats and a former high-ranking official of the Central Bank, resigned on Thursday. Spanish officials say some 20 suspect operations at the bank are being examined. Spanish authorities are separately investigating substantial assets held at the Banca Privada d'Andorra by members of the Pujol family, who have long been prominent in the politics of Catalonia, a region of Spain that includes Barcelona. The director of the U.S. Treasury's Financial Crimes Enforcement Network, Jennifer Shasky Calvery, said that "BPA's corrupt high-level managers and weak antimoney laundering controls have made BPA an easy vehicle for third-party money launderers to funnel proceeds of organized crime, corruption and human trafficking through the U.S. financial system." BPA has correspondent accounts with four banks -- HSBC, Citigroup, Bank of America and Deutsche Bank -- through which hundreds of millions of dollars passed. Senior managers at BPA tailored services to their clients to disguise the origin of funds, the Treasury said. One manager provided "substantial assistance" to a Russian client, Andrei Petrov, described by the Treasury as a "third-party money launderer working for Russian criminal organizations." Petrov had also received a line of credit from Banco Madrid and is alleged to have bribed local officials in the resort where he set up a property development company. He was arrested in Spain two years ago and is accused of helping launder some 56 million euros (\$59 million) in proceeds from Russian criminal organizations. Petrov is yet to go on trial. According to the U.S. Treasury, Petrov has links with one of the FBI's most wanted fugitives, Simeon Mogilevich. BPA is also alleged to have helped Venezuelan money launderers siphon funds from the state-owned oil company, Petroleos de Venezuela. "This money-laundering network worked closely with high-ranking government officials in Venezuela, resident agents in Panama, and an Andorran lawyer to establish Panamanian shell companies," the Treasury said. BPA processed about \$2 billion in transactions by shell companies related to the scheme. Treasury said another senior official at BPA accepted bribes in return for processing bulk cash transfers for a Chinese money launderer, Gao Ping, who was arrested in Spain in September 2012. "Through his associate, Ping bribed Andorran bank officials to accept cash deposits into less scrutinized accounts and transfer the funds to suspected shell companies in China," it said in a statement. Credit rating agency Standard & Poor's has reacted to the growing scandal by downgrading Andorra's rating. Andorra is highly dependent on its banking sector, which makes up some 20% of its GDP. Spain has long battled the presence of Russian organized crime on its soil. After the collapse of the Soviet Union, wealthy Russians came to Spain for its climate and what were then lax financial controls. Among them were more than a few "vory v zakone," the top echelon of Russian organized crime, according to Spanish officials. Spanish prosecutor Jose Grinda Gonzalez told U.S. officials five years ago that these individuals had no known jobs and unknown sources of income, yet they lived in large mansions. Grinda's remarks were reported in a diplomatic cable later published by Wikileaks. Grinda had prosecuted Zakhar Kalashov, a Georgian-born, Russian citizen widely regarded as one of the most powerful figures in the Russian mafia. Last year, before he completed his nine-year sentence, a Spanish appeals court deported Kalashov to Russia, where he is now a free man. Another Spanish prosecutor, Fernando Bermejo, told US officials in 2009 that there was large scale money-laundering going on in Catalonia and "many, many" members of the Russian mafia were active there. Because of growing international cooperation, Spanish prosecutors have stepped up their pursuit of alleged gang leaders, money launderers and embezzlers from Eastern Europe. Among the latest to be detained is a former finance minister from Ukraine, Yuriy Kolobov. He was detained at a luxury development in Alicante earlier this month, after prosecutors in Kiev charged him with embezzlement and is awaiting extradition. Kolobov was a minister in the government of President Viktor Yanukovich, who fled Ukraine during street protests a year ago. Helena Cavendish de Moura contributed to this report .

-----label-----

The U.S. Treasury is casting a spotlight on the alleged misdeeds of senior managers at the Banca Privada d'Andorra . The Andorran authorities took over the running of the bank after the Treasury revelations .

-----generate summary-----

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Rouge-L: {'r': 0.0967741935483871, 'p': 0.3333333333333333, 'f': 0.1499999965125001}

-----generate summary t5 model-----

The U.S. Treasury is casting a spotlight on the alleged misdeeds of senior managers at the Banca Privada d'Andorra . The bank has been a source of corruption among public officials . The scandal has spread to its neighbor, Spain .

Rouge-L between label and generate summary with t5 model is {'r': 0.5757575757575758, 'p': 0.7037037037037037, 'f': 0.6333333283833334}

r:0.09677  
p: 0.3333  
f: 0.15000

r: 0.57575  
p: 0.70370  
f: 0.63333

-----article-----

(CNN)A freshly fallen tree in the roadway was Jason Warnock's first clue. Warnock was driving through a canyon in Lewiston, Idaho, on Wednesday when he saw the tree, then looked up to see an SUV dangling over the edge of a cliff. The only thing holding the GMC Yukon and its terrified driver from a 30-foot drop was a crumpled chain-link fence, still clinging to the earth above Bryden Canyon Road. "I seen that guy hanging there and he was trying to beat the window out or the door open and I was like 'Oh man,' 'cause only like five links were hanging there," Warnock told KXLY, a CNN affiliate. "I was like, I gotta do something and no one was doing anything." What Warnock did next, captured in a dramatic photo by Lewiston Tribune photographer Barry Kough, made headlines around the world. Warnock dashed from his car and scrambled up a hill to the Yukon and its driver, 23-year-old Matthew Sitko, who appeared to be in shock. "I got up there and I was like, 'Are you alright man?' He shook his head, yeah. I grabbed my Snap-on multi-tool and it had jagged edges on each end. I hit the window three times and it didn't break. Every time I hit it, the thing rocked like it was going to fall off," Warnock told KXLY. Sitko was finally able to get the passenger-side window down. Warnock then reached in and pulled Sitko out to safety -- a moment recorded by Kough's camera. Then Warnock disappeared. "I left and got out of there before anyone knew who I was," he said. He remained an unknown good Samaritan, his identity a mystery, until Kough's picture of the daring rescue appeared in the Lewiston paper and spread across the Internet. "I don't feel like I deserve any credit or anything," Warnock said. "I just did what anyone would do, went right back to work." Thanks to Warnock, Sitko went to the hospital with just minor injuries. "The Lewiston Police Department would like to thank Jason Warnock for his quick and decisive actions in helping Mr. Sitko and preventing the situation from worsening," said Roger Lanier, the interim police chief. Warnock told KXLY he didn't want or expect all the attention and would rather be fishing in the mountains than reading about himself.

-----label-----

Jason Warnock rescued a man whose SUV was dangling off the edge of a cliff . Warnock: "I don't feel like I deserve any credit ... I just did what anyone would do"

-----generate summary-----

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Rouge-L: {'r': 0.1267605633802817, 'p': 0.3103448275862069, 'f': 0.17999999588200008}

-----generate summary t5 model-----

Jason Warnock was driving through a canyon in Lewiston, Idaho . He saw a freshly fallen tree in the roadway . He then looked up to see a car dangling over the edge of a cliff .

Rouge-L between label and generate summary with t5 model is {'r': 0.32142857142857145, 'p': 0.3103448275862069, 'f': 0.31578946868574953}

r:0.12676  
p: 0.3103  
f: 0.18000

r: 0.32142  
p: 0.31034  
f: 0.31578

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Chris Ramsey will attempt to tame a monster of his own creation on Saturday, but fears talents such as Harry Kane will remain rare so long as clubs and fans apply fickle judgements to their homegrown players. The QPR manager was instrumental in his 10 years at Tottenham in the rise and breakthrough of Kane, but on Friday recalled the sort of attitudes that mean the 24-goal striker remains something of an exception in this country. ‘We played him towards the end of the season last year and the fans weren't having him,’ Ramsey said. ‘They were trying to get the galacticos on the pitch. We stuck to our guns and got a lot of flak for it. Harry Kane battles with Ki Sung-Yueng during Tottenham's clash with Swansea on Wednesday night . Chris Ramsey says that he is not surprised by Kane's remarkable rise to prominence at Tottenham . Kane breaks away from the challenge of Gary Cahill during the Capital One Cup final at Wembley last week . ‘Clubs have to stick their necks out to get English players playing in the Premier League, and getting them judged in the same way as players who cost a lot of money and don't produce.’ In Kane’s case, the bravery of Tim Sherwood and Mauricio Pochettino, his White Hart Lane successor, has been central to the 21-year-old proving he can thrive in the higher reaches of the Premier League. The same can be said of players such as Ryan Mason, Nabil Bentaleb and Danny Rose, who have all excelled at times this season. But Ramsey added: ‘I know quite a lot of Spurs fans. I used to tell them about the players coming in. I said to a friend of mine that Ryan Mason is probably the best footballer at the club. Ramsey (right) was part of Tim Sherwood's backroom staff when Kane broke through to the first team . Many Tottenham fans were unhappy when Kane began to play in the first team (he is pictured on his debut in August 2011) but Ramsey says they stuck with him and were rewarded . Football data analysts BSports predict that a Spurs win at QPR is the most likely outcome on Saturday . ‘They don't know what goes on in the background and they were like, “We need this person from this country and we need that guy from that country”. To Tottenham's credit and the manager's (Pochettino) credit, he has come in and has been very brave. All credit to him for being very unbiased to expensive players and actually seeing the players who are on form. ‘What normally happens is a player will go in, not do very well on their first game and then you will never see that player again. And then people will go and buy a player who is similar, who can play 10 bad games and the fans or the people will say, “Oh, he’s got to get used to the Premier League”. ‘Why should a player that £20m be given more favour than the player that comes from down the road and cost less money? That’s one of the biggest problems we have in this country.’

-----label-----

Chris Ramsey was at Tottenham before joining Queens Park Rangers . He was part of the backroom staff when Harry Kane broke into first team . Now at QPR, Ramsey says he is not surprised by Kane's rise to fame . He revealed that some Tottenham fans were not happy when Kane was given his chance in the first team, instead calling for experienced players .

-----generate summary-----

‘Clubs have to stick their necks out to get English players playing in the Premier League, and getting them judged in the same way as players who cost a lot of money and don't produce.’ ‘They don't know what goes on in the background and they were like, “We need this person from this country and we need that guy from that country”. And then people will go and buy a player who is similar, who can play 10 bad games and the fans or the people will say, “Oh, he’s got to get used to the Premier League”.

Rouge-L:  {'r': 0.0972222222222222, 'p': 0.13725490196078433, 'f': 0.11382113335712891}

-----generate summary t5 model-----

Tottenham boss Chris Ramsey will try to tame Harry Kane on Saturday . The 24-year-old was instrumental in his 10 years at Tottenham in the rise and breakthrough of Kane . Ramsey says he is not surprised by Kane's remarkable rise to prominence .

Rouge-L between label and generate summary with t5 model is  {'r': 0.5714285714285714, 'p': 0.39215686274509803, 'f': 0.46511627424283397}



# Result analysis

'Clubs have to stick their necks out to get English players playing in the Premier League, and getting them judged in the same way as players who cost a lot of money and don't produce.' They don't know what goes on in the background and they were like, "We need this person from this country and we need that guy from that country". And then people will go and buy a player who is similar, who can play 10 bad games and the fans or the people will say, "Oh, he's got to get used to the Premier League".  
Rouge-L: {'r': 0.09722222222222222, 'p': 0.13725490196078433, 'f': 0.11382113335712891}

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# Alternatives

- **Unsupervised Learning Methods:**
  - **Latent Semantic Analysis (LSA):** This technique uses singular value decomposition (SVD) on the term-document matrix to identify patterns and generate summaries based on concepts.
  - **Graph-based Techniques:** Algorithms like TextRank use the relationships between sentences as a graph and leverage PageRank to score sentences for summarization.



# Different industries

- 1. Tech Companies:** Organizations like Google, Facebook, and Microsoft use advanced NLP models for a range of applications, from improving search engine results to powering virtual assistants and translation services.
- 2. Financial Services:** Banks and financial institutions use NLP models for sentiment analysis to gauge market sentiment and for automating document analysis for due diligence or compliance purposes.
- 3. Healthcare:** NLP models are used to extract information from medical records, assist in diagnostics by analyzing patient notes, and summarize medical research.
- 4. News and Media Outlets:** They use summarization models to quickly provide digests of news articles or to generate headlines.
- 5. Customer Service:** Many companies implement chatbots that can handle a range of customer queries, using models like T5 to understand and generate human-like responses.
- 6. Automotive Companies:** Firms like Tesla and BMW are exploring NLP to enhance their in-car voice command systems and to provide better customer interaction.
- 7. Education and Research:** Educational tech companies use NLP to develop tools for plagiarism detection, automated grading, and personalized learning experiences.

# Real life applications

- **News Aggregation:** Websites that provide summarized versions of longer news articles can use this code to automatically generate concise versions, helping readers quickly catch up on the most important points without reading the entire article.
- **Document Summarization:** In legal and academic fields, where professionals are required to go through large volumes of documents, this code can be used to create summaries of cases, research papers, or reports to save time.
- **Email Summarization:** Busy professionals who received an large amount of emails daily could use this type of tool to provide a quick digest of each email's content.
- **Meeting and Interview Transcripts:** Businesses can use such tools to summarize meetings, interviews, and conference calls, providing attendees and stakeholders with the highlights and action items.
- **Medical Record Summarization:** Healthcare providers can employ this code to summarize patient records, research findings, or medical articles, allowing clinicians to quickly grasp patient history or research conclusions.

Thank you