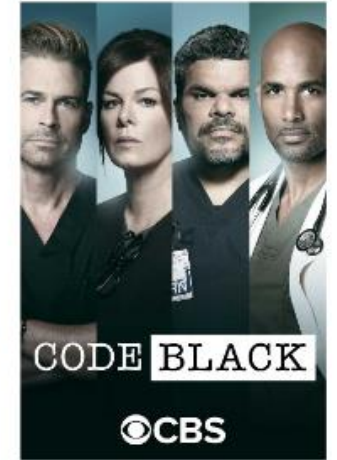


Identifying Medical Drama
Narratives: a Multi-Output
Regression approach with CNNs
and BERT

Alice Fedotova

Introduction

- Medical dramas are a popular genre of television programming that depicts the lives and work of medical professionals
- It is one of the most popular and longest-running genres on global television

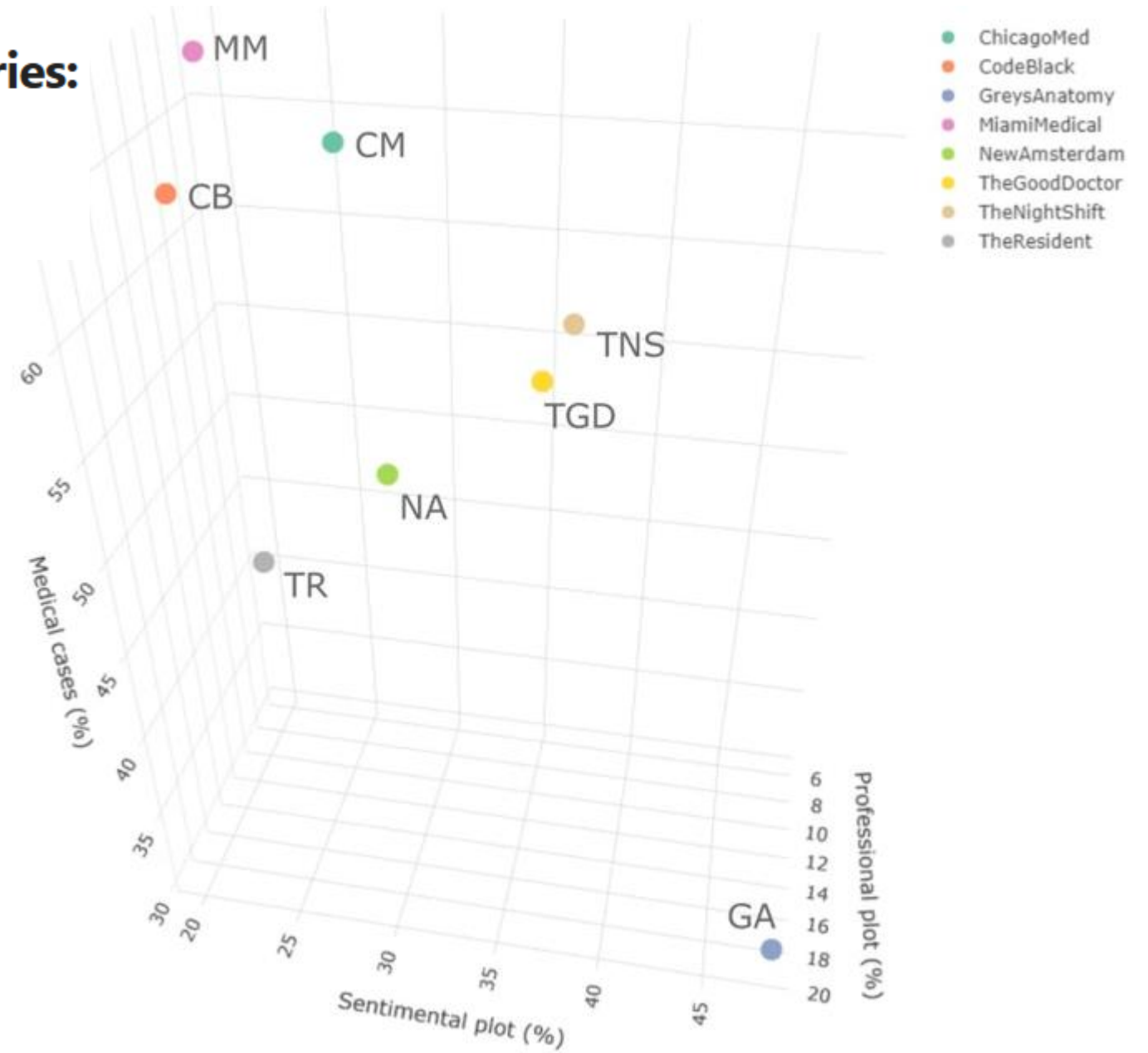


Introduction

- In the field of media studies, **content analysis** has long been employed as a methodology for the study of audiovisual products. A central aspect of content analysis is **coding**, which consists in assigning units of analysis to categories for the purpose of describing and quantifying phenomena of interest (Krippendorff, 1995).
- Previous research has identified three fundamental categories or “isotopies” that characterize the medical drama genre: the **medical case**, which refers to the new medical cases that are presented in each episode; the **professional plot**, which focuses on the portrayal of medical professionals and their work; and the **sentimental plot**, which focuses on the personal lives and relationships of the characters (Rocchi and Pescatore, 2019).

Modeling narrative features in TV series: coding and clustering analysis

[Marta Rocchi](#) & [Guglielmo Pescatore](#)



<https://doi.org/10.1057/s41599-022-01352-9>

Introduction

- Content analysis requires expert knowledge and trained annotators
- The task of manually identifying *segments* that pertain to the isotopies, combined with the time required to assign the appropriate codes, makes content analysis a significantly time-consuming process (Rocchi and Pescatore, 2022)

Introduction

- Content analysis requires expert knowledge and trained annotators
- The task of manually identifying *segments* that pertain to the isotopies, combined with the time required to assign the appropriate codes, makes content analysis a significantly time-consuming process (Rocchi and Pescatore, 2022)
- **Is it possible to predict the narrative composition of a medical drama by looking only at the subtitles?**

Dataset

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|-----|--------|----------|------------|----------|----------|----------|----|---------|----|-----------|----|---------|--------|
| 113 | Season | Codice | N_segmento | Inizio | Fine | Durata | PP | PP_rel | SP | SP_rel | MC | MC_rel | Note |
| 114 | GAS13 | GAS13E03 | 1 | 00:00:00 | 00:00:01 | 00:00:01 | NA | | NA | | NA | | Contes |
| 115 | GAS13 | GAS13E03 | 2 | 00:00:01 | 00:01:04 | 00:01:03 | 0 | | 6 | SP3,SP7 | 0 | | Pg+mo |
| 116 | GAS13 | GAS13E03 | 3A | 00:01:04 | 00:01:20 | 00:00:16 | 0 | | 6 | SP3 | 0 | | |
| 117 | GAS13 | GAS13E03 | 3B | 00:01:20 | 00:01:59 | 00:00:39 | 0 | | 6 | SP3 | 0 | | |
| 118 | GAS13 | GAS13E03 | 4A | 00:01:59 | 00:02:26 | 00:00:27 | 0 | | 6 | SP3 | 0 | | |
| 119 | GAS13 | GAS13E03 | 4B | 00:02:26 | 00:02:40 | 00:00:14 | 6 | PP1 | 0 | | 0 | | |
| 120 | GAS13 | GAS13E03 | 4C | 00:02:40 | 00:03:13 | 00:00:33 | 0 | | 6 | SP3 | 0 | | |
| 121 | GAS13 | GAS13E03 | 5 | 00:03:13 | 00:04:20 | 00:01:07 | 0 | | 6 | P1,SP2,SP | 0 | | |
| 122 | GAS13 | GAS13E03 | 6 | 00:04:20 | 00:05:25 | 00:01:05 | 0 | | 0 | | 6 | MC1,MC3 | montag |
| 123 | GAS13 | GAS13E03 | 7 | 00:05:25 | 00:06:37 | 00:01:12 | 0 | | 0 | | 6 | MC4,MC7 | |
| 124 | GAS13 | GAS13E03 | 8 | 00:06:37 | 00:07:14 | 00:00:37 | 6 | PP1,PP6 | 0 | | 0 | | |

Dataset

| | | | | | | | | | | | |
|------|-------|----------|---------|---------|---------|---|-----|---|---------|---|-------|
| 1563 | GAS13 | GAS13E24 | 0:35:44 | 0:36:05 | 0:00:21 | 0 | | 4 | PP1 | 2 | ← SP7 |
| 1564 | GAS13 | GAS13E24 | 0:36:05 | 0:36:29 | 0:00:24 | 0 | | 0 | | 6 | SP7 |
| 1565 | GAS13 | GAS13E24 | 0:36:29 | 0:36:33 | 0:00:04 | 0 | | 0 | | 6 | SP10 |
| 1566 | GAS13 | GAS13E24 | 0:36:33 | 0:36:50 | 0:00:17 | 0 | | 2 | PP1 | 4 | SP1 |
| 1567 | GAS13 | GAS13E24 | 0:36:50 | 0:36:55 | 0:00:05 | 0 | | 0 | | 6 | SP10 |
| 1568 | GAS13 | GAS13E24 | 0:36:55 | 0:37:22 | 0:00:27 | 5 | MC1 | 1 | PP1 | 0 | |
| 1569 | GAS13 | GAS13E24 | 0:37:22 | 0:37:45 | 0:00:22 | 4 | MC4 | 2 | PP1 | 0 | |
| 1570 | GAS13 | GAS13E24 | 0:37:45 | 0:38:36 | 0:00:51 | 0 | | 0 | | 6 | SP10 |
| 1571 | GAS13 | GAS13E24 | 0:38:36 | 0:39:08 | 0:00:32 | 0 | | 6 | PP1 PP5 | 0 | |
| 1572 | GAS13 | GAS13E24 | 0:39:08 | 0:39:15 | 0:00:07 | 0 | | 6 | PP1 | 0 | |

Dataset

- 1
00:00:04,671 --> 00:00:06,739
Meredith:
Every patient who gets bad news
- 2
00:00:06,773 --> 00:00:08,207
<i>wants to be the exception...</i>
- 3
00:00:08,241 --> 00:00:10,709
<i>the one in a million, the miracle.</i>
- 4
00:00:12,016 --> 00:00:14,279
<i>But surgeons
don't believe in miracles.</i>
- 5
00:00:14,314 --> 00:00:16,615
<i>We have to make them happen.</i>
- 6
00:00:16,649 --> 00:00:17,983
Are you okay?
- 7
00:00:18,018 --> 00:00:19,651
He has all the power now.
- 8
00:00:19,686 --> 00:00:21,787
It's wrong. I'm his boss.

Dataset

| | Segment start | Segment end | Subtitle start | Subtitle end | PP | SP | MC | Subtitle text |
|-------|---------------|-------------|----------------|--------------|-----|-----|-----|---|
| 0 | 00:00:01 | 00:01:04 | 00:00:04.671 | 00:00:06.739 | 0 | 6 | 0 | Meredith: Every patient who gets bad news |
| 1 | 00:00:01 | 00:01:04 | 00:00:06.773 | 00:00:08.207 | 0 | 6 | 0 | wants to be the exception... |
| 2 | 00:00:01 | 00:01:04 | 00:00:08.241 | 00:00:10.709 | 0 | 6 | 0 | the one in a million, the miracle. |
| 3 | 00:00:01 | 00:01:04 | 00:00:12.016 | 00:00:14.279 | 0 | 6 | 0 | But surgeons don't believe in miracles. |
| 4 | 00:00:01 | 00:01:04 | 00:00:14.314 | 00:00:16.615 | 0 | 6 | 0 | We have to make them happen. |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 21143 | 00:41:23 | 00:41:43 | 00:41:23.297 | 00:41:26.065 | 0 | 0 | 0 | Sometimes, we wake up, we face our fears... |
| 21144 | 00:41:43 | 00:41:47 | 00:41:42.849 | 00:41:45.149 | 0 | 0 | 6 | We take them by the hand. |
| 21145 | 00:41:59 | 00:42:10 | 00:42:01.299 | 00:42:03.800 | 0 | 0 | 6 | And we stand there, waiting... |
| 21146 | 00:41:59 | 00:42:10 | 00:42:03.836 | 00:42:06.169 | 0 | 0 | 6 | ... hoping, ready... |
| 21147 | 00:41:59 | 00:42:10 | 00:42:06.205 | 00:42:08.705 | 0 | 0 | 6 | ... for anything. |

Dataset

| | Instances |
|----------------|------------------|
| Train | <i>55,567</i> |
| Dev | <i>11,907</i> |
| Test | <i>11,908</i> |
| Overall | <i>79,382</i> |

Dataset

| | PP | SP | MC | Total |
|----------------|-----------|-----------|-----------|--------------|
| Train | 17,391 | 34,555 | 25,250 | 77,196 |
| Dev | 3,773 | 7,343 | 5,415 | 16,531 |
| Test | 3,701 | 7,384 | 5,449 | 16,534 |
| Overall | 24,865 | 49,282 | 36,124 | 110,271 |

Instances in the dataset divided by plot type: SP is the most prevalent in the case of Grey's Anatomy

Task Definition

- Given the structure of the resulting dataset, the task of predicting the narratives along with the corresponding weights was framed as **multi-output regression**, also known as **multi-target regression**
- It is a combination of multiple regression problems, where each output is predicted using the same input data
- In the case of the present work, the outputs are the weights relative to the three plot types, whereas the input is the text of a subtitle

CNNs

- **Embeddings:** GloVe
- **Preprocessing:** lowercasing and *normalization*
- **Tuning:**
 - CNN₁ → manual
 - CNN₂ → automated
- **Output layer:** sigmoid with three outputs

| Parameters | Settings | CNN ₁ | CNN ₂ |
|---------------------|---------------------------------------|------------------|------------------|
| Conv1D kernel size | ∈ [1, 2, 3, 4, 5] | 3 | 2 |
| Conv1D filters | ∈ [50 ... 250] with a step size of 25 | 250 | 50 |
| Dense units | ∈ [32 ... 256] with a step size of 32 | 250 | 352 |
| Dropout value | ∈ [0.05, 0.1, 0.2, 0.3] | 0.2 | 0.1 |
| Intermediate layers | ∈ [1, 2, 3] | 1 | 2 |
| Loss function | MAE, MSE | MSE | MSE |
| Adam learning rate | ∈ [0.002, 0.001, 0.0001] | 0.001 | 0.001 |

| Subtitle | PP | SP | MC |
|---|-----------|-----------|-----------|
| amelia invited riggs to dinner at our house. | 0 | 1 | 0 |
| it's about the whole healthcare system, not this place. | 1 | 0 | 0 |
| noelle webb, 43, complains of abdominal pain | 0 | 0 | 1 |
| i'm the chief of general, i loved working with you, | 0.5 | 0.5 | 0 |
| if I have to look him in the eye and tell him i blew it... | 0 | 0.83 | 0.16 |
| yes, well, the medical community and i are in a fight. | 0.33 | 0.66 | 0 |
| why? my patient is terrified. | 0.33 | 0 | 0.66 |
| yeah, not by you. page surgery. | 0.66 | 0 | 0.33 |
| whatever. he bends his rules all the time to save his own patients. | 0.5 | 0.5 | 0 |

BERT

| | Batch size | |
|--------|------------|--------|
| Epochs | 16 | 32 |
| 2 | 0.2832 | 0.2824 |
| 3 | 0.2898 | 0.2868 |
| 4 | 0.2891 | 0.2882 |

Performance on the validation set with a learning rate of $2e-5$, expressed in MAE

- **Model:** bert-base-uncased
- **Preprocessing:** BertTokenizer
- **Tuning:** experimented with the parameters suggested by Devlin et al. (2019)
- **Parameters:** 2 epochs, batch size of 32, learning rate of $2e-5$
- **Output layer:** sigmoid with three outputs

| | pp | sp | mc | pp_pred | sp_pred | mc_pred | subtitle_text | data_type |
|------|-----|-----|-----|---------|---------|---------|---|-----------|
| 0 | 0.0 | 0.0 | 1.0 | 0.0005 | 0.0093 | 0.5616 | wh... am i gonna die? | test |
| 1 | 1.0 | 0.0 | 0.0 | 0.0010 | 0.0571 | 0.5083 | she'd be dead right now if it weren't for you ... | test |
| 2 | 1.0 | 0.0 | 0.0 | 0.0001 | 0.8240 | 0.0009 | she's my new best friend. | test |
| 3 | 1.0 | 0.0 | 0.0 | 0.0003 | 0.9800 | 0.0006 | ...like the kind we feel when we win. | test |
| 4 | 1.0 | 0.0 | 0.0 | 0.0002 | 0.5105 | 0.0025 | just him and me against the world. | test |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 7827 | 0.0 | 0.0 | 1.0 | 0.0002 | 0.3212 | 0.0260 | you realize how this looks, don't you? | test |
| 7828 | 0.0 | 0.0 | 1.0 | 0.0002 | 0.6068 | 0.0012 | i'm prioritizing my family, my sister. | test |

| | pp | sp | mc | pp_pred | sp_pred | mc_pred | subtitle_text | data_type |
|------|------------|-----|-----|---------|---------------|---------|---|-----------|
| 0 | 0.0 | 0.0 | 1.0 | 0.0005 | 0.0093 | 0.5616 | wh... am i gonna die? | test |
| 1 | 1.0 | 0.0 | 0.0 | 0.0010 | 0.0571 | 0.5083 | she'd be dead right now if it weren't for you ... | test |
| 2 | <u>1.0</u> | 0.0 | 0.0 | 0.0001 | <u>0.8240</u> | 0.0009 | <u>she's my new best friend.</u> | test |
| 3 | 1.0 | 0.0 | 0.0 | 0.0003 | 0.9800 | 0.0006 | ...like the kind we feel when we win. | test |
| 4 | 1.0 | 0.0 | 0.0 | 0.0002 | 0.5105 | 0.0025 | just him and me against the world. | test |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 7827 | 0.0 | 0.0 | 1.0 | 0.0002 | 0.3212 | 0.0260 | you realize how this looks, don't you? | test |
| 7828 | 0.0 | 0.0 | 1.0 | 0.0002 | 0.6068 | 0.0012 | i'm prioritizing my family, my sister. | test |

Results and Evaluation

| | $R^2 \uparrow$ | | | | MAE \downarrow | | | | RMSE \downarrow | | | |
|------------------------|----------------|-------------|-------------|-------------|------------------|-------------|-------------|-------------|-------------------|-------------|-------------|-------------|
| | PP | SP | MC | All | PP | SP | MC | All | PP | SP | MC | All |
| Baseline | 0.00 | 0.00 | 0.00 | 0.00 | 0.26 | 0.39 | 0.37 | 0.34 | 0.32 | 0.43 | 0.41 | 0.15 |
| CNN₁ | -0.05 | -0.05 | -0.06 | -0.05 | 0.24 | 0.38 | 0.35 | 0.32 | 0.33 | 0.44 | 0.42 | 0.16 |
| CNN₂ | 0.02 | 0.05 | 0.03 | 0.03 | 0.26 | 0.37 | 0.36 | 0.33 | 0.32 | 0.41 | 0.41 | 0.15 |
| BERT | 0.05 | 0.11 | 0.07 | 0.08 | 0.19 | 0.35 | 0.31 | 0.28 | 0.37 | 0.47 | 0.46 | 0.19 |

Conclusion and Future Work

- The problem of predicting the narrative composition of Grey's Anatomy was addressed with three multioutput regression models in order to learn both the plot types and the weights, at the level of a subtitle
- The best performing model, based on BERT, obtained an R^2 score of 0.08; CNN_2 performed better than CNN_1
- While visual and audio information have been widely studied, textual clues are less explored (Weng et al., 2021)
- As demonstrated by Li et al. (2021), **leveraging both the video and the subtitles** achieves competitive results on video understanding tasks