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Hamlet Seen through the Python's Eyes

Миштерова Івона, Миштера Адам. Гамлет очима Python.

Інформаційно-комунікаційні технології (ІКТ) відіграють все більш важливу роль майже в усіх наукових дисциплінах, включаючи лінгвістику, літературознавство та переклад. Дослідники англійської мови, вчителі, науковці та практики використовують такі онлайн-ресурси, як одномовні та двомовні словники, тезауруси (що містять синоніми та антоніми), Інтернет-форуми, веб-журнали та корпуси. Крім того, вони знайомі з пошуковими системами (наприклад, Alta Vista, Lycos, Infoseek і HotBot), які дозволяють отримати доступ до різноманітних автентичних джерел та здійснювати пошук відповідних термінів, словосполучень, ідіом і паралельних текстів.

Ця стаття спрямована на дослідження мовлення персонажів трагедії Шекспіра «Гамлет» шляхом поєднання машинного навчання та вбудовування слів за допомогою мови програмування Python. Основна мета – з'ясувати, чи здатен штучний інтелект розуміти шекспірівських персонажів і нюанси їхніх промов так само, як це роблять шекспірознавці. Продемонстровано функціональність і корисність індексування текстових кейсів за допомогою безперервних просторових векторних зображень слів у обраному «шекспірівському семантичному просторі».

Ключові слова: Вільям Шекспір, «Гамлет», штучний інтелект, машинне навчання, Python, лексична схожість.

“Nothing can come of nothing: speak again.”
(*King Lear* I, 1)

1. Shakespeare and Artificial Intelligence

This paper was inspired by a rapid advancement of artificial intelligence, in particular artificial neural networks. In the current

world, artificial intelligence plays an important role in improving the life of humankind and provides effective solutions for various problems. It has a number of products including intelligent systems, which are used in many fields of study to obtain effective and accurate results of the problems encountered. Linguistics, translation, and even literary studies are (or at least may be) among the areas in which artificial intelligence can be used. The objective of this article is to explore the speeches of the characters in Shakespeare's tragedy *Hamlet* through a combination of machine learning and word vectors using a powerful general-purpose programming language Python, which is currently widely used in natural language processing. The fundamental research question is whether artificial intelligence is able to understand Shakespeare's characters and the nuances of their speeches in a manner similar to that of Shakespearean scholars.

Before discussing our research, it is worth mentioning how artificial intelligence has already been applied in Shakespeare studies. One such example is the use of stylometry techniques to determine authorship. In his book *Versification and Authorship Attribution* (2021), Petr Plecháč examined the applicability of stylometry on poetry. He attempted to prove if specific versification features are suitable for authorship recognition. The novelty of his approach lies primarily in the focus on poetry and drama since stylometry has been used mainly for the analysis of novels. Working with poetic corpora in three languages (Czech, German, and Spanish), he explored two cases of disputed authorship. One of them was a Jacobean play *The Two Noble Kinsmen* (1634) attributed partly to John Fletcher and partly to William Shakespeare. Plecháč's objective was to determine which segment was written by Shakespeare, and which was contributed by Fletcher. A combined versification- and word-based model proved to be highly efficient in distinguishing between the two writing styles. As the results of the research show, Shakespeare authored scenes 1–5 in Act 1, scenes 1–2 in Act 3, and scenes 1, 3–4 in Act 5. Fletcher was confirmed as an author of scenes 2–6 in Act 2, scenes 3–6 in Act 3, scene 2 in Act 4, and scene 2 in Act 5.

IV. Свіжий погляд на давні тексти

The authorship of scene 1 in Act 4 remains unproven.¹ A combined analysis of vocabulary and versification together with machine learning techniques were applied to explore the authorship of *Henry VIII*.²

Another example of interconnection between artificial intelligence and Shakespeare studies is a theatre play generated by a recurrent neural network. A data scientist Rosaria Silipo conducted a unique experiment to see if artificial intelligence could write a play in the Shakespearean spirit while preserving the specifics of the characters and their speeches. Using full texts of three famous Shakespeare plays *King Lear*, *Othello*, and *Much Ado About Nothing* available from *The Complete Works of William Shakespeare* website, she trained a deep learning recurrent neural network with a hidden layer of long short-term memory units on this corpus to produce a new text.³ The results of Silipo's research experiment are stimulating but also to a certain degree expectable. The AI-created text imitates Shakespeare's writing style and makes use of Shakespeare's characters. The trigger for the creation of the play is, however, the scientist per se who, through a short prompt containing approximately 100 characters, sets up the situation and provides the impetus for its further development. Acts and scenes are thus naturally derived from Silipo's hints, which vary regarding the characters whose words and actions are to open the play. The first experiment was commenced with a short dialogue between Desdemona and Othello, which set the tone of the whole play. Later on, Gloucester, Cassio, Regan, and Oswald joined the conversation. As Silipo admits, the most difficult task was not to continue a given scene but to initiate a new one. The experiment shows that artificial intelligence

¹ Plecháč notes that his research corresponds with the findings of other authors, e.g., Fleay (1874) and Oras (1953), who moreover provided mostly orthogonal evidence in favour of Fletcher's authorship of scene 1 in Act 4. It thus seems probable that Fletcher wrote the scene, in which the jailer and his daughter are pardoned for Palamon's escape but the jailer's daughter has gone insane. Plecháč P. *Versification and Authorship Attribution*. Praha : Karolinum, 2021. P. 79.

² *Ibid.* P. 430–438.

³ The neural network designed by Silipo was “built, trained, and deployed using the GUI-based integration of Keras [an open-source software library] and TensorFlow [an end-to-end open-source platform for machine learning] provided by KNIME [Konstanz Information Miner] Analytics Platform”. Silipo R. Can AI write like Shakespeare?. *Towards Data Science*, 19 Sept. 2019. URL: <https://towardsdatascience.com/can-ai-write-like-shakespeare-de710befbfee>.

managed to grasp the essence of Shakespeare's writing style, identify main and minor characters and assign them a more or less appropriate amount of text. However, it would be AI experts' task to assess to what extent the neural network (only) connects the words it predicts to be semantically connected⁴, and to what extent it actually produces a really meaningful and graspable text. With respect to speakability and playability, it would be the role of theatre practitioners to evaluate whether it is possible to stage the text of a play created by artificial intelligence.

A similar experiment was conducted in connection with this research. The neural network was trained on the full texts of Shakespeare's plays available from *The Complete Works of William Shakespeare* website. The network was quite complex, so it took a longer time to train it. The training was carried out by Python using an open-source machine learning library Keras. The results of the experiment were similar to Rosaria Silipo's research. The greater amount of trained data led to the integration of more characters but also to a certain fragmentation of the plot. The opening speech of Romeo, who introduces himself as "a special gentleman" is followed by the utterance of two Roman tribunes, to whom a man named Peter replies, wandering at the presence of York [the Duke of York]. Right at the beginning of the AI play, there is an intersection of three Shakespeare's plays that are neither genre nor thematically related. It is not without interest, however, that a certain logical continuity of the speeches of the aforementioned characters was preserved, even though it naturally differed from their "roles" in the source plays. Thanks to artificial intelligence, the characters who would never meet in Shakespeare's plays or in the real world were brought together: a young lover in *Romeo and Juliet*; two tribunes, who are surprised that Romeo does not intend to stay with them and express their concern about Henry (but originally only receive information from the Senator in *Cymbeline*); and a man called Peter who may be a

⁴ Some mathematical models allow us to predict the words that follow a certain sequence of words. This is related, among other things, to the fact that semantically similar words lie close to each other in a virtual semantic space and vice versa. The second factor that plays an important role here is the so-called linguistic regularity, or more precisely, the possibility to express most of the morphological and semantic properties of words through vectors. This is the driving principle of a technique for natural language processing, which was developed in 2013 by Tomáš Mikolov.

IV. Свіжий погляд на давні тексти

minor character in *Romeo and Juliet*, *Taming of the Shrew*, or even *2 Henry IV*. His name could also refer to Peter Quince, a carpenter with literary ambitions in the comedy *A Midsummer Night's Dream*. A similar attempt obviously requires a careful and smaller selection of plays, preferably those that are close in genre and theme, in order to avoid a redundant number of characters and a fragmented plot.

When discussing the connection between Shakespeare's work and artificial intelligence, Charisma, which was founded in 2015, is also worth mentioning. As the official website specifies, the use of advanced artificial intelligence and creative storytelling techniques enables the creation of unique conversational experiences (Charisma np). It offers various kinds of epic games and activities through which it is possible to talk to an Apokoliptian general and a member of Darkseid's Elite (Steppenwolf)⁵; create high-quality digital humans (MetaHumans); meet customers of a traditional Western saloon (Project Howdy); develop the plots of Sherlock Holmes's detective investigations; influence the course of events in "the Vampires of London" (Charisma App); have oneself tested both mentally and physically by AI "Spy Master" Alastair (AI-Spy); and encounter characters from Shakespeare's plays *Romeo and Juliet* and *Macbeth* and transform their speeches into a 'WhatsApp' style conversation (Will Play). *Will Play*, which was developed in cooperation with Oxford University students, intends to introduce school children to the world of Shakespeare's plays through modern applications. The first step after entering and logging in to *Will Play* is to choose an area, which is to be explored, i.e. love, hate, and death. Afterwards, it is necessary to select one of ten avatars and start playing the game, which begins with a greeting from William Shakespeare:

Good morrow! Tis I, William Shakespeare, the Bard with the Beard, the playwright in tights! I'm here to find out how much you've learned about the first two acts of my fabulous play *Romeo and Juliet*. I'm going to ask you a series of questions, expertly devised by my brilliant self. All you have to do is type your answer

⁵ Darkseid is an evil ruler of Apokolips, who plans a universal conquest. He was one of the founding fathers of the original Secret Society of Super Villains.

in the chat box below (no messing around with quills for you!)
where did Romeo and Juliet first meet?⁶

As the sample suggests, the player chats with William Shakespeare himself, who asks him/her questions in the chosen field, which is love in this case. The way in which the question is designed draws the player into the plot and naturally adds further information about the character. It should be noted, however, that it is rather difficult to carry on the conversation with Shakespeare without familiarity with the play. The player has enough time to consider correct answers, but EFL speakers should have a good level of English language proficiency, which is necessary to understand the questions and further comments provided by Shakespeare. At the end of the conversation, it is possible to view the score and, in case of failure, play again. *Will Play* is thought-provoking, however, as already noted, it requires knowledge of Shakespeare's plays and characters. It combines educational and entertainment elements, with the former—at least in our opinion—predominating. The advantage is a natural form of mediation and easy accessibility, e.g., via tablet or smartphone.

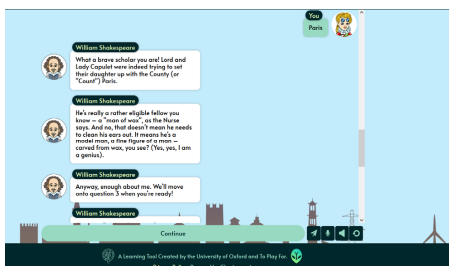


Fig. 1 *Will Play*
(The author's [Paris] conversation with the avatar of William Shakespeare during the game)

2. Analysis of Shakespeare Characters Using Python

As already mentioned, artificial intelligence has made significant strides in recent years. It also inspired the research described in this article. The main aim is to explore the speeches of

⁶ Will Play, <https://will-play-web.vercel.app/love/quiz>.

IV. Свіжий погляд на давні тексти

the characters in Shakespeare's tragedy *Hamlet* through a combination of machine learning and word embeddings using a powerful general-purpose, multiparadigm programming language Python with common machine learning libraries.⁷ Properties of Python include "suppression of non-mandatory delimiters, dynamic typic, and dynamic memory usage".⁸ The fundamental research question is whether artificial intelligence is able to understand Shakespeare's characters and the nuances of their speeches in a manner similar to that of Shakespearean scholars.

Concerning particular stages of research, first, it is necessary to load and pre-process the dataset. This means that all speeches of individual characters are processed and stored in prepared data structures. Second, each word must be converted to a vector. Words in the same context have the same or a similar vector. For example, the words king and queen are similar and will be placed close to each other in contrast to the words king and actor. Afterwards, it is possible for all speeches of individual characters to be represented as a n-dimensional vector in a virtual multidimensional space. A virtual space of characters thus consists of the entire vocabulary of the play. Subsequently, the dimensionality of the space is then reduced using Principal Component Analysis and characters are mapped into two-dimensional space, so each character is then represented only by x and y coordinates. All characters can then be fairly easily visualised using a simple scatter plot.

Our aim is to condense the characters, or more precisely, all the vectors representing them, into a two-dimensional space to see if they create hidden clusters or anomalies, and then analyse them. The visualisation of each character's space will provide more detailed information about their relationship to Prince Hamlet.

Before proceeding with the description of our experiment, it is necessary to briefly recapitulate the relationship between Hamlet and the other characters. In an imaginary virtual space, Hamlet will be perceived as a zero-point against which other characters will be defined. Early in the play, Prince Hamlet is urged by the

⁷ In this paper, open-source libraries Keras and scikit-learn are used.

⁸ Iguar L., Santi S. Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications. Cham, Switzerland : Springer, 2017. P. 6.

Ghost of his murdered father, King of Denmark, to take revenge on his usurping brother Claudius, who dispatched him of his life, crown, and queen in the “blossoms of his sins” (I, 5, 76).⁹ The Ghost's request becomes a source of mental discomfort for Hamlet since he is unsure of the nature of the spirit and its intentions. As G. R. Hibbard observes in his annotated edition of *Hamlet*, “the reality of the Ghost has been firmly established; but its nature is left in doubt”¹⁰ and the Prince is not sure whether the mysterious night visitor is “a spirit of health or goblin damned” (I, 4, 19). He gradually becomes surer that it is the spirit of his father coming from Purgatory, a transitional space between Heaven and Hell, but he still does not know if it is trustworthy. The identity of the Ghost is questionable for it can be perceived as the ghost of Hamlet's father, but also as the revenant ghost and the devil.¹¹ Irving Ribner points to the bond between Hamlet and his father (dead or alive), which can be equated with filial devotion and obedience, but is also controversial due to the Ghost's demand for vengeance for murder, which contradicts the divine commandment: “The [g]host stands for the paradox implicit in an action against evil which is itself a submission to evil”.¹² Stephen Greenblatt offers a similar interpretation of the Ghost's contradictory demand.¹³ Upon his return from Purgatory, the Ghost laments his death without receiving the last rites but almost immediately asks his son for revenge, though without acting against his mother. In fact, it is not clear if Python identifies the Ghost with Hamlet's dead father or considers it a product of Hamlet's tortured mind, as Gertrude's inability to see the ghost would suggest, when the Ghost urges his son to speak to his mother in the fourth scene of the third act.

Gertrude	To whom do you speak this?
Hamlet	Do you see nothing there?
Gertrude	Nothing at all; yet all that is I see.
Hamlet	Nor did you nothing hear?
Gertrude	No, nothing but ourselves.

⁹ All quotations used in this article are from the following edition: Shakespeare W. *Hamlet* / Edited by G. R. Hibbard. Oxford : Oxford University Press, 2008.

¹⁰ *Ibid.* P. 40.

¹¹ Prosser E. *Hamlet and Revenge*. Stanford : Stanford University Press, 1971. P. 138.

¹² Ribner I. *Patterns in Shakespearian Tragedy*. London : Methuen & Co Ltd., (1960), 2013. P. 72.

¹³ Greenblatt S. *Hamlet in Purgatory*. Princeton and Oxford : Princeton University Press, 2001. P. 4.

IV. Свіжий погляд на давні тексти

Hamlet Why, look you there. Look how it steals away.
 My father, in his habit as he lived! (III, 4, 124–130)

The dialogue can be read as Hamlet's reaction to an extreme situation that he is unprepared for and unable to process. Feeling disoriented, lost, and desperate, he may thus be haunting if not ghosting himself. Given the nature of the Ghost's speeches, however, the first option seems more likely. The character of the Ghost will probably not be placed in close proximity to Hamlet, but neither will it be distant from him.¹⁴

A similar location in virtual space might be expected for Hamlet's mother Gertrude, a beloved and admired wife of the late King Hamlet but remarried to Hamlet's uncle. Her new hasty marriage dismays Hamlet, who turns his hatred towards his mother into hatred directed towards women in general, Ophelia included. The Prince and Ophelia's (so far smooth) relationship is, however, further complicated by the interventions of Ophelia's brother Laertes and her father Polonius, who forbids her to see Hamlet (I, 3, 123–135). As a docile daughter, Ophelia obeys her father and returns Hamlet's letters, which becomes another source of stress and real or feigned madness for the Prince. She then witnesses Hamlet's presumably sincere confession, which she conveys in detail to her father. "(...) pale as his shirt, his knees knocking each other, / And with a look so piteous in purport / As if he had been loosed out of hell / To speak of horrors" (II, 1, 82–85). In Hibbard's view, Ophelia's description of the Prince's paleness echoes back to Horacio's description of the Ghost who returned from Purgatory or the grave to speak of the horrors it had experienced. Hamlet thus consciously or unconsciously identifies himself with the spirit of his father and relives the moment of their encounter¹⁵. Later on, Ophelia experiences an even more hostile attack when Hamlet explicitly recommends her to enter a nunnery so that she cannot give birth to sinners of the same type as Claudius (III, 1, 122–123). Given the mixed feelings Ophelia has towards her "honoured lord" and her father at the same time, we may expect her character to be placed in a virtual space in a centre

¹⁴ For more information on the clash of reason and emotions in Hamlet, see: Krajník F. Hamlet. Translated by Filip Krajník. Brno : Větrné mlýny, 2022.

¹⁵ Shakespeare W. Hamlet. P. 201.

of the triangle with three vertices represented by Hamlet, Polonius, and Laertes, whose exhortations she listens to before he goes to France. In light of Polonius's murder at Hamlet's hand, it is also possible that Ophelia's character will be situated closer to her family clan. Closeness to the character of Hamlet can be expected in the case of the Prince's friend and confidant Horatio, who is the sole survivor of the tragedy and, at Hamlet's appeal, a herald recounting the latest events to Fortinbras.

The position of the figure of the Prince of Norway in multidimensional space is a rather challenging question. Although he does not appear in person until the fourth scene of the fourth act, the first mention of him is in the first scene of the first act, when Horatio describes him and his deceased father. Horatio's speech implies a number of parallelisms between Hamlet and Fortinbras. Both princes had a warm and close relationship with their fathers, after whom they are named. They represent "the old-style heroism".¹⁶ They are both royal princes and the rightful heirs to the royal throne upon the death of their fathers. Although they are de jure heirs to the throne, their countries are de facto ruled by their uncles, the usurpers of the throne. Their actions also stand in juxtaposition. Just as Hamlet sets out to avenge his father's murder, Fortinbras intends to reclaim the territory his father lost in Denmark and Poland. James Michael Thomas considers such parallelisms foils, "meaning characters that are presented as contrasts to another character to point to or show to advantage some aspect of the other character".¹⁷ In his view, Hamlet, Laertes, and Fortinbras are foils for one another. However, all of them eventually achieve their revenge through Hamlet's death.

3. Research Results and Conclusion

The results of our research show Shakespeare's characters mapped into a two-dimensional space as individual points

¹⁶ In Fortinbras's campaign against Poland, Hamlet is, however, confronted by an image of Fortinbras as a man driven by a desire for territory: Cantor P. A. Shakespeare's Roman Trilogy: The Twilight of the Ancient World. Chicago and London : University of Chicago Press, 2017. P. 47.

¹⁷ Thomas J. M. Script Analysis for Actors, Directors, and Designers. 3rd ed. Amsterdam, Boston, Heidelberg, London, New York, Oxford, Paris, San Diego, San Francisco, Singapore, Sydney, Tokyo : Taylor & Francis, 2005. P. 19.

IV. Свіжий погляд на давні тексти

represented by x and y coordinates, some of which form clusters of unequal size. The occurrence of unequal-size clusters is not, however, random, but results from inner high dimensional representation of individual characters, that was created using machine learning algorithms in Python. The zero-point of the semantic space is the character of Hamlet, against whom other characters are defined.

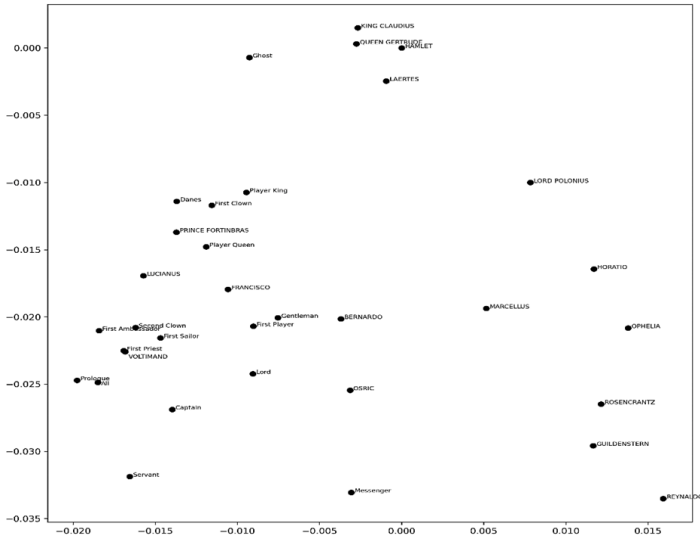


Fig. 2. Scatter plot presenting the visualisation of semantic space of Shakespeare's tragedy *Hamlet*

In the light of between-character distances, the character that is closest to the zero-point is Queen Gertrude. The minimum distance to Prince Hamlet indicates their specific mother-son relationship, however problematic it is. She seems to understand the cause of Hamlet's suffering, including her own (perhaps unintended) contribution in the form of her hasty marriage to her brother-in-law (2.2. 56–57). She carefully follows her son's instructions as she reports to Claudius on the state of the Prince's ailing mind, expresses concern about his mental and physical health, and

probably believes he is insane when she is not able to see the Ghost in the closet scene. What brings Gertrude fundamentally closer to the character of Hamlet is her disobedience of Claudius's command not to drink the poisoned wine originally intended for Hamlet (5.2. 241–245). Her rebellion stands out all the more because throughout the play she adopts her husband's views and identifies with them. However, the real motifs for her actions remain disputable.¹⁸

Characters who are also very close to Hamlet are Claudius and Laertes. Claudius's closeness to the Prince can be explained by his role as Hamlet's stepfather and uncle, underlined in the text by addressing the young man his "cousin Hamlet and his son" (I, 2, 64) and his "chiefest courtier, cousin and son" (I, 2, 117). Leaving aside the fact that he does not consciously call Hamlet his nephew, which would make the Prince a patrilinear heir, and the fact that Hamlet is aware of the meanings of Claudius's carefully chosen verbal expressions, it is the nature of his speech that brings him closer to the prince in semantic space. *Stricto sensu*, Claudius's true nature seems to be overshadowed by his Machiavellian eloquence, which is characterised by feigned care and warmth.¹⁹ Laertes's closeness to Hamlet was not unexpected. He was anticipated to be located near Ophelia and Polonius. The Hamlet-Laertes relationship is, nevertheless, of dramatic importance. Although they do not meet in person on stage until Act V, their lives are obviously interconnected. They have probably known each other since their childhood. However, Hamlet's odd relationship with Ophelia, as well as the murder of Polonius, makes them enemies. They only reconcile at the moment of Laertes's death, which is marked by his confession and a plea for forgiveness: "Exchange forgiveness with me, noble Hamlet / Mine and my father's death come not upon thee, / Nor thine upon me!" (V, 2, 282–284).

¹⁸ Samuel Crowl asks explicit questions to which there are only hypothetical answers: "Is Gertrude innocent or guilty of adultery? Is she complicit in her first husband's murder?" Crowl S. *Screen Adaptations: Shakespeare's Hamlet: The Relationship between Text and Film*. London, New Delhi, New York, Sydney : Bloomsbury, 2014. P. 1.

¹⁹ James E. Hirsh even observes that Hamlet becomes as Machiavellian as Claudius in his "To be, or not to be" soliloquy. Hirsh J. E. *Shakespeare and the History of Soliloquies*. Madison, Teaneck : Fairleigh Dickinson University Press, 2003. P. 256.

IV. Свіжий погляд на давні тексти

As expected, the Ghost was placed almost on the same line as Hamlet, though at some small distance to him. The location corresponds both to the familial relationship between the son and his deceased father and to the doubts Hamlet has about the mysterious creature (see above). In the case of Fortinbras's close proximity to Player King and Player Queen, the decisive factor may have been the theatrical performance in which, at Hamlet's explicit request, they took on the roles of king and queen. The cluster was thus formed on the basis of their social status, albeit given only by theatre, not by actual reality. The greater distance from Hamlet was probably due to the lower number of Fortinbras's speeches. But here, too, the relationship between Hamlet and Fortinbras must be seen as crucial, since, as already noted, it reflects the Hamlet-King of Denmark and Fortinbras-King of Norway relationships and at the same time creates an analogy to the relationship between Polonius and Laertes. The considerable distance between Hamlet and Ophelia was expected as Hamlet rejects her and, in a way, tries to free himself from her, although this effort must be understood as a "transference" reaction to his relationship with his mother. However, the question is to what extent artificial intelligence grasped the searing ironies of (not only) Hamlet's speeches.

Our experiment was an attempt to connect Shakespeare to artificial intelligence. It benefited from word-vector conversion and showed a stimulating visualisation of semantic space and between-character distances as well as within-clusters distances. One such example is the royal family cluster, which shows most of its characters semantically closely related, with the exception of the Ghost as an outlier at a fair distance. The characters outside the family of Prince Fortinbras, Ophelia and Horatio are noticeably detached. In future, a similar experiment will be carried out for other Shakespeare plays with the use of different and more advanced NLP algorithms.

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