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Going Beyond Intentions: A Methodology For Assessing Entrepreneurial Activity Among Engineering Education Alumni

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GOING BEYOND INTENTIONS: A METHODOLOGY FOR ASSESSING ENTREPRENEURIAL ACTIVITY AMONG ENGINEERING EDUCATION ALUMNI

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ABSTRACT

This research paper proposes a novel methodology for evaluating entrepreneurial activity among engineering education alumni using their public CVs as our main source of information. The objective is to go beyond measuring entrepreneurship intentions or mindset through surveys, and instead analyse actual career data to assess the impact of entrepreneurship education. The study utilises shared user data and employs GPT (Generative Pretrained Transformer) models to infer entrepreneurial activity that extends beyond job titles, delving into the specific responsibilities and achievements associated with each position.

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The analysis shows that the proposed methodology, which uses context enriching to enhance model accuracy, effectively identifies instances of entrepreneurial activity among CVs profiles data. This approach provides a way to evaluate the effectiveness of entrepreneurship and innovation courses. Combining the insights gained through the proposed method with internal data sources would enable institutions to conduct a comprehensive evaluation of program impact on alumni career paths.

The study underscores the potential of AI models to facilitate the collection and analysis of data that has traditionally been challenging to access. Moreover, the research highlights the importance of evaluating the long-term impact of entrepreneurship education on alumni career trajectories, a key factor in addressing the growing field of engineering education. Ultimately, this study contributes to the academic discourse on entrepreneurship education by offering a novel approach for assessing the impact of such programs on alumni outcomes, thus enabling institutions to make data-driven decisions to improve program offerings.

1 Introduction

Entrepreneurship and innovation have become increasingly vital in engineering education, as they are fundamental skills for students to develop in order to succeed in the global economy. Numerous higher education institutions have implemented entrepreneurship programs to provide students with the necessary knowledge and skills to launch their own businesses or innovate within existing organisations. However, evaluating the effectiveness of these programs has been challenging, as existing methods often rely on self-reported data from surveys, which may not accurately reflect actual entrepreneurial activity. This research paper proposes a novel methodology for assessing entrepreneurial activity among engineering education alumni by analysing their public CVs. The methodology aims to move beyond measuring entrepreneurship intentions or mindset and instead analyse actual career data to assess the impact of entrepreneurship education. The study utilises shared user data and employs GPT (Generative Pretrained Transformer) models to infer entrepreneurial activity that extends beyond job titles, delving into the specific responsibilities and achievements associated with each position.

Although the research question of the overall project could potentially be: "How can entrepreneurship and innovation be effectively promoted among engineering students, and how can the impact of these efforts on their career trajectories be measured using AI and machine learning?", this paper aims to solely describe the methodology and present a first set of preliminary results. Therefore, the research question adjusted to the scope of this paper would be: "Is it possible to extract useful information about the entrepreneurship and innovation activities of engineering education alumni using AI with their public CVs?"

1.1 Literature review

Within the field of artificial intelligence research, one particular type of transformer has garnered significant attention due to its text-generating capabilities. This popularity can be largely attributed to the groundbreaking work of OpenAI and its ChatGPT platform. Specifically, the GPT models, including GPT, GPT-2 and GPT-3, have become widely recognized as standard transformer architectures trained using a language model objective. While their primary success has been in natural language generation, these models have also demonstrated impressive performance in other tasks (Radford et al. 2018; 2019; Brown et al. 2020). However, the field of AI research is constantly evolving, with ongoing research and publications exploring the potential applications of GPT-4 and future versions, as well as the associated concerns (Liu et al. 2023).

The field of education is no exception to this trend, with growing literature on the use cases and applications of LLMs (Large Language Models) in general, and GPT in particular, for educational purposes. Previous work highlights the advantages of this new technology in engineering education, which can be extrapolated to the education realm in general. These recommendations aim to embrace the technology

to reduce manual work, contribute to and use open sourced models, and shift to a more student-centred approach, while understanding the current limitations of the available models and establishing ground rules and standards for their fair use for both students and practitioners (Yan et al. 2023; Qadir 2023).

Building on these recommendations, this study aims to leverage this new technology to provide a new approach for evaluating entrepreneurship or innovation programs within engineering education. Past literature contains existing examples of evaluation methods for this type of program, which can be grouped into three categories: (1) surveys to students upon program completion to assess entrepreneurial skills (Bellotti et al. 2013; Bilén et al. 2005; Wang and Kleppe 2001; Ohland et al. 2004); (2) surveys to evaluate entrepreneurial intentions (Souitaris, Zerbinati, and Al-Laham 2007; Joseph 2013); and (3) alternative assessment methods such as qualitative interviews with students upon program completion (Creed, Suuberg, and Crawford 2002). However, to the best of our knowledge, no existing method incorporates AI techniques as a supplementary means of program evaluation. Therefore, this study aims to introduce an AI-based approach to augment the existing evaluation methods for entrepreneurship and innovation programs in engineering education.

2 Methodology

In this section, we present the proposed methodology for assessing entrepreneurial activity among engineering education alumni. The methodology involves a multi-step process as depicted in Fig. 1.

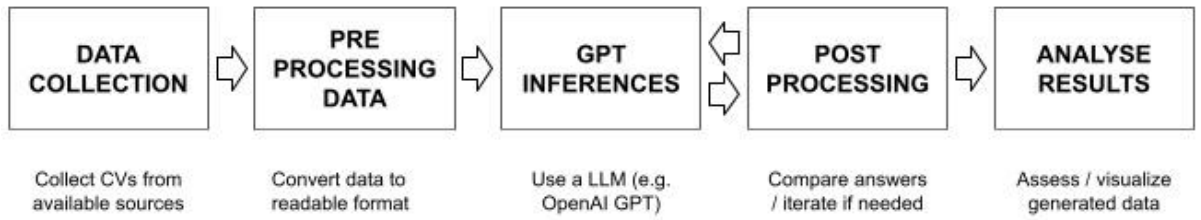


Fig. 1. Methodology flowchart.

2.1 Data collection and preprocessing

The methodology of the present study involves the collection and evaluation of curriculum vitae (CVs) from a sample of engineering education alumni. However, due to the lack of standardisation in the format and template of the CVs, it was necessary to employ a dedicated group named *"Xarxa Telecos BCN - Associació Oficial d'Alumni de la UPC ETSETB* LinkedIn to obtain 200 CVs in PDF format. This group, with approximately 2,000+ members, aims to gather Technical University of Catalonia (UPC) - Telecos BCN alumni. Therefore, we decided to review approximately ~10% of randomly selected users to conduct this initial experiment since the expectation is that members in this group have graduated in engineering. Thus, we can run this first experiment with them to test this methodology. Please

note that the CV generation was done manually, so no scraping technique or whatsoever was involved. We directly had access to these profiles as we are part of the same group and share our personal information as well.

It should be noted that while the PDF files have the same format in this study, the proposed methodology is not limited to a specific template and would work equally well with different types of CVs. This is because the methodology uses GPTs to extract information from the content of the CVs, irrespective of the formatting one can find in the real world as seen in Fig. 2. The pre-processing stage involves converting the PDF files into plain text that can be used as input for GPT inference. Additionally, data cleansing techniques are applied to eliminate special characters and ensure that the GPT model can accurately interpret the data.

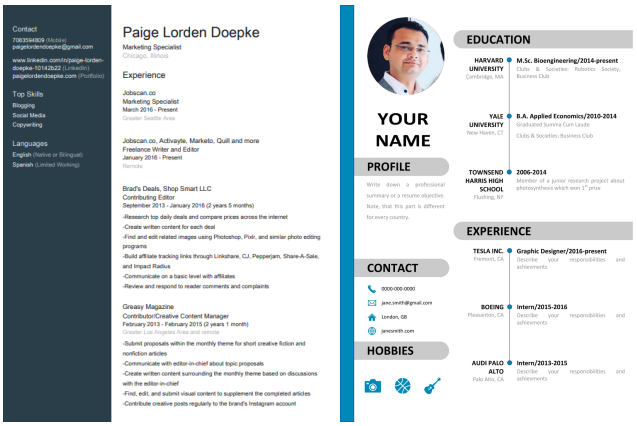


Fig. 2. Potential problem for just parsing information from different CV templates.

2.2 GPT Inferences and postprocessing

This research employs GPT models to analyse entrepreneurial activity beyond job titles, exploring the specific responsibilities and accomplishments associated with each role. To accomplish this task, the study utilised the API (Application Programming Interface) from OpenAI, specifically their commercial model *"gpt-3.5-turbo"*. When employing such models, it is crucial to refine the prompt to ensure that the model comprehends the task requested. As a result, the prompt underwent initial trial and error modifications to obtain the expected results. In this study, a prompt was constructed utilising a chat format by concatenating various text chunks:

- Background information: *"You are about to analyse a CV…"*
- CV information: CV content in txt format
- Information requested: *"From the previous CV I need you to confirm the following information: 1) Full name of the person…"*

In order to facilitate the extraction of data from the responses generated by the GPT model, we employed a strategy whereby the desired answer was specified within brackets, as exemplified by the prompt: *"What is the name of the person? in your*

reply put the full name between brackets []”. Notwithstanding the clarity of these instructions, it is possible that the desired outcome may not be achieved even when the correct answer is correctly bracketed. The probabilistic nature of the GPT model implies that the responses generated by the model will vary from one instance to another, even when the same prompt is used. In Fig. 3, we present an illustrative example of this phenomenon, where four duplicate CVs were subjected to analysis, yielding different outcomes: results that are coloured red indicate that they are not valid due to missing information or errors, and require repeating the GPT inference; orange-coloured results denote that the generated responses differed from the same prompt, and green-coloured results signify that the responses were identical across both inferences.The main takeaway is that, through this iterative process, the AI model used in this particular case eventually transforms "N/A" into actual values and validates initially uncertain information inferred from the CV after iterating again.

ID	Full_Nam	Current_Role	Current_Comp	Education_UPC	Last_Year	Business_Man	Entrepreneur	Entrepreneur_Description
CV_000001	[DTS]	[Purchasing Engineer]	[DENSO]	[M.D. in Organization ...]	[1997-1998]	[N/A]	[Freelance Engineer]	[He worked as a freelance...]
CV_000001	[DTS]	[Purchasing Engineer]	[DENSO]	[M.D. in Organization ...]	[1998]	[N/A]	[Freelance Engineer]	[He worked as a Freelance Engineer...]
CV_000002	[XS]	[Project Manager D... T... Global Business Iberia]	[D... T...]	[Ingeniero Superior Telecomunicaciones ...]	[1992]	[PMP - Project Management]	[N/A]	[N/A]
CV_000002	[XS]	[Project Manager]	[...Global Business Iberia]	[Ingeniero Superior Telecomunicaciones ...]	[1992]	[PMP - Project Management]	[N/A]	[N/A]
CV_000003	NA	NA	NA	NA	NA	NA	NA	NA
CV_000003	NA	NA	NA	NA	NA	NA	NA	NA
CV_000004	[ORS]	[Blockchain Engineer & Venture Developer]	[... Venture Studio]	[Master's degree in Cybersecurity - UPC]	[2022]	[Business Intelligenc e... - M]	[Flipside Crypto]	[As per the CV, he worked as Web3.0...]
CV_000004	[ORS]	[Blockchain Engineer & Venture Developer]	[... Venture Studio]	[Master’s degree in Cybersecurity - UPC]	[2022]	[Business Intelligenc e ... Cert. from M.]	[Yes]	[He currently works as a Blockchain Engineer and Venture Developer...]

Fig. 3. Different answer for the same prompt. Some answers were anonymized.

Therefore, a post-processing stage was established to mitigate missing information in data entries extracted by the GPT models in Fig.1. Although capturing all information within brackets allowed us to tabulate data efficiently, some entries contained incomplete information. This was resolved by repeating the GPT inference for only those entries with missing data. Consequently, all 200 data entries or CVs were accurately tabulated and ready for analysis to draw initial conclusions, as elaborated in the next section.

2.3 Analysing results

The present study utilised GPT models to analyse output data for identifying entrepreneurial activities among alumni, with statistical software R employed for this purpose. The data summary is presented in Table 1, revealing that out of the total number of CVs analysed, 174 had an engineering education degree at UPC, while 26 did not. Here, we refer to engineering education as the process of obtaining any engineering degree.

Table 1. Summary of the gathered data.

Engineering Education (EE)	Business or Management Education (BME)	Entrepreneurial Experience (ENT)	Total Data Entries
Yes	Yes	Yes	35
		No	37
	No	Yes	29
		No	73
No			26
Total			**200**

When considering the subset of CVs from individuals who had graduated from any engineering education degree, slightly more than 40% (72) of the CVs reviewed indicated that they had received supplementary education or training in business or management. Notably, although the sample size is small, individuals who had education in Business or Management exhibited a nearly 50% likelihood of possessing entrepreneurial experience, with 35 CVs as compared to 37 CVs. Conversely, individuals without business or management education were less likely to have entrepreneurial experience, with 29 CVs as compared to 73 CVs. Additionally, Fig. 4 revealed how the final academic year of their studies affected their decisions, with studying business or management higher education and being involved in entrepreneurial activities appearing more probable the more recently they completed their studies. Section 3 outlines the implications of these findings.

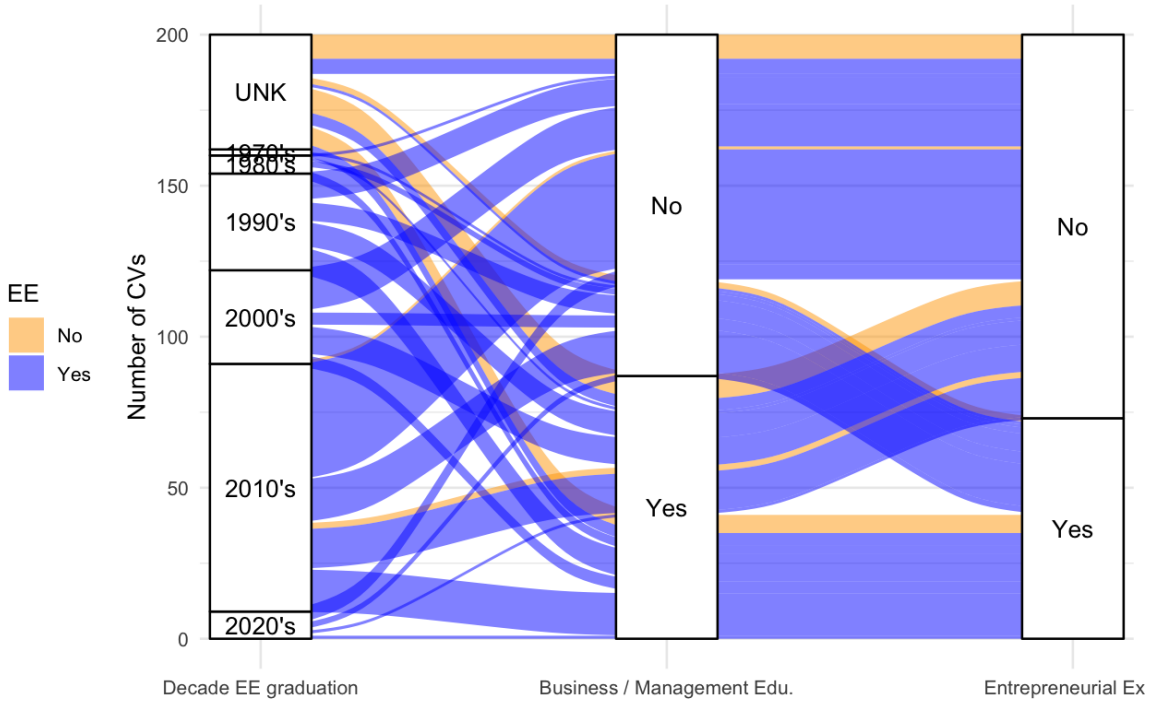
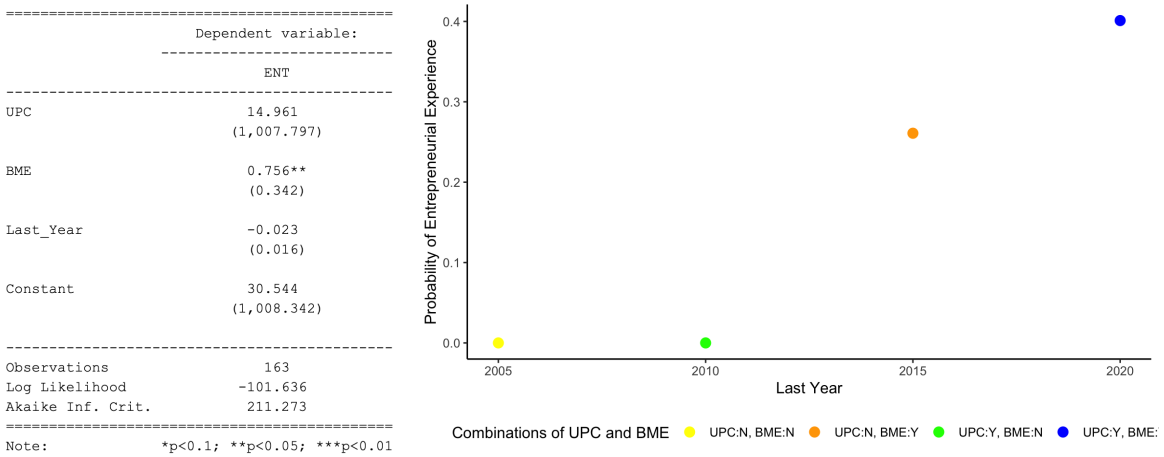


Fig. 4. Descriptive analytics for the data gathered.

3 Results

3.1 Exploratory analyses

The analysis of the collected data provides valuable insights into the relationship between education and entrepreneurial activity among engineering education alumni. The study examined 200 CVs, and information was extracted to construct a database. A logit model was subsequently developed using the constructed database, with *ENT* serving as the dependent variable, reflecting the existence of entrepreneurial activity. The independent variables were *UPC* and *BME*, representing whether a person studied engineering education or business or management education, respectively, and *Last_Year*, indicating the year of completion of studies. As demonstrated in the regression analysis, *BME* exhibited a statistically significant positive correlation with entrepreneurial activity, with a coefficient of 0.756 at the 5% level of significance. Conversely, *UPC* and *Last_Year* did not demonstrate any significant relationship with entrepreneurial activity. Therefore, the findings suggest that holding a business or management education may increase the likelihood of alumni participation in entrepreneurial activity. Nonetheless, these outcomes necessitate further verification with a larger data sample.



	Dependent variable:
	ENT
UPC	14.961
	(1,007.797)
BME	0.756**
	(0.342)
Last_Year	-0.023
	(0.016)
Constant	30.544
	(1,008.342)
Observations	163
Log Likelihood	-101.636
Akaike Inf. Crit.	211.273
Note:	*p<0.1; **p<0.05; ***p<0.01

Fig. 5. Regression analysis.

3.2 Conclusions and future directions

The present study has aimed to introduce a new approach for evaluating entrepreneurship and innovation programs offered by higher education institutions in Engineering degrees. As aforementioned, previous studies have largely relied on assessing intention or skills rather than actual entrepreneurship activity, through surveys or interviews. The proposed approach utilised the new GPT technology in conjunction with the availability of resumes or CVs of alumni from a given institution. The preliminary results showed that holding a business or management education is positively associated with entrepreneurial activity among engineering education alumni, while no significant relationship was found between studying engineering education or the year of completion and entrepreneurial activity. These findings

highlight the potential value of business or management education in fostering entrepreneurship among engineering graduates. Going further in our future research, we aim to add additional data sources to provide more information about the alumni in the study, particularly data related to specific courses taken in entrepreneurship and innovation while studying their engineering education degree. The expectation is that these courses have positive effect in Entrepreneurial intention and with this methodology can proxy the longitudinal data needed to assess the venture creation by the alumni (Cannata, Colombelli, and Serraino 2022), and go beyond intentions.

Nonetheless, it is important to note that the current study has certain limitations which may be addressed by future research. Firstly, the proposed method could be augmented by incorporating additional internal data sources, such as data on elective courses related to innovation, product development projects, or challenge-based learning. By doing so, institutions would be able to conduct a more comprehensive evaluation of the impact of their programs on alumni career trajectories. Secondly, while the results obtained from OpenAI APIs were encouraging, fine-tuning GPT models with additional training data could enhance the accuracy and consistency of responses across data samples. Lastly, the sample size used in the study may not be sufficiently robust to draw definitive conclusions. It is recommended that future studies utilise larger and more diverse data samples, including a balanced number of CVs from people who finished their engineering education studies in different decades, and incorporate the aforementioned improvements in order to yield more robust and sustained results.

The current study proposes a novel data-driven method for assessing the effectiveness of entrepreneurship and innovation programs offered by higher education institutions, through the combination of the proposed approach and future directions on incorporating alumni enrollment information in courses related to entrepreneurship and innovation. The proposed methodology offers a comprehensive understanding of alumni career paths and highlights the potential for AI to revolutionise the evaluation of program impact. Ultimately, this study contributes to the academic discourse on entrepreneurship education by emphasising the significance of assessing the long-term impact of entrepreneurship education on alumni career trajectories.

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