Personality Prediction Via Mono-Modal and Multi-Modal Information Analysis

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Abstract. Personality prediction has become an important part of the field where psychology and computer science meet. It is used for things like making suggestions, checking on mental health, and watching what people think about. Traditional assessment procedures such as questionnaires, interviews, etc. are limited by subjectivity, time consumption, scalability issues. With the rise of digital platforms, there's been a ton of unstructured data—stuff like text and pictures and charts and sound—that's showing up, allowing for actual computation methods when it comes to predicting personality. This paper is a review of personality prediction research between 2020 and 2025, including unimodal and multimodal methods. examines text-based kinds that extract linguistic features and chart-based sorts that look at behavioral and physiological patterns. Reviewing multiple modes which combine various data sources for improvement And also it talks about some mainstream datasets, current issues like data bias problems and data fusion difficulties are pointed out, suggestions for the future include developing cross-cultural datasets, using more advanced fusion algorithms and thinking about ethical factors. this overall summary can provide researchers who want to improve personality prediction technology and how it is used with a lot of useful ideas.

Keywords: Personality Prediction; Unimodal Information; Mmultimodal Information; Text Analysis; Chart Analysis.

1. Introduction

As a set or combination of psychological qualities which affect a person's way of thinking, behaviour and emotions, personality has always been one of the main research areas of psychologist [1]: In recent years, with the integration of computer and social media technology, the use value of personality prediction is no longer limited to the field of psychology and many other practical areas. E-commerce platforms adopt personality insights to fine-tune personalized recommendation systems, and mental health institutions depend on personality-related data to assess the risk of emotional disorders, and they use personality prediction models to fight against false news [2]. And these apps have made it a must for lots of different subjects to predict personality correctly and quickly. But at the same time, it brings up some problems in personality prediction [3]:

The traditional personality test methods can be divided into two types: self-report questionnaire assessment method and expert interview assessment method. But there are also limitations. There is a study that says that people who self-report with a questionnaire would be impacted by response bias. They could possibly be answering questions so as to meet social expectations. This can cause wrong answers [4]. But, on the contrary, expert interviews need much time and labor costs, so it is impractical to make such surveys for large scale population. With the rise of digital platforms, there is now a lot of readily accessible unstructured data: text posts from social media sites, facial images from video calls, voice recordings from daily communications, etc. It gives new resources for how to deal with the flaws of old ways, making people change from just subjective, manual look at things to objective, calculation-based personality forecast [5].

Computationally predicting personality has two kinds of studies: those with either mono-modal (single type) or multi-modal (multiple types) information modalities. When talking about mono-modal, text-based and image-based are the most popular. In text-based studies, people are generally extracting some semantic feature of a text dataset to build prediction models, which tend to ignore some non-verbal signals reflecting the personality. Image-based ones, on the contrary, rely on looking at face but do not have a context from language. Multi-modal methods combining two or more kinds

of data try to merge the advantages of each type of them. but multi-modal now also have problems, like data quality not being consistent across different modalities, and it's hard to do good feature combining. Despite the progress in both mono-modal and multi-modal fields, there is still a lack of a systematic summary that organizes existing methods, compares their advantages and disadvantages, and clarifies available datasets and future research directions.

To address this gap, this paper conducts a targeted review of computational personality prediction studies from 2020 to 2024. First, the paper elaborates on mono-modal personality prediction, with separate analyses of text-based and image-based methods—including the core techniques and experimental results of representative studies. Second, the paper summarizes multi-modal personality prediction research, focusing on common fusion strategies and their effects on prediction accuracy. Finally, the paper collates mainstream datasets used in current studies, discusses the limitations of the field, and proposes potential future directions.

2. Personality Prediction Based on Unimodal Information

Unimodal information refers to data from a single source or format, such as text, charts, or audio. In personality prediction, unimodal methods lay the foundation for early computational research, as they focus on extracting valid personality cues from a single type of data. This chapter elaborates on two mainstream unimodal approaches: text-based and chart-based personality prediction.

2.1. Personality Prediction Based on Textual Information

Textual information, including social media posts, comments, and personal diaries, contains rich linguistic features that reflect an individual's thinking patterns, emotional tendencies, and behavioral preferences—all of which are closely related to personality traits. Text-based personality prediction aims to mine these linguistic cues and build predictive models using natural language processing techniques. Personality traits, as an important psychological structure of human beings, play a crucial role in predicting human behaviors and emotions. They have extensive applications in various fields such as mental health, recommendation systems, and public opinion monitoring. Traditional personality trait analysis relies on scale evaluation, which not only consumes a large amount of manpower and time but also lacks timeliness, severely limiting its application scope. According to the research in this document [6], Personality trait vectors are generated by constructing networks, improving walking strategies and the skip-gram algorithm. This method performs better than comparison methods on multiple datasets. In addition, this research designs and implements a visual prototype system, which provides users with convenient personality trait prediction operations and result display functions. Another study points out that a Turkish Twitter personality trait dataset has been constructed. Stem extraction preprocessing is combined with BERT vectorization, and deep learning models are compared. The results show that stem extraction and BERT perform better on Turkish data than their previous performance on English data, and the BiLSTM model outperforms other methods on both language datasets.[7] Personality prediction based on text information is realized by means of language features in texts such as social media posts and diaries, and by mining personality-related clues through natural language processing technologies. It has applications in multiple fields including mental health and recommendation systems. It can overcome the limitations of traditional scale evaluation, such as consuming manpower and time and lacking timeliness. Relevant studies are also continuously exploring more effective methods to improve prediction effects.

2.2. Personality Prediction Based on Chart Information

Personality prediction based on chart information is a research direction that infers individual personality traits by analyzing implicit patterns and characteristics in various types of chart data. The charts here cover multiple forms, such as visual charts of individual behavior data (e.g., daily activity

time allocation charts, social interaction frequency statistics charts) and physiological index change curves (e.g., heart rate fluctuation charts, skin conductance response trend charts).

Its core logic is that personality traits are reflected through external manifestations such as individuals' stable behavior patterns and physiological response rules. As a quantitative carrier of these manifestations, charts can concentrate and present relevant characteristics. For example, individuals with high conscientiousness may show regular work and rest patterns in time allocation charts, and people with strong extraversion may display more frequent interpersonal connections in social interaction frequency charts. Researchers extract and analyze data distribution, trend changes, correlation characteristics and other aspects in the charts. They combine machine learning models (such as regression analysis and neural networks) to establish mapping relationships between features and personality traits, thereby achieving prediction.

The advantages of such methods lie in the ability to use objective and quantitative chart data, reducing biases caused by subjective expressions. They are particularly suitable for scenarios where personality analysis needs to combine behavioral or physiological indicators. However, their effects also depend on the completeness and accuracy of chart data as well as the effectiveness of feature extraction. They often need to be combined with other information modalities to improve the comprehensiveness of prediction. A study on personality prediction based on chart information focuses on automatic personality prediction from texts.[8] With the Big Five personality model as the evaluation basis, it designs a three-stage implementation plan. First, texts are preprocessed to screen out core concepts. Then, a knowledge graph is constructed based on the DBpedia knowledge base, and after supplementing information with various databases, the graph is converted into a numerical matrix through tools. Finally, four deep learning models are used to perform personality prediction on the matrix. The experiment uses 2467 essays as samples. The results show that the BiLSTM model achieves the best prediction effect, all models perform better than previous studies, and the knowledge graph has a positive effect on the prediction of each personality dimension. This study provides a reference process for personality prediction based on chart information, proves that the knowledge graph can help models more fully explore the value of text concepts to improve prediction accuracy, and also provides references for model selection and method improvement in subsequent related studies. In addition, another study proposes the KGrAt-Net three-stage method: first, preprocessing texts to extract core concepts; then, constructing and pruning knowledge graphs in combination with DBpedia; finally, using graph attention networks (which can be added with RDF2vec graph embedding) to realize personality prediction [9]. The experiment uses 2467 essays as samples. The average accuracy rate is 70.26% when only the attention network is used, and it reaches 72.41% after combining with embedding, which is better than most baseline models. This study provides a framework for personality prediction based on chart information, confirming that knowledge graphs and attention mechanisms can improve the efficiency of using text concept knowledge. The construction and optimization of knowledge graphs, as well as the application of deep learning models in these two studies, provide a reference framework for personality prediction based on chart information. Personality prediction based on chart information can draw on this "feature extraction - knowledge integration - model prediction" path. It first extracts core features from behavioral, physiological and other charts, constructs knowledge graphs associated with personality traits, and then uses appropriate deep learning models to explore the mapping relationship between chart data and personality to improve prediction effects. At the same time, it can also refer to the role of knowledge graphs in information integration to enhance the utilization efficiency of implicit personality clues in chart data.

3. Personality Prediction Based on Multimodal Information

Personality prediction based on multimodal information is a research direction that comprehensively uses various types of data (such as text, images, audio, behavior records, etc.) to infer personality traits. Its core logic is that the external manifestations of personality traits are diverse.

They may be revealed through language expressions (text information), facial expressions, body postures (image information) or voice intonation (audio information). Information from a single modality can only reflect one aspect of personality, while multimodal fusion can capture personality clues more comprehensively.

For example, extraversion may be reflected in frequent interactive language in text, open body postures in images and high-pitched intonation in audio at the same time. Researchers extract features from different modal data through technical means (such as semantic features of text, visual features of images, and acoustic features of audio), and then integrate these features through fusion models (such as concatenation fusion, attention mechanism fusion) to finally predict personality traits (such as the Big Five personality traits).

Compared with single-modal methods, multimodal personality prediction can reduce biases from a single information source and improve the accuracy and robustness of prediction. It is especially suitable for complex scenarios (such as multi-dimensional data from social media, comprehensive information from human-computer interaction). However, it also faces challenges such as large modal differences and complex fusion strategies. A proposed multimodal personality prediction framework achieves results through a progressive method of "modal feature extraction - bimodal association mining - feature fusion - joint learning and loss optimization" [10]. It first uses encoders of pre-trained multimodal models as backbones to mine unimodal features from different modalities. Then, it extracts personality-related bimodal association features by means of a new adaptive graph Transformer network, which learns high-order temporal dependencies based on relation graphs and highlights key information. Subsequently, fused features are obtained through a multimodal channel attention residual fusion module, and a joint learning regression head for multimodal and unimodal data is used to predict personality trait scores. Finally, a multi-task loss function is designed to enhance the robustness and accuracy of predictions. Another study also uses multimodal information and applies video analysis algorithms to personality prediction [11]. It builds an end-to-end video analysis network based on 3D-ConvNet, uses LSTM to fuse image features (with 16 frames determined as the optimal number for fusion), and solves network overfitting through pre-training and data augmentation. The final experiment confirms that the prediction effect is the best when fusing 16 frames, and 3D-ConvNet can improve the accuracy of personality prediction by fusing video spatiotemporal information. This study focuses on videos (dynamic visual modality), breaks through the limitation of static image single modality, represents a deepening of the visual modality in multimodality, and its technical logic also provides a reference for multimodal information fusion.

4. Existing Limitations and Future Prospects

4.1. Existing Limitations

From the perspective of unimodal prediction, personality prediction based on text information is susceptible to language and cultural differences. Expression habits and semantic connotations of different languages may lead to poor performance of models in cross-language scenarios. Meanwhile, ambiguity in texts can also interfere with the accuracy of feature extraction. Personality prediction methods based on image information are limited by factors such as shooting conditions and dynamic changes in facial expressions. Static images are difficult to comprehensively capture the manifestation of individual personality traits, which easily leads to prediction biases.

In the field of multimodal prediction, heterogeneity between modalities is one of the main challenges. Data structures and feature distributions of different modalities such as text, image and audio are significantly different. How to achieve effective fusion of these heterogeneous features and give full play to the complementary advantages of each modality remains a problem to be solved urgently. In addition, multimodal models are relatively complex and require a lot of computing resources, which limits their practical application to a certain extent. Moreover, most existing studies focus on the Big Five personality model, with less attention paid to other personality models, which affects the universality of the research.

4.2. Future Prospects

To address the limitations of current research, future studies on personality prediction can advance from the following aspects:

In terms of dataset construction, more large-scale, cross-cultural, and multi-scenario multimodal datasets need to be built, and unified annotation standards should be formulated to reduce the impact of data biases on research results. Meanwhile, attention should be paid to the dynamic update of data to adapt to the ever-changing social environment and individual behavior patterns.

At the technical method level, better cross-modal fusion algorithms need to be studied deeply. Attention based methods, Graph Neural Networks etc can be integrated to enable enhanced mining of association features between modalities and improved representational learning on fusion of features. Besides, combining psychological theories with machine learning models could enhance the interpretability of the result of prediction, so that it is not just accurate but also explain the prediction process.

In application expansion, people should expand the scope of application of personality prediction. Take mental health assessment as an example, it is possible to give an early warning of psychological problems through individuals' multimode information analysis, and in the area of human-computer interaction, the interactive strategy can be modified according to personality prediction results to optimize user experience. At the same time, attention should be paid to ethical issues in technical applications, and the protection of data privacy should be strengthened to ensure the reasonable and compliant use of personality prediction technology.

In addition, attempts can be made to explore the prediction of new personality models, break through the limitations of existing research, and enrich the research dimensions of personality prediction. Through interdisciplinary cooperation, the theory and technical system of personality prediction can be continuously improved to promote the sustainable development of this field.

5. Conclusions

This paper comprehensively surveys computational personality prediction research from 2020 to 2024, including unimodal and multimodal methods. Review the Text based and chart-based personality prediction techniques, major techniques and experiments as well as their limitations. Also does multimodal methods, looks at fusions and how they change the prediction accuracy. Last but not least is the overview of popular data set, current problem and proposed research direction.

Unimode approaches give useful thoughts about personality expression by using single information sources. Text based approaches use language features to get thinking patterns and emotions based on writing. Chart based approaches look at people's behaviors and bodies from shapes they made. But they both have problems related to data quality plus cultural differences and context-related stuff.

Multimodal approaches handle such shortcomings by utilizing complementary details from many sources. Advanced fusion technique - adaptive graph transformer and attention mechanism - with more accurate predictions by having inter-modal relationship. The reviewed studies agree that combining information from texts, visual images, and other data gives us better personality guesses than each type by itself.

Existing datasets analysis shows there are more big, multi-cultural and timely updated resources needing standard annotation. Technically, it is more in favor to develop more efficient algorithms for fusion or to make better the interpretability of models and to include psychological theory into computations.

In future research, I will use more situations when considering ethical and privacy issues. maybe people could find out more about people's personalities by looking at other personality models besides the big five. When the above issues are considered, the area of computational personality prediction would be able to evolve further into more accurate, explanatory and ethical applications across different fields. This way, this paper brings together all the information already out there,

points to any problematic areas and proposes possible answers for future studies that can act as a reference for both the development and the study of personality predictions.

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