

## INTISARI

### MODEL DETEKSI KOMUNITAS DINAMIK MELALUI EVOLUSI TOPIK DAN REPRESENTASI SEMANTIK

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Deteksi komunitas dalam jejaring sosial dinamis menjadi tantangan penting. Hal ini terjadi karena struktur kolaborasi ilmiah dan fokus tematik penulis terus berubah seiring waktu. Namun, sebagian besar pendekatan sebelumnya masih memisahkan analisis struktur jaringan, topik, dan semantik. Pendekatan tersebut juga belum mengintegrasikan dimensi temporal secara komprehensif. Pemodelan topik statis seperti LDA belum mampu merepresentasikan evolusi topik secara temporal. Sementara itu, Word2Vec dan FastText memiliki keterbatasan dalam menangani kata-kata *out-of-vocabulary* (OOV) yang berdampak pada kualitas representasi semantik. Keterbatasan tersebut berimplikasi pada pembentukan komunitas berbasis konten yang kurang stabil dan interpretasi komunitas yang belum sepenuhnya bermakna secara kognitif, terutama pada korpus ilmiah berskala besar dan multidisipliner.

Penelitian ini mengembangkan model SCOPE (*Semantic COmmunity Pattern Evolution*) sebagai pendekatan deteksi komunitas dinamis. Model ini mengintegrasikan representasi semantik, struktur graf, dan evolusi topik secara simultan. Representasi vektor dibangun menggunakan Fast2Vec, yaitu kombinasi Word2Vec dan FastText yang dirancang untuk memperkuat kualitas semantik sekaligus mengurangi dampak OOV. Hasil *embedding* kemudian digunakan untuk membentuk *K-Nearest Neighbor Graph* (K-NNG), yang selanjutnya diproses menggunakan *Spectral Clustering* untuk mengidentifikasi struktur komunitas penulis. Distribusi topik pada setiap komunitas dianalisis menggunakan *Dynamic Topic Model* (DTM) untuk menangkap dinamika variasi tematik komunitas dari waktu ke waktu. Melalui integrasi tersebut, model SCOPE memungkinkan pemetaan evolusi semantik dan pola perubahan komunitas penulis dalam jejaring ilmiah dinamis.

Evaluasi menggunakan metrik *Normalized Mutual Information* (NMI), *Adjusted Rand Index* (ARI), *F1-score*, dan *modularity* menunjukkan bahwa meskipun nilai NMI (0,20-0,50), ARI (0,0098-0,34), dan F1 (0,20-0,42) relatif rendah akibat keterbatasan *ground truth* yang bersifat makro (15 bidang ilmu Scopus), nilai *modularity* konsisten tinggi (0,66-0,867) yang mengindikasikan kohesi internal komunitas kuat dan bermakna secara struktural. Analisis lebih lanjut mengungkap adanya pola komunitas monotopik dan multitematik, serta dinamika stabil, bergeser, dan fluktuatif. Selain itu, ditemukan topik *bridging* yang menghubungkan komunitas lintas bidang, serta perpindahan penulis antarkomunitas yang merefleksikan dinamika kolaborasi ilmiah. Temuan ini menegaskan bahwa model SCOPE tidak hanya adaptif terhadap perubahan semantik dan topik, tetapi juga mampu merepresentasikan evolusi struktur komunitas secara lebih kontekstual. Kontribusi Fast2Vec dan integrasi topik-semantik dalam SCOPE menjadi dasar penting bagi pengembangan model deteksi komunitas berbasis konten yang lebih akurat, adaptif, dan relevan terhadap ekosistem riset nasional.

Kata kunci: *dynamic community detection, topic evolution, semantic representation, Fast2Vec, SCOPE*

## ABSTRACT

### DYNAMIC COMMUNITY DETECTION MODEL THROUGH THE INTEGRATION OF TOPIC EVOLUTION AND SEMANTIC REPRESENTATION

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*Community detection in dynamic social networks is a significant challenge. This is because the structures of scientific collaborations and the authors' thematic focuses constantly change over time. However, most previous approaches still separate the analysis of network structure, topics, and semantics. These approaches also fail to comprehensively integrate the temporal dimension. Static topic modeling, such as LDA, cannot capture the temporal evolution of topics. Meanwhile, Word2Vec and FastText have limitations in handling out-of-vocabulary (OOV) words, which affects the quality of their semantic representations. These limitations result in the formation of less stable content-based communities and community interpretations that are not fully cognitively meaningful, especially in large-scale, multidisciplinary scientific corpora.*

*This research develops the SCOPE (Semantic Community Pattern Evolution) model for dynamic community detection. This model simultaneously integrates semantic representation, graph structure, and topic evolution. The vector representation is constructed using Fast2Vec, a combination of Word2Vec and FastText designed to enhance semantic quality while mitigating the impact of OOV. The resulting embedding was then used to construct a K-Nearest Neighbor Graph (K-NNG), which was then processed using Spectral Clustering to identify the structure of the author community. The topic distribution within each community was analyzed using a Dynamic Topic Model (DTM) to capture the dynamics of thematic variation over time. Through this integration, the SCOPE model enables mapping of semantic evolution and patterns of change in author communities within a dynamic scientific network.*

*Evaluation using Normalized Mutual Information (NMI), Adjusted Rand Index (ARI), F1-score, and modularity metrics showed that although the NMI (0.20-0.50), ARI (0.0098-0.34), and F1 (0.20-0.42) values were relatively low due to the limited macro-scale ground truth (15 Scopus disciplines), the modularity values were consistently high (0.66-0.867), indicating strong and structurally meaningful internal community cohesion. Further analysis revealed monotopic and multithematic community patterns, as well as stable, shifting, and fluctuating dynamics. Furthermore, bridging topics connecting communities across disciplines were identified, as well as author movement between communities, reflecting the dynamics of scientific collaboration. These findings confirm that the SCOPE model is not only adaptive to semantic and topic changes but also capable of representing the evolution of community structure in a more contextually rich manner. The contributions of Fast2Vec and the integration of topic semantics in SCOPE provide an important foundation for developing a content-based community-detection model that is more accurate, adaptive, and relevant to the national research ecosystem.*

*Keywords: dynamic community detection, topic evolution, semantic representation, Fast2Vec, SCOPE.*