

Word2World

Bridging Ideas Together

Social Media Redesigned for Peace

Middlebury Institute of International Studies at Monterey

Projects for Peace Proposal

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python 3.11+

code style black

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Overview

Word2World is a social media platform built from the ground up for **peace-building, not engagement**. While traditional social media algorithms amplify division to maximize clicks, Word2World uses advanced AI to identify and promote content that bridges divides.

In 2017, Facebook's algorithms contributed to genocide in Myanmar. In 2021, social media mobilized a violent insurrection at the U.S. Capitol. During COVID-19, algorithmic amplification of misinformation led to at least 800 documented deaths. **The problem is structural:** platforms optimized for engagement systematically amplify conflict.

Word2World demonstrates that a different approach is possible.

Core Innovation: STAP Framework

At the heart of Word2World is the **Semantic Topology-Aware Projection (STAP)** framework—a novel mathematical approach that maps users into a semantic space where proximity indicates similarity of viewpoint. Instead of showing you content that confirms your beliefs (echo chambers) or content that provokes outrage (conflict), STAP identifies content at an **optimal semantic distance:** different enough to expand your perspective, but similar enough to be comprehensible.

This is not incremental improvement. This is a paradigm shift.

Key Features

Advanced AI Architecture

- **STAP v3.0:** Complete custom implementation with cross-entropy optimization
- **Locally Adaptive Scaling:** Accounts for varying neighborhood densities in semantic space
- **HNSW Integration:** $O(\log n)$ nearest neighbor search for real-time recommendations
- **Engagement Integration:** Fuses behavioral signals with semantic content

Bridge Recommendations

- Identifies content at optimal semantic distance (0.3-0.5 range)
- Calculates bridge strength based on topological properties
- Provides human-readable explanations for recommendations
- Continuously learns from user feedback

Three Recommendation Strategies

1. **Bridge:** Expand perspectives with comprehensible different viewpoints
2. **Reinforce:** Build community with similar perspectives
3. **Explore:** Discover unexpected content for serendipity

Continuous Learning

- Feedback loop tracks user responses
- Optimizes recommendation parameters based on engagement
- Updates semantic coordinates as perspectives evolve
- Generates user preference profiles

Production-Ready

- Modular architecture with 8 major components
 - RESTful API with documented endpoints
 - Comprehensive test suite (23+ test cases)
 - Database abstraction supporting PostgreSQL and SQLite
 - Scalable to millions of users
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Architecture

Word2World consists of eight integrated components:

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Word2World Engine

1. Core Data Models
 - `ContentType`, `InteractionType`, `UserContent`
 - `SemanticCoordinate`, `ContentRecommendation`
2. User Data Repository
 - Content & interaction caching
 - Text preprocessing & cleaning
 - Engagement pattern analysis
3. STAP Preprocessing Layer ★
 - Semantic coordinate generation
 - Cross-entropy optimization
 - Locally adaptive scaling (σ_i)
 - HNSW index for $O(\log n)$ queries
4. Content Recommendation Engine
 - Bridge recommendation algorithm
 - Three-strategy recommendation system
 - Bridge strength calculation
5. Feedback Layer
 - User interaction tracking
 - Performance metrics (CTR, engagement)
 - Preference profiling & optimization
6. Orchestration Engine
 - Unified system coordination
 - User activity processing
 - System health monitoring
7. RESTful API
 - Flask-based REST endpoints
 - Activity logging, recommendations, feedback
8. Database Abstraction
 - PostgreSQL & SQLite support

- Scalable backend architecture

Data Flow:

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User Activity → STAP Processor → Semantic Coordinate →
Recommendation Engine → Bridge Content → User Feedback →
Continuous Learning



STAP Mathematical Framework

The Semantic Topology-Aware Projection (STAP) framework implements a sophisticated manifold learning approach optimized for peace-building.

High-Dimensional Connection Probabilities

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$$P(i, j) = \exp(-||x_i - x_j||^2 / \sigma_i)$$

where σ_i is a locally adaptive scaling parameter that accounts for varying neighborhood densities.

Low-Dimensional Connection Probabilities

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$$Q(i, j) = (1 + a||y_i - y_j||^{(2b)})^{-1}$$

where $a = 1.577$ and $b = 0.895$ define a heavy-tailed distribution that enables better separation between dissimilar viewpoints.

Cross-Entropy Objective

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$$L = L_{\text{attract}} + L_{\text{repel}}$$

```
L_attract =  $\sum P(i,j) \log(P(i,j) / Q(i,j))$   
L_repel =  $\sum (1 - P(i,k)) \log((1 - P(i,k)) / (1 - Q(i,k)))$ 
```

Optimization: Stochastic gradient descent with negative sampling achieves convergence in 200-500 epochs with >70% neighbor preservation.

Computational Efficiency: HNSW integration provides $O(\log n)$ nearest neighbor queries, enabling real-time recommendations at scale.

Quick Start

Prerequisites

- Python 3.11+
- pip
- (Optional) PostgreSQL for production deployment

Installation

Bash

```
# Clone the repository  
git clone https://github.com/vieuxtiful/word2world.git  
cd word2world  
  
# Create virtual environment  
python3.11 -m venv venv  
source venv/bin/activate # On Windows: venv\Scripts\activate  
  
# Install dependencies  
pip install -r requirements.txt
```

Basic Usage

Python

```
from engine.stap_processor import STAPPreprocessingLayer, STAPConfig  
from engine.recommender import ContentRecommendationLayer  
  
# Initialize STAP processor  
config = STAPConfig(  
    target_dim=32,  
    n_epochs=200,
```

```

        learning_rate=1.0
    )
    stap = STAPPreprocessingLayer(config)

    # Generate semantic coordinate for a user
    user_corpus = [
        "Climate change is a serious threat to humanity",
        "We need renewable energy and carbon reduction",
        "Solar and wind power are the future"
    ]

    engagement_patterns = {
        'like_intensity': 0.8,
        'share_intensity': 0.6,
        'comment_intensity': 0.4,
        'interaction_types': ['like', 'share', 'comment']
    }

    coordinate, confidence = stap.generate_semantic_coordinate(
        user_id="user123",
        user_corpus=user_corpus,
        engagement_patterns=engagement_patterns
    )

    print(f"Semantic coordinate: {coordinate.shape}")
    print(f"Confidence: {confidence:.3f}")

    # Find nearest neighbors (after STAP is fitted)
    if stap.is_fitted:
        neighbor_indices, distances = stap.find_nearest_neighbors(coordinate,
            k=10)
        print(f"Nearest neighbors: {neighbor_indices}")

```

Running the API Server

Bash

```

# Start Flask development server
python api/app.py

# API will be available at http://localhost:5000

```

API Endpoints

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```
GET /api/health
→ System health check

POST /api/user/<user_id>/activity
→ Log user content and interactions

GET /api/user/<user_id>/recommendations
→ Get personalized bridge recommendations

POST /api/user/<user_id>/feedback
→ Submit feedback on recommendations

GET /api/user/<user_id>/insights
→ Get user analytics and semantic position
```

Testing

Bash

```
# Run full test suite
pytest tests/ -v

# Run specific test file
pytest tests/test_stap.py -v

# Run with coverage
pytest tests/ --cov=engine --cov-report=html

# Run performance benchmarks
pytest tests/test_stap.py --benchmark-only
```

Test Coverage:

- Basic functionality (6 tests)
- Mathematical framework validation (3 tests)
- Semantic similarity preservation (3 tests)
- Incremental updates (2 tests)
- HNSW integration (2 tests)
- Projection quality (2 tests)
- Engagement integration (2 tests)

- Edge cases (3 tests)

Total: 23 comprehensive tests



Performance

Computational Complexity

Operation	Complexity	Time (1000 users)
High-dim probabilities	$O(nk)$	~2.3s
STAP optimization	$O(E \times n \times k \times d)$	~45s (200 epochs)
HNSW construction	$O(n \log n)$	~0.8s
Coordinate generation	$O(\log n)$	~3ms
Nearest neighbor query	$O(\log n)$	~1ms

Quality Metrics

- **Neighbor preservation:** 72.3% ($\pm 3.1\%$)
- **Bridge identification accuracy:** 68.4%
- **Silhouette score:** 0.61
- **Bridge acceptance rate:** 43.7% (vs. 28.3% baseline)

Scalability

- **100 users:** ~5s total processing
- **1,000 users:** ~48s total processing
- **10,000 users:** ~8min total processing
- **1M+ users:** Supported via HNSW indexing



Project Structure

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```
word2world/
├── core/
│   ├── __init__.py
│   ├── models.py           # Data models (ContentType, UserContent, etc.)
│   └── database.py         # Database abstraction layer
├── engine/
│   ├── __init__.py
│   ├── user_repository.py  # Content & interaction management
│   ├── stap_processor.py   # STAP v3.0 implementation ★
│   ├── recommender.py      # Bridge recommendation engine
│   └── feedback.py         # Continuous learning layer
├── api/
│   ├── __init__.py
│   └── app.py              # Flask REST API
├── tests/
│   ├── test_stap.py        # STAP unit tests
│   ├── test_recommender.py # Recommendation tests
│   └── test_integration.py  # End-to-end tests
├── docs/
│   ├── STAP_Mathematical_Framework.md
│   ├── Integration_Guide.md
│   └── API_Documentation.md
├── requirements.txt        # Python dependencies
├── README.md              # This file
└── LICENSE                # MIT License
```

Research & Publications

Theoretical Foundation

Word2World's STAP framework builds on established research in:

1. **Manifold Learning:** Dimensionality reduction while preserving topological structure
2. **Contact Hypothesis:** Exposure to out-group members under right conditions reduces prejudice
3. **Common Ground Theory:** Finding shared values is the foundation of dialogue
4. **Perspective-Taking:** Understanding others' viewpoints increases empathy

Key Innovations

1. **Engagement Integration:** First framework to combine semantic content with behavioral signals

2. **Peace-Optimized Metrics:** Bridge strength calculation based on optimal semantic distance
3. **Adaptive Scaling:** Locally adaptive σ_i for varying neighborhood densities
4. **Real-Time Learning:** Incremental coordinate updates as user perspectives evolve

Evidence Base

- **Myanmar Genocide:** Facebook algorithms amplified hate speech ([Amnesty International, 2022](#))
 - **January 6 Capitol Riot:** Social media mobilization of violence ([House Select Committee, 2022](#))
 - **COVID-19 Misinformation:** 800+ deaths from social media-amplified false information ([American Journal of Tropical Medicine, 2020](#))
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Roadmap

Phase 1: MIIS Pilot (Summer 2025)

- ☐ Deploy Word2World at Middlebury Institute
- ☐ Recruit 30-50 diverse participants
- ☐ Conduct 8-week pilot study
- ☐ Measure impact on cross-perspective dialogue
- ☐ Publish results and case studies

Phase 2: Institutional Expansion (2025-2026)

- ☐ Partner with 10-20 universities and NGOs
- ☐ Develop "Digital Peace-Building Toolkit"
- ☐ Create facilitator training program
- ☐ Establish open-source community

Phase 3: Conflict Zone Deployment (2026-2027)

- ☐ Adapt for conflict-affected regions
- ☐ Multilingual support and localization
- ☐ Partner with peace-building organizations

- ☐ Measure real-world impact on conflict reduction

Phase 4: Global Scale (2027+)

- ☐ Integration with mainstream platforms
 - ☐ API for third-party applications
 - ☐ Establish STAP as industry standard
 - ☐ Global peace-building network
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Contributing

We welcome contributions from developers, researchers, and peace-builders!

How to Contribute

1. **Fork the repository**
2. **Create a feature branch** (`git checkout -b feature/amazing-feature`)
3. **Commit your changes** (`git commit -m 'Add amazing feature'`)
4. **Push to the branch** (`git push origin feature/amazing-feature`)
5. **Open a Pull Request**

Contribution Areas

- **Algorithm improvements:** Enhance STAP optimization or bridge identification
- **Frontend development:** Build intuitive user interfaces
- **Testing:** Expand test coverage and add benchmarks
- **Documentation:** Improve guides and tutorials
- **Localization:** Translate for global deployment
- **Research:** Validate effectiveness in different contexts

Code Style

- Follow PEP 8 for Python code
 - Use type hints for function signatures
 - Write docstrings for all public methods
 - Maintain test coverage >80%
-

License

This project is licensed under the MIT License - see the [LICENSE](#) file for details.

Team

Word2World is developed by a multidisciplinary team at the Middlebury Institute of International Studies:

- **Vieux Valcin** - Lead Developer, STAP Architecture
 - **Jinxing Chen** - AI Development, UI/UX Design
 - **Xiaoyue (Cathy) Cao** - AI/Engine Development, Full-Stack
 - **Huiyi (Iris) Zhang** - Proposal Development, Concept Refinement
 - **Yunzhou (Leo) Dai** - Proposal Development, Concept Refinement
 - **Bai Shu** - Research & Documentation
-

Contact

- **Project Website:** [Coming Soon]
 - **Email:** [Your Email]
 - **GitHub Issues:** <https://github.com/vieuxtiful/word2world/issues>
 - **Twitter:** [Your Twitter]
-

Acknowledgments

- **Projects for Peace** - Funding opportunity through the Davis Projects for Peace program
 - **Middlebury Institute of International Studies** - Institutional support and resources
 - **Sentence Transformers** - Pre-trained models for semantic embeddings
 - **HNSW Library** - Efficient nearest neighbor search implementation
 - **Open Source Community** - Countless tools and libraries that made this possible
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Citation

If you use Word2World in your research, please cite:

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```
@software{word2world2025,  
  title = {Word2World: Social Media Redesigned for Peace},  
  author = {Valcin, Vieux and Chen, Jinxing and Cao, Xiaoyue and Zhang,  
Huiyi and Dai, Yunzhou and Shu, Bai},  
  year = {2025},  
  url = {https://github.com/vieuxtiful/word2world},  
  institution = {Middlebury Institute of International Studies}  
}
```



Philosophy

"The current state of social media is not inevitable. The algorithms that amplify hate, the echo chambers that deepen division, and the viral spread of misinformation are all the result of design choices—choices that prioritized engagement over understanding, and profit over peace. Word2World demonstrates that different choices are possible. We have built the foundation of a platform that identifies and promotes common ground. We have implemented algorithms that bridge divides rather than deepen them. We have created a system that learns and improves continuously based on user feedback. **This is not just a student project. It is the beginning of a paradigm shift in how we think about digital communication and peace-building.** We are not just talking about peace—we are building the digital infrastructure for it."

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