UAE Legal AI GraphRAG

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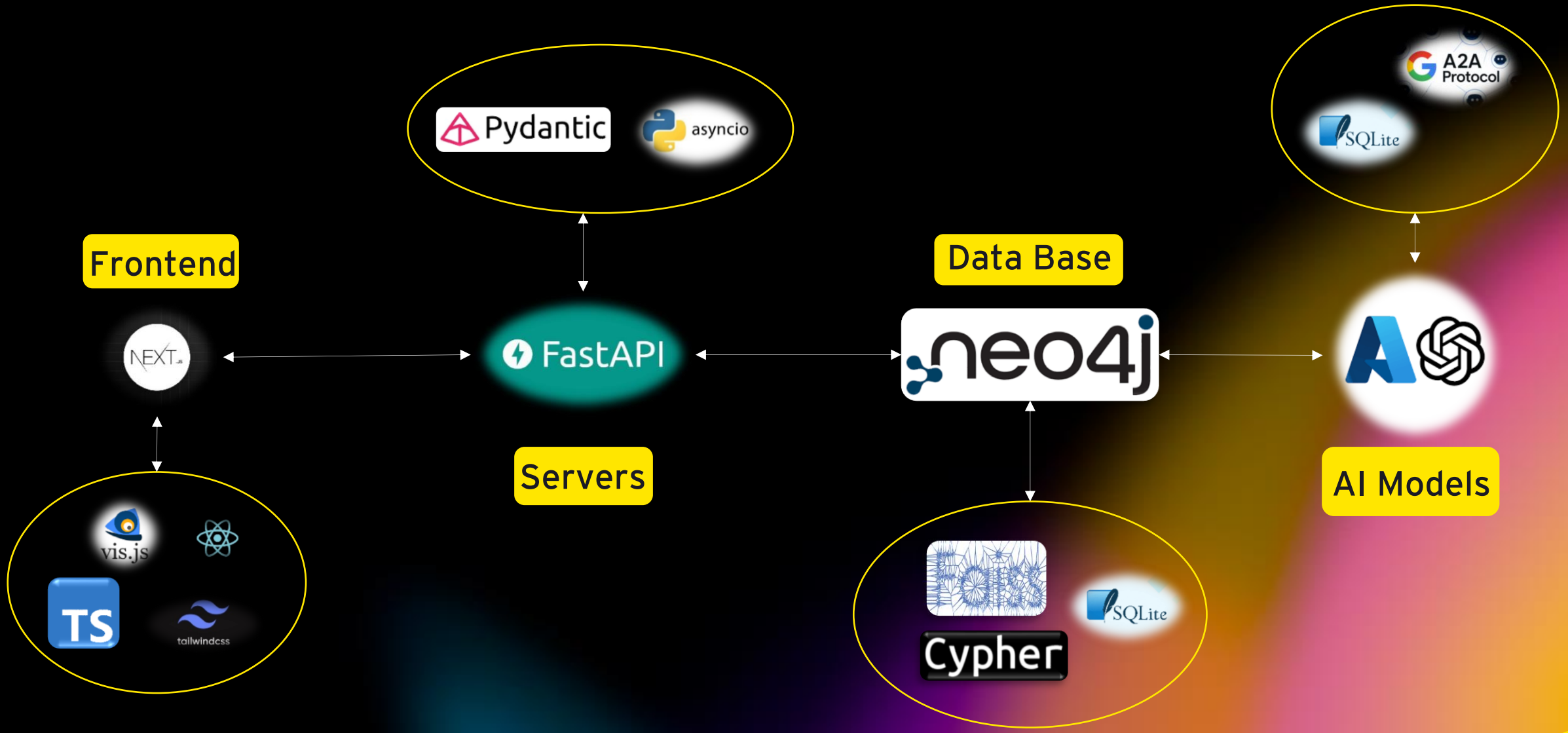
Key Points

- **Problem:** Complex legal research requiring multi-source analysis.
- **Solution:** AI Queries GraphRAG-powered.
- **Technology Stack**: Neo4j + FastAPI + Next.js + Azure OpenAI.
- **Outcome**: Real-time legal analysis with citation tracking and contradiction detection.

Technical Architecture Overview

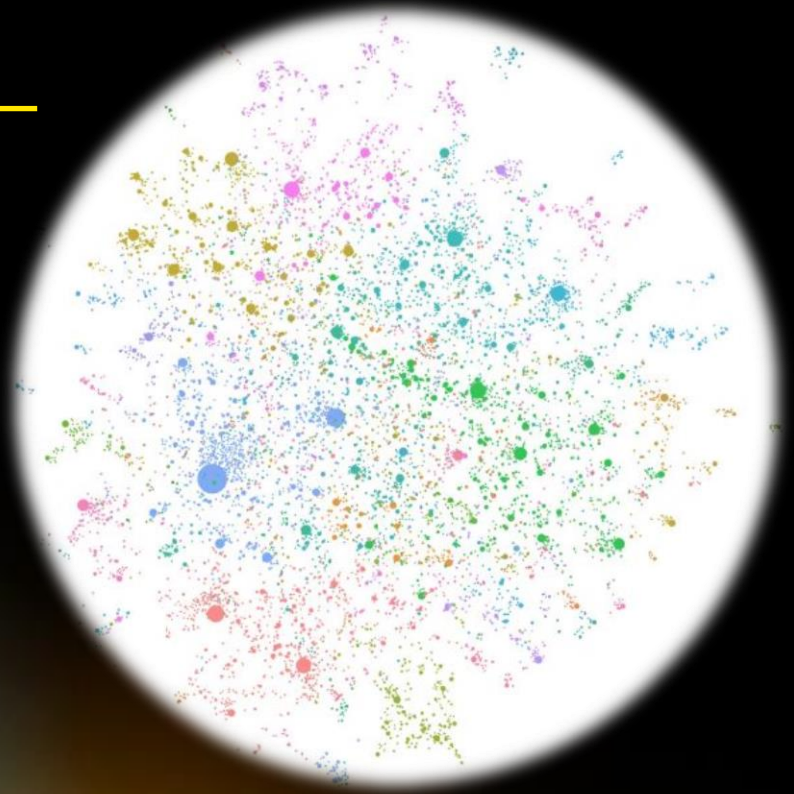


Knowledge Graph

Knowledge Graph

Nodes

- Instrument
- Provision
- Event
- Gazette Issue
- Authority Jurisdiction
- Court
- Judgment
- Topic



Edges

- HAS_PROVISION
- PUBLISHED_IN
- ISSUED_BY
- APPLIES_IN
- AMENDS
- IMPLEMENTED_BY
- CITES
- INTERPRETED_BY
- HAS_TOPIC

Knowledge Graph

Temporal Nodes

```json
{
  "id": "corporate_tax_2022",
  "title": "Federal Decree-Law No. 47/2022",
  "content": "Full legal text...",
  "metadata": {
    "law_number": "47/2022",
    "category": "Taxation",
    "effective_date": "2023-06-01"
  }
}
```

Hyper-Dimensional Edges

```json
{
  "type": "CONTRADICTS",
  "priority": "HIGH",
  "severity": "CRITICAL",
  "description": "Tax rate conflicts between versions"
}
```

GraphRAG Implementation

Local GraphRAG

- **Local neighborhood traversal** (1-hop relationships).
- **Degree-based ranking** (nodes with more connections get higher priority).
- **Focused retrieval** for specific legal concepts.
- **High precision, lower recall.**

Local GraphRAG Agent

python — Apply to rag.py

```python
class LocalGraphRAG(GraphRAGBase):
    """Focused retrieval using local graph traversal"""

    async def retrieve(self, query: str, max_results: int = 10) -> RAGResult:
        # Cypher query for LOCAL neighborhood search
        cypher_query = """
        MATCH (n:LegalNode)
        WHERE toLower(n.content) CONTAINS toLower($query)
           OR toLower(n.title) CONTAINS toLower($query)
        WITH n, size([(n)-[]-() | 1]) as degree
        ORDER BY degree DESC
        LIMIT $max_results
        OPTIONAL MATCH (n)-[r]-(related)  # Only immediate neighbors
        RETURN DISTINCT n, r, related
        """
```

Global GraphRAG

- Multi-hop traversal.
- **Global graph analysis** for comprehensive coverage.
- **Path-based retrieval** to find distant but relevant connections.
- **Higher recall, balanced precision.**

Global GraphRAG Agent

python

Apply to rag.py

```python
class GlobalGraphRAG(GraphRAGBase):
    """Comprehensive retrieval using global graph analysis"""

    async def retrieve(self, query: str, max_results: int = 10) -> RAGResult:
        # Cypher query for GLOBAL graph traversal
        cypher_query = """
        MATCH (n:LegalNode)
        WHERE toLower(n.content) CONTAINS toLower($query)
        WITH n, size([(n)-[]-() | 1]) as degree
        ORDER BY degree DESC
        LIMIT $max_results
        MATCH (n)-[r*1..2]-(related)  # 2-hop relationships
        WHERE related <> n
        RETURN DISTINCT n, r, related
        """
```

DRIFT GraphRAG

- **Dynamic relevance scoring** based on query context.
- **Importance tracking** through graph centrality.
- **Adaptive retrieval** strategies.
- **Balanced precision and recall.**

DRIFT GraphRAG Agent

python

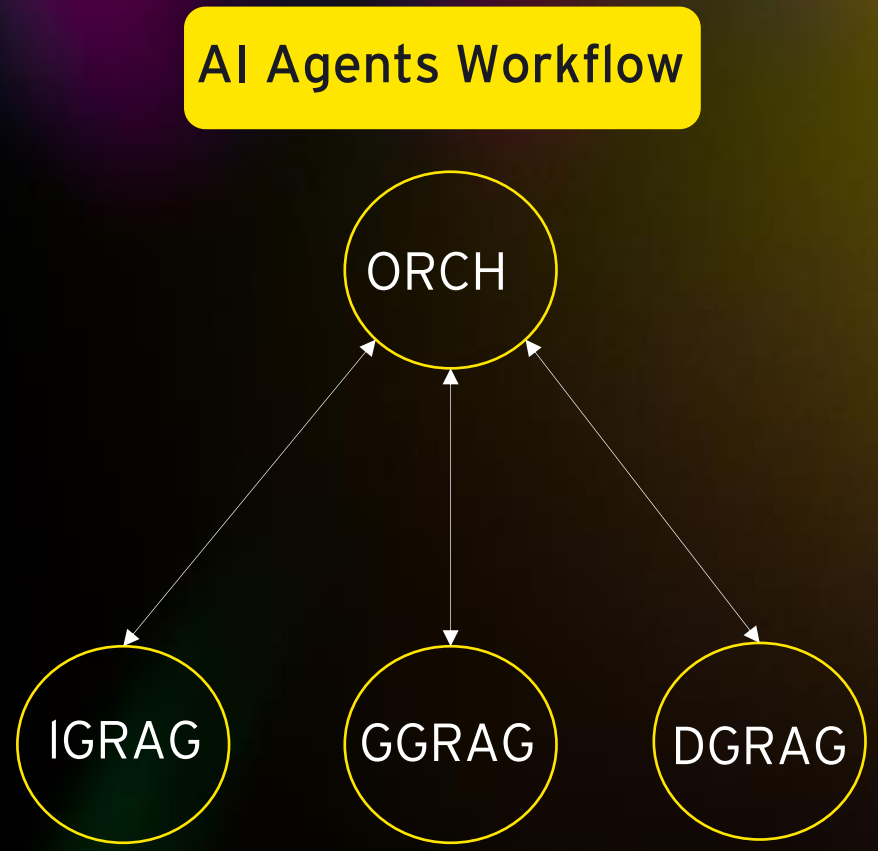
Apply to rag.py

```python
class DRIFTGraphRAG(GraphRAGBase):
    """Dynamic relevance and importance tracking"""

    async def retrieve(self, query: str, max_results: int = 10) -> RAGResult:
        # Cypher query for DRIFT algorithm
        cypher_query = """
        MATCH (n:LegalNode)
        WHERE n.content CONTAINS $query OR n.title CONTAINS $query
        WITH n, size([(n)-[]-() | 1]) as degree
        ORDER BY degree DESC
        LIMIT $max_results
        MATCH (n)-[r]-(related)
        RETURN DISTINCT n, r, related
        """
```

GraphRAG Implementation

- **Retrieval Strategy Selection:** Intelligent strategy selection based on query complexity.
- **Citation Tracking**: Full provenance with node metadata.



Backend API Architecture

Component	Type	Count	Purpose
FastAPI Backend	Application Server	1	API endpoints, GraphRAG, Agents
Next.js Frontend	Web Server	1	React app, API proxies
Neo4j Database	Graph Database	1	Knowledge graph storage
Azure OpenAI	AI Service	1	LLM and embeddings
SQLite Event Store	Local Database	1	Agent message persistence

Frontend Implementation

Next.js Architecture:

```typescript
// API Routes with error handling
export default async function handler(req: NextApiRequest, res: NextApiRespons
  try {
    const backendResponse = await fetch(`${BACKEND_URL}/api/chat`, {
      method: 'POST',
      headers: { 'Content-Type': 'application/json' },
      body: JSON.stringify(request)
    });

    if (!backendResponse.ok) {
      // Fallback to mock data
      return res.status(200).json(mockResponse);
    }

    return res.status(200).json(await backendResponse.json());
  } catch (error) {
    // Graceful degradation
    return res.status(200).json(mockResponse);
  }
}
```

Vis.js Graph Visualization:

```typescript
const network = new vis.Network(container, data, options);
network.on('click', (params) => {
  if (params.nodes.length > 0) {
    const nodeId = params.nodes[0];
    displayNodeDetails(nodeId);
  }
});
```

Cost Analysis

Cost Projection

Cloud Infrastructure (Azure)

Service	Specification	Monthly Cost	Notes
Azure App Service Plan	P2V2 (2 vCPU, 7GB RAM)	$146.00	Backend API hosting
Azure Container Instances	2 instances (Neo4j Enterprise)	$240.00	Neo4j Enterprise containers
Azure OpenAI GPT-4o	10M tokens/month	$300.00	LLM API calls
Azure OpenAI Embeddings	1M tokens/month	$0.10	Text embedding generation
Azure Database for PostgreSQL	Standard S2 (50 DTU)	$75.00	Event store & metadata
Azure Blob Storage	100GB + CDN	$25.00	File storage & caching
Azure Application Insights	Standard tier	$15.00	Monitoring & analytics
Azure Key Vault	Standard tier	$3.00	Secrets management
Azure Load Balancer	Standard tier	$18.25	Traffic distribution
Azure Virtual Network	Basic networking	$5.00	Network isolation
Azure Backup	100GB backup storage	$10.00	Data protection
Total Azure Infrastructure	**$837.35**		

Cost Projection

Neo4j Enterprise Licensing

Component	Specification	Monthly Cost	Notes
Neo4j Enterprise	2 cores, unlimited data	$1,000.00	Production license
Neo4j Bloom	User interface	$200.00	Graph visualization tool
Neo4j Graph Data Science	Advanced analytics	$300.00	Graph algorithms
Neo4j Ops Manager	Monitoring & management	$150.00	Operational tooling
Total Neo4j Enterprise	**$1,650.00**		

Demo

UAE Legal GraphRAG

Advanced legal research platform powered by GraphRAG technology and AI agents for comprehensive UAE legal analysis

Neo4j • Next.js • Azure AI

System Health

healthy

- Database Connection
- Embeddings Service
- AI Service

Database Statistics

Refresh

Documents	Entities	Relationships	Communities
77	83	103	6

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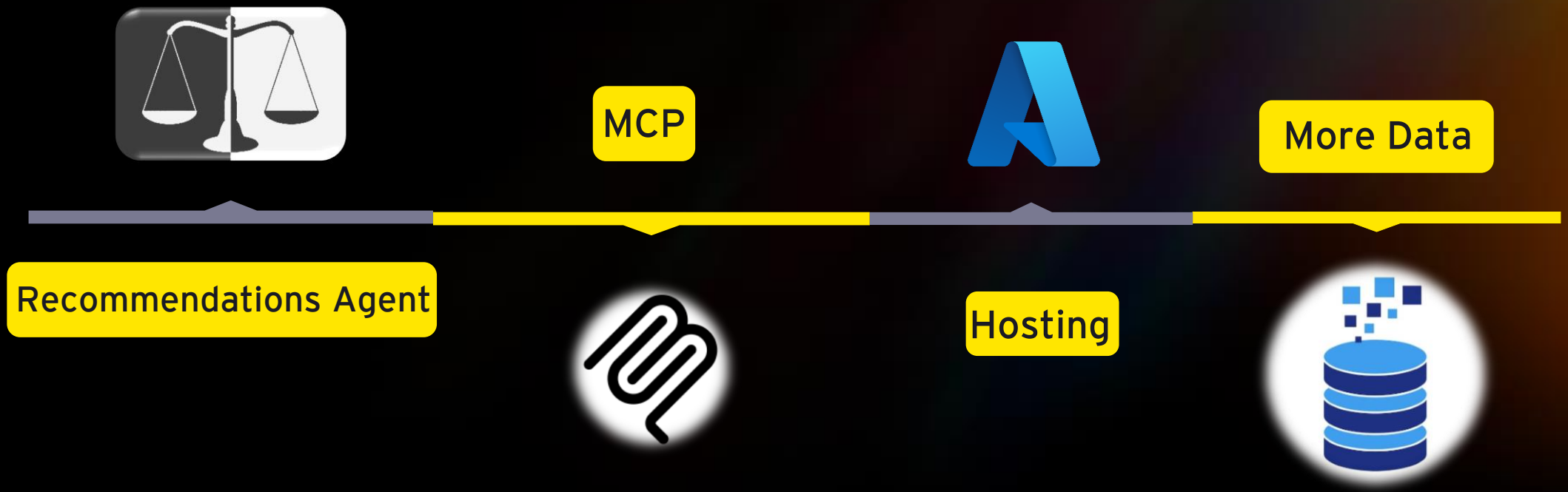
GraphRAG Retrieval Methods

Future Enhancements & Roadmap



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