

Sequential Workflows in LangGraph

Create a simple wf

Aim: Calculate BMI

```
from langgraph.graph import StateGraph, START, END
from typing import TypedDict
```

Define state:

```
class BMIState(TypedDict):

    weight_kg: float
    height_m: float
    bmi: float
```

Define functions:

```
def calculate_bmi(state: BMIState) → BMIState:
    weight = state['weight_kg']
    height = state['height_m']

    bmi = weight/(height**2)

    state['bmi'] = round(bmi, 2)

    return state
```

```
weight = state['weight_kg']  
height = state['height_m']
```

- Here, we extracted the values of weight and height from the state

```
bmi = weight/(height**2) → Calculated BMI
```

```
state['bmi'] = round(bmi, 2) → Added the BMI to state
```

Define graph:

- Make a graph object of `StateGraph` class

```
graph = StateGraph(BMIState)
```

Add nodes & edges:

```
graph.add_node('calculate_bmi', calculate_bmi)
```

```
graph.add_edge(START, 'calculate_bmi')
```

```
graph.add_edge('calculate_bmi', END)
```

Compile:

```
workflow = graph.compile()
```

Execute

```
workflow.invoke(  
    {  
        'weight_kg': 80,  
        'height_m': 1.73
```

```
}  
)
```

```
{'weight_kg': 80, 'height_m': 1.73, 'bmi': 26.73}
```

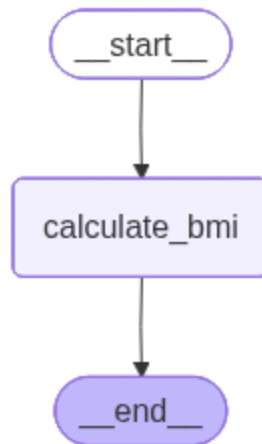
Better way to write the above code:

```
initial_state =(  
    {  
        'weight_kg': 80,  
        'height_m': 1.73  
    }  
)  
  
final_state = workflow.invoke(initial_state)  
  
print(final_state)
```

```
{'weight_kg': 80, 'height_m': 1.73, 'bmi': 26.73}
```

Visualize the graph:

```
from IPython.display import Image  
Image(workflow.get_graph().draw_mermaid_png())
```



- The code is pasted from LG documentation.

Add Fit/Overweight

- We have to add a node → `label_bmi`
- Add an attribute in the state → `category`

```
class BMIState(TypedDict):  
  
    weight_kg: float  
    height_m: float  
    bmi: float  
    category: str
```

Define node:

```
def label_bmi(state: BMIState) → BMIState:  
  
    bmi = state['bmi']  
  
    if bmi < 18.5:  
        state["category"] = "Underweight"  
    elif 18.5 <= bmi < 25:  
        state["category"] = "Normal"
```

```

elif 25 <= bmi < 30:
    state["category"] = "Overweight"
else:
    state["category"] = "Obese"

return state

```

Add node & edge:

```

graph.add_node('calculate_bmi', calculate_bmi)
graph.add_node('label_bmi', label_bmi)

graph.add_edge(START, 'calculate_bmi')
graph.add_edge('calculate_bmi', 'label_bmi')
graph.add_edge('label_bmi', END)

```

- Compile & execute

```

workflow = graph.compile()

initial_state = (
    {
        'weight_kg': 80,
        'height_m' : 1.73
    }
)

final_state = workflow.invoke(initial_state)

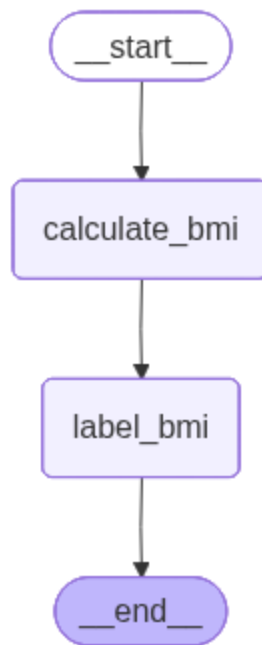
print(final_state)

```

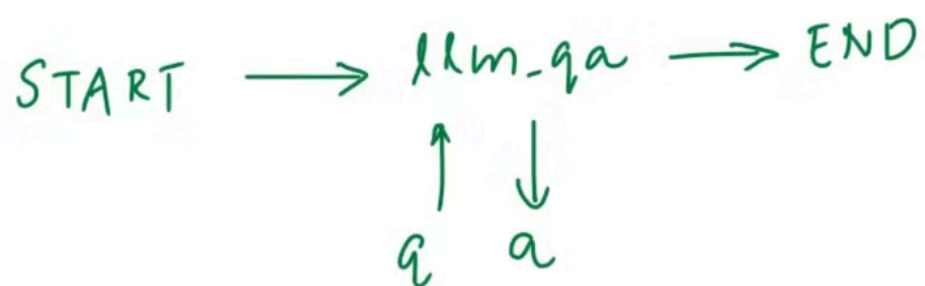
```
{'weight_kg': 80, 'height_m': 1.73, 'bmi': 26.73, 'category': 'Overweight'}
```

Visualize

```
from IPython.display import Image  
Image(workflow.get_graph().draw_mermaid_png())
```



Simple LLM Workflow



state
ques: str
ans: str

```
from langgraph.graph import StateGraph, START, END
from langchain_groq import ChatGroq
from typing import TypedDict
from dotenv import load_dotenv
```

Model:

```
model = ChatGroq(model="openai/gpt-oss-20b")
```

Create a state:

```
# create a state
```

```
class LLMState(TypedDict):
```

```
    question: str
```

```
    answer: str
```

Define function:

```
def llm_qa(state: LLMState) → LLMState:

    # Extract Q from state
    question = state['question']

    # Form a prompt
    prompt = f'Answer the following question {question}'

    # Ask that Q to the LLM
    answer = model.invoke(prompt).content

    #Update the answer in the state
    state['answer'] = answer

    return state
```

Add node & edges:

```
# create our graph

graph = StateGraph(LLMState)

# add nodes
graph.add_node('llm_qa', llm_qa)

# add edges
graph.add_edge(START, 'llm_qa')
graph.add_edge('llm_qa', END)

# compile
workflow = graph.compile()
```


Test:

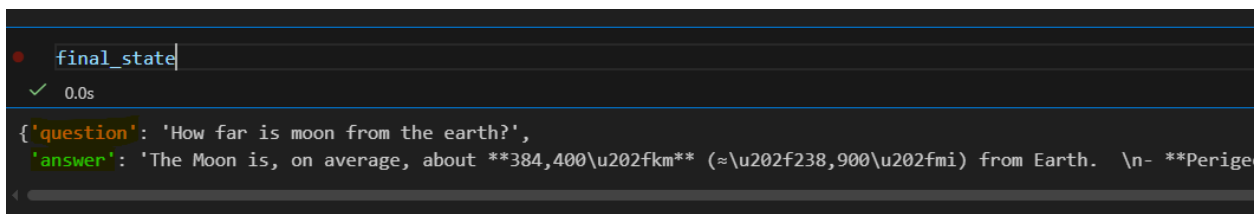
```
# execute
```

```
intial_state = {'question': 'How far is moon from the earth?'}
```

```
final_state = workflow.invoke(intial_state)
```

```
print(final_state['answer'])
```

```
The Moon is, on average, about **384,400 km** (~ 238,900 mi) from Earth.
- **Perigee (closest)**: ~ 356,500 km
- **Apogee (farthest)**: ~ 406,700 km
So the distance varies roughly from 356,500 km to 406,700 km, with an average of 384,400 km.
```



```
• final_state |
✓ 0.0s
{'question': 'How far is moon from the earth?',
 'answer': 'The Moon is, on average, about **384,400\u202fkm** (~\u202f238,900\u202fmi) from Earth. \n- **Perige
```

- `final_state` has 2 attributes → `question` & `answer`

Simple Alternative Method:

```
model.invoke('How far is moon from the earth?').content
```

```
'The Moon is about 384\u202fkm (238\u202fmi) from Earth o
```

Prompt Chaining

- We'll provide a topic → LLM will generate blog

WF: Topic → Outline → Blog

```
from langgraph.graph import StateGraph, START, END
from langchain_groq import ChatGroq
from typing import TypedDict
from dotenv import load_dotenv
```

```
model = ChatGroq(model="openai/gpt-oss-20b")
```

Define state:

```
class BlogState(TypedDict):

    title: str
    outline: str
    content: str
```

Functions:

```
def create_outline(state: BlogState) → BlogState:
    # Fetch title
    title = state['title']

    # Call LLM
    prompt = f'Generate a detailed outline for a blog on the topic - {title}'
    outline = model.invoke(prompt).content

    #Update state
    state['outline'] = outline
```

```
return state
```

```
def create_blog(state: BlogState) → BlogState:
```

```
    title = state['title']
```

```
    outline = state['outline']
```

```
    prompt = f'Write a detailed blog on the title - {title} using the following outline \n {outline}'
```

```
    content = model.invoke(prompt).content
```

```
    state['content'] = content
```

```
    return state
```

Add nodes & edges

```
graph = StateGraph(BlogState)
```

```
#nodes
```

```
graph.add_node('create_outline', create_outline)
```

```
graph.add_node('create_blog', create_blog)
```

```
#edges
```

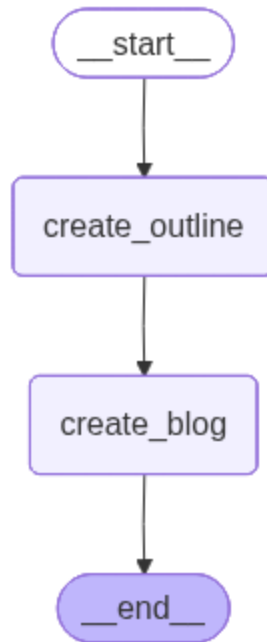
```
graph.add_edge(START, 'create_outline')
```

```
graph.add_edge('create_outline', 'create_blog')
```

```
graph.add_edge('create_blog', END)
```

Compile:

```
workflow = graph.compile()
```



Test:

```
initial_state = {  
    'title': 'rise of ai in India'  
}
```

```
final_state = workflow.invoke(initial_state)
```

```
print(final_state)
```

▼ Output:

```
{'title': 'rise of ai in India', 'outline': '**Blog Title:** \n**"From Silicon Valle  
y to Silicon Valley of India: The Rise of AI in the Subcontinent**\n\n---\n\n## 1. Introduction \n- Hook: A striking statistic or anecdote (e.g., "India's  
AI market is projected to reach $8.5\u202fbn by 2028.") \n- Brief definitio  
n of AI and why it matters today. \n- Thesis statement: India is rapidly em
```

erging as a global AI powerhouse—thanks to talent, policy, and a booming startup ecosystem.

2. Historical Context

- **Early AI research in India** (1970s–1990s):
 - IITs & BARC pioneering work.
 - First AI labs and seminal research papers.
 - **The “IT boom” era**:
 - Role of software outsourcing in building foundational data skills.
 - **Transition to AI**:
 - Shift from rule-based systems to machine learning in the 2000s.

3. Current AI Landscape in India

3.1 Market Size & Growth

- CAGR, current valuation, projected 2028–2030 figures.
- Comparison with global leaders (USA, China, EU).

3.2 Key Sectors Leveraging AI

Sector	AI Applications	Representative Companies
Healthcare	Diagnostics, drug discovery	Practo, SigTuple
Finance	Fraud detection, credit scoring	Paytm, Razorpay
Agriculture	Yield prediction, pest detection	CropIn, Ninjacart
Education	Adaptive learning, skill analytics	BYJU'S, Unacademy
Manufacturing	Predictive maintenance, robotics	Bosch, Siemens India
Smart Cities	Traffic optimization, surveillance	CityMart, Intel India

3.3 Talent Pool

- Number of AI/ML researchers, PhDs, and industry practitioners.
- Universities with top AI programs (IIT Bombay, IIT Delhi, NIT Trichy, etc.).
- Growing number of online courses and bootcamps (Coursera, Udacity, local platforms).

3.4 Startup Ecosystem

- Notable AI startups (CognitiveScale, SigTuple, Niramai, Lattice).
- Funding rounds: VC, corporate, and government investments.
- Incubators & accelerators (NASSCOM, T-Hub, Microsoft Accelerator).

4. Government Initiatives & Policy Framework

4.1 National Strategy for Artificial Intelligence (NSAI)

- Objectives: “Create a conducive environment for AI research, development, and deployment.”
- Key pillars: AI research, talent development, industry adoption, ethical AI.

4.2 AI & Data Initiatives

- **AI for All**: AI-driven public services (e.g., AI in e-Governance).
- **Data.gov.in**: Open data for AI training.
- **National AI Mission**: Funding, research grants, and collaboration with academia.

4.3 Ethical & Regulatory Landscape

- Draft AI Ethics Guidelines (Transparency, Accountability, Fairness).
- Data protection laws (DPDP Bill, GDPR influence).
- AI in critical infrastructure: guidelines for autonomous systems.

5. Education & Skill Development

- **Academic Programs**: New AI degrees (MSc in AI, PhD in Machine Learning).
- **Corporate Training**: Upskilling initiatives by TCS, Infosys,

Wipro. \n- **MOOCs & Online Platforms**: Data Science India, NPTEL. \n- **Competitions & Hackathons**: Kaggle India, AI Hackathons, NASSCOM AI Challenge. \n\n## 6. Case Studies \n1. **Practo's AI-driven Telemedicine** \n- Problem: Rural patient access. \n- Solution: NLP + image recognition for diagnostics. \n- Impact: 30% reduction in travel time. \n\n2. **SigTuple's AI for Pathology** \n- Problem: Shortage of pathologists. \n- Solution: Deep learning on histopathology images. \n- Impact: 95% accuracy, 10× faster results. \n\n3. **Niramai's AI Breast Cancer Screening** \n- Problem: Invasive mammography. \n- Solution: Thermal imaging + ML. \n- Impact: 90% detection rate, non-invasive. \n\n4. **T-Hub's AI Lab** \n- Problem: Bridging research and industry. \n- Solution: Incubation + funding for AI startups. \n- Impact: 50+ AI startups launched. \n\n## 7. Challenges & Risks \n- **Data Quality & Availability** \n- Bias, under-representation of certain demographics. \n- **Talent Gap & Brain Drain** \n- Competition for AI talent globally. \n- **Infrastructure Constraints** \n- Need for high-performance computing clusters. \n- **Ethical Concerns** \n- Privacy, surveillance, algorithmic bias. \n- **Regulatory Uncertainty** \n- Rapid tech evolution outpacing policy. \n\n## 8. The Future Outlook \n- **Emerging Trends** \n- Edge AI, federated learning, AI-in-hardware. \n- **Strategic Partnerships** \n- Collaborations with US, EU, and China. \n- **Potential Impact on GDP** \n- AI's contribution to India's economic growth. \n- **Vision 2030** \n- AI as a core driver of digital India. \n\n## 9. Take-away Insights (Bullet Points) \n- India's AI growth is fueled by a blend of talent, policy, and entrepreneurial spirit. \n- Government's proactive stance (NSAI, funding) is a key differentiator. \n- Cross-sector adoption demonstrates AI's versatility. \n- Ethical AI and data governance remain critical for sustainable growth. \n\n## 10. Conclusion \n- Recap of India's AI journey from research labs to commercial powerhouse. \n- Call to action: Encourage readers to engage—whether as policymakers, entrepreneurs, or students—to shape AI's future in India. \n\n## 11. Suggested Visuals & Interactive Elements \n- **Infographics**: AI market size growth, sector adoption heat map. \n- **Timeline**: Milestones in Indian AI history. \n- **Interactive Map**: AI startup density across Indian cities. \n- **Video Clip**: Interview with an AI startup founder. \n\n## 12. Further Reading & Resources \n- Links to NSAI whitepaper, NASSCOM AI reports, academic journals. \n- List of MOOCs and certification pro

grams. \n- Contact info for AI incubators and accelerators. \n\n--- \n\n**Note:** \n- Keep the tone accessible yet data-driven. \n- Use real statistics (cited with sources) to bolster credibility. \n- End with a compelling quote or statistic to leave readers inspired.', 'content': '**From Silicon Valley to Silicon Valley of India: The Rise of AI in the Subcontinent** \n*By [Your Name]* \n\n---\n\n#### 1. Introduction \n\n> **Hook:** "India's AI market is projected to reach **\$8.5\u202fbn** by 2028, outpacing many developed economies." [1] \n\nArtificial Intelligence (AI) is no longer a buzzword; it's a transformative force reshaping industries, governance, and everyday life. From diagnosing diseases in remote villages to powering fintech fraud detection, AI is redefining "possible." \n\n**Thesis:** India is rapidly emerging as a global AI powerhouse—thanks to a deep talent reservoir, forward-thinking policy, and a vibrant startup ecosystem that turns ideas into market-ready solutions.\n\n---\n\n#### 2. Historical Context \n\n| Era | Milestones | Key Players | Impact |\n|-----|-----|-----|-----|\n| **1970s-1990s – Early AI research** | • IITs (Bombay, Delhi) and BARC set up AI labs.
• First Indian AI papers on expert systems and knowledge bases. | *Prof. T. V. Ramakrishnan (IIT Bombay), Dr. B. S. Subrahmanyam (BARC)* | Laid the theoretical foundations; created a cadre of AI scholars. |\n| **1990s-2000s – IT boom** | • Global outsourcing hubs (Bangalore, Hyderabad) cultivated massive data-processing talent.
• Indian engineers became the "software workforce" of the world. | *Infosys, TCS, Wipro* | Built a pool of programmers who later pivoted to data science. |\n| **2000s – Transition to Machine Learning** | • Shift from rule-based expert systems to data-driven machine learning.
• Adoption of open-source libraries (e.g., TensorFlow, PyTorch) in academia and industry. | *IIT Kharagpur, IIT Madras* | Sparked the first wave of AI startups in 2010-2015. |\n\n---\n\n#### 3. Current AI Landscape in India \n\n##### 3.1 Market Size & Growth \n\n| Metric | 2023 | 2025 (forecast) | 2030 (forecast) |\n|-----|-----|-----|-----|\n| Market Value | \$4.2\u202fbn | \$6.3\u202fbn | \$10.1\u202fbn |\n| CAGR (2023-2030) | 24% | — | — |\n\n- **Global comparison:** USA (\$200\u202fbn), China (\$150\u202fbn), EU (\$70\u202fbn). India is projected to be the 4th largest AI market by 2030. [2] \n\n##### 3.2 Key Sectors Leveraging AI \n\n| Sector | AI Applications | Representative Companies |\n|-----|-----|-----|\n| **Healthcare** | Diagnostics, drug discovery, remote monitoring |

Practo, SigTuple, Niramai | **Finance** | Fraud detection, credit scoring, algorithmic trading | Paytm, Razorpay, PolicyBazaar | **Agriculture** | Yield prediction, pest detection, precision farming | CropIn, Ninjacart, AgroStar | **Education** | Adaptive learning, skill analytics, automated grading | BYJU'S, Unacademy, Vedantu | **Manufacturing** | Predictive maintenance, robotics, quality control | Bosch India, Siemens India, Lattice | **Smart Cities** | Traffic optimization, surveillance analytics, citizen services | CityMart, Intel India, CitySpark

3.3 Talent Pool

Researchers & PhDs: ~20,000 active AI/ML researchers; ~1,500 PhDs awarded annually in CS/AI. [3]

Top Academic Institutions: IIT Bombay, IIT Delhi, IIT Madras, NIT Trichy, IISc Bangalore.

Online Upskilling: Coursera (AI for Everyone), Udacity (Data Science Nanodegree), local platforms like Data Science India and NPTEL.

3.4 Startup Ecosystem

Notable AI Startups: CognitiveScale, SigTuple, Niramai, Lattice, Haptik, Zest AI.

Funding Landscape (FY 2023): \$1.5B raised across 120+ AI ventures; 30% from corporate VCs.

Incubators & Accelerators: NASSCOM AI Labs, T-Hub (Hyderabad), Microsoft Accelerator (Bangalore), Google Launchpad (Delhi).

4. Government Initiatives & Policy Framework

4.1 National Strategy for Artificial Intelligence (NSAI)

Vision: "Create a conducive environment for AI research, development, and deployment."

Pillars:

- Research & Innovation** – National AI Mission funds.
- Talent Development** – AI scholarships, AI PhD fellowships.
- Industry Adoption** – Public-private partnership (PPP) models.
- Ethical AI** – Transparent, accountable, and fair AI systems.

4.2 AI & Data Initiatives

Initiative	Purpose	Key Features
AI for All	AI-driven public services (e-Governance, health, agriculture).	Pilot projects in 10 states; 50+ AI tools deployed.
Data.gov.in	Open data portal for AI training.	1,200 datasets; 500+ APIs.
National AI Mission	Funding, research grants, academia-industry collaboration.	₹3,000Cr in 2024-25 for 20 flagship projects.

4.3 Ethical & Regulatory Landscape

Draft AI Ethics Guidelines (2023): Transparency, accountability, fairness, privacy.

Data Protection: Draft DPDP Bill (inspired by GDPR) – 2024.

Critical Infrastructure: Guidelines for autonomous systems in transportation, power, and defense.

5. Education & Skill Development

Domain

| Programs & Initiatives |-----|-----| | **Academic** | MSc in AI (IIT Bombay), PhD in Machine Learning (IISc), AI certificate (IIT Madras). | **Corporate Training** | TCS's AI Academy, Infosys' Data Science Academy, Wipro's AI Upskilling. | **MOOCs & Online Platforms** | NPTEL AI courses, Data Science India, Coursera's "AI for Everyone." | **Competitions & Hackathons** | Kaggle India, NASSCOM AI Challenge, Hackerrank AI contests.

6. Case Studies

1. **Practo's AI-driven Telemedicine** | **Problem**: Rural patients face travel barriers for specialist care. | **Solution**: NLP-powered chatbots + image recognition for triage. | **Impact**: 30% reduction in travel time, 25% cost savings for users.

2. **SigTuple's AI for Pathology** | **Problem**: Shortage of pathologists in rural hospitals. | **Solution**: Deep learning on histopathology slides. | **Impact**: 95% diagnostic accuracy; 10× faster turnaround.

3. **Niramai's AI Breast Cancer Screening** | **Problem**: Invasive, expensive mammography. | **Solution**: Thermal imaging + ML to detect tumors. | **Impact**: 90% detection rate; non-invasive, low-cost.

4. **T-Hub's AI Lab** | **Problem**: Gap between research and commercial deployment. | **Solution**: Incubation + seed funding for AI startups. | **Impact**: 50+ AI startups launched; 200+ jobs created.

7. Challenges & Risks

Challenge | Why It Matters | Mitigation Path |-----|-----|-----|

Data Quality & Availability | Biases, under-representation of minorities. | Open data initiatives, data auditing frameworks. |

Talent Gap & Brain Drain | Global competition for AI talent. | Competitive salaries, research grants, diaspora engagement. |

Infrastructure Constraints | Need for HPC clusters, GPUs. | Cloud partnerships, national data centers. |

Ethical Concerns | Privacy, surveillance, algorithmic bias. | Robust AI ethics guidelines, public consultation. |

Regulatory Uncertainty | Rapid tech evolution outpacing policy. | Adaptive regulatory sandbox, continuous policy review. |

8. The Future Outlook

Emerging Trends: Edge AI, federated learning, AI-in-hardware (ASICs).

Strategic Partnerships: Collaborations with US (MIT, Stanford), EU (EU AI Alliance), China (Baidu, Alibaba).

Economic Impact: AI could contribute up to **\$1.5** to India's GDP by 2030 (NASSCOM 2024).

Vision 2030: AI as the core engine of Digital India—smart healthcare, autonomous transport, AI-enabled governance.

9. Take-away Insights (B

bullet Points) \n\n- **Talent + Policy + Entrepreneurship** = India's AI acceleration. \n- Government's proactive stance (NSAI, funding) is a decisive differentiator. \n- Cross-sector adoption showcases AI's versatility and scalability. \n- Ethical AI and data governance are non-negotiable for sustainable growth. \n\n---\n\n### 10. Conclusion \n\nFrom the first AI research papers at IIT Bombay to today's AI-powered startups that are changing lives across the subcontinent, India's journey is a testament to the power of **people, policy, and perseverance**. As the nation strides toward a data-driven future, the collective responsibility falls on policymakers, entrepreneurs, and students alike to **ensure that AI is inclusive, ethical, and impactful**. \n\n> **"Artificial Intelligence is not a technology that will replace us; it is a technology that will amplify the human potential we already possess."** – Sundar Pichai, 2023 \n\nLet's harness this potential together. \n\n---\n\n### 11. Suggested Visuals & Interactive Elements \n\n| Visual | Purpose |\n|-----|-----|\n| **Infographic** – AI market size growth (2023-2030). | Quick data snapshot. |\n| **Timeline** – Milestones in Indian AI history. | Contextual narrative. |\n| **Interactive Map** – AI startup density across Indian metros. | Engagement & discovery. |\n| **Video Clip** – Interview with a founder of SigTuple. | Humanize the story. |\n\n---\n\n### 12. Further Reading & Resources \n\n| Resource | Link |\n|-----|-----|\n| **NSAI Whitepaper** | <https://www.nasi.gov.in/whitepaper> |\n| **NASSCOM AI Report 2024** | <https://www.nasscom.in/ai-report-2024> |\n| **AI Ethics Guidelines (Draft)** | <https://www.mha.gov.in/ai-ethics> |\n| **Data Science India** | <https://www.datascienceindia.org> |\n| **NPTEL AI Courses** | <https://nptel.ac.in/courses/AI> |\n| **T-Hub Accelerator** | <https://www.t-hub.co.in> |\n| **AI for All Pilot Projects** | <https://www.aiforall.gov.in> |\n\n---\n\n#### Sources \n\n1. **NASSCOM & KPMG, "India's AI Market Outlook 2023-2028", 2023.** \n2. **McKinsey Global Institute, "Artificial Intelligence: The Next Digital Frontier", 2024.** \n3. **IIT Research Report, "AI Research Landscape in India 2023", 2023.** \n\n**All data points are up to date as of December 2024.**

Outline:

```
print(final_state['outline'])
```

```
**Blog Title:**
**“From Silicon Valley to Silicon Valley of India: The Rise of AI in the Subcontinent”**

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## 1. Introduction
- Hook: A striking statistic or anecdote (e.g., “India’s AI market is projected to reach $8.5 b
- Brief definition of AI and why it matters today.
- Thesis statement: India is rapidly emerging as a global AI powerhouse—thanks to talent, polic

## 2. Historical Context
- **Early AI research in India** (1970s–1990s):
  - IITs & BARC pioneering work.
  - First AI labs and seminal research papers.
- **The “IT boom” era**:
  - Role of software outsourcing in building foundational data skills.
- **Transition to AI**:
  - Shift from rule-based systems to machine learning in the 2000s.

## 3. Current AI Landscape in India
### 3.1 Market Size & Growth
- CAGR, current valuation, projected 2028–2030 figures.
- Comparison with global leaders (USA, China, EU).

### 3.2 Key Sectors Leveraging AI
...
**Note:**
- Keep the tone accessible yet data-driven.
- Use real statistics (cited with sources) to bolster credibility.
- End with a compelling quote or statistic to leave readers inspired.
```

Content:

```
print(final_state['content'])
```

```

**From Silicon Valley to Silicon Valley of India: The Rise of AI in the Subcontinent**
By [Your Name]

---

### 1. Introduction

> **Hook:** **“India’s AI market is projected to reach **$8.5 bn** by 2028, outpacing many developed economies.”** [1]

Artificial Intelligence (AI) is no longer a buzzword; it’s a transformative force reshaping industries, governance, and everyday life. From

**Thesis:** India is rapidly emerging as a global AI powerhouse—thanks to a deep talent reservoir, forward-thinking policy, and a vibrant

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### 2. Historical Context

| Era | Milestones | Key Players | Impact |
|-----|-----|-----|-----|
| **1970s-1990s – Early AI research** | • IITs (Bombay, Delhi) and BARC set up AI labs.<br>• First Indian AI papers on expert systems and
| **1990s-2000s – IT boom** | • Global outsourcing hubs (Bangalore, Hyderabad) cultivated massive data-processing talent.<br>• Indian engi
| **2000s – Transition to Machine Learning** | • Shift from rule-based expert systems to data-driven machine learning.<br>• Adoption of op

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...

2. *McKinsey Global Institute, “Artificial Intelligence: The Next Digital Frontier”, 2024.*
3. *IIT Research Report, “AI Research Landscape in India 2023”, 2023.*

```