AIDS Lab II
EXP 3

AIM: Smarter cities Cognitive Computing in Government

THEORY:
Cognitive computing in government for smarter cities integrates AI, machine learning, and data analytics to create adaptive urban ecosystems that learn from interactions and data. It extends smart city concepts by enabling systems to process unstructured data, predict outcomes, and respond dynamically to changes, such as in traffic, energy use, or public safety. In government applications, this supports decision-making, citizen services, and infrastructure management by analyzing IoT sensor data, crowdsourced inputs, and historical patterns to foster collective intelligence and resilience. Key theories include connectivism for knowledge sharing via human-technology interactions and computational thinking for problem-solving in complex urban environments. For instance, cognitive systems enable predictive analytics for energy efficiency, pollution control, and transportation, transforming cities into proactive entities that adapt to citizen needs and environmental shifts. This approach aligns with government goals for sustainable development, using tools like neural networks to simulate human-like reasoning over big data.

CODE:
```
import torch
import torch.nn as nn
import torch.optim as optim
import numpy as np
# Synthetic data for smart city: features - hour, temperature, traffic_density; label - energy_consumption
(higher during peak hours/hot weather)
np.random.seed(42)
num_samples = 200
hours = np.random.uniform(0, 24, num_samples)
temps = np.random.uniform(15, 35, num_samples)
traffic = np.random.uniform(0, 1, num_samples)
X = np.column_stack((hours, temps, traffic))
# Synthetic rule: energy = base + peak_hour_factor + temp_factor + traffic_factor, with noise
peak_hour = np.where((hours >= 7) & (hours <= 9) | (hours >= 17) & (hours <= 19), 1, 0)
energy = 50 + 20 * peak_hour + 2 * (temps - 15) + 30 * traffic + np.random.normal(0, 5, num_samples)
X_tensor = torch.from_numpy(X).float()
y_tensor = torch.from_numpy(energy).float().unsqueeze(1)
# Define the neural network model
class EnergyPredictor(nn.Module):
    def __init__(self):
        super().__init__()
        self.fc1 = nn.Linear(3, 16)
        self.fc2 = nn.Linear(16, 8)
        self.fc3 = nn.Linear(8, 1)
    def forward(self, x):
        x = torch.relu(self.fc1(x))
        x = torch.relu(self.fc2(x))
        x = self.fc3(x)
        return x
```

```
model = EnergyPredictor()
criterion = nn.MSELoss()
optimizer = optim.Adam(model.parameters(), lr=0.01)
# Train the model
epochs = 500
for epoch in range(epochs):
    optimizer.zero_grad()
    outputs = model(X_tensor)
    loss = criterion(outputs, y_tensor)
    loss.backward()
    optimizer.step()
    if (epoch + 1) % 100 == 0:
        print(f'Epoch [{epoch+1}/{epochs}], Loss: {loss.item():.4f}')
# Test the model with sample inputs
test_samples = [
    [8.0, 25.0, 0.8],  # Peak hour, moderate temp, high traffic
    [12.0, 20.0, 0.3], # Midday, cool, low traffic
    [18.0, 30.0, 0.9]  # Evening peak, hot, high traffic]
test_tensor = torch.tensor(test_samples).float()
predictions = model(test_tensor)
print('\nTest Predictions (energy consumption):')
for i, pred in enumerate(predictions):
    print(f'Sample {i+1}: {pred.item():.2f}')
```

OUTPUT:

```
Epoch [100/500], Loss: 302.7948
Epoch [200/500], Loss: 227.2705
Epoch [300/500], Loss: 203.7278
Epoch [400/500], Loss: 178.9177
Epoch [500/500], Loss: 150.8095

Test Predictions (energy consumption):
Sample 1: 91.83
Sample 2: 71.18
Sample 3: 109.17
```

CONCLUSION:

This application showcases how cognitive computing empowers governments in smarter cities by enabling data-driven predictions for efficient resource management, such as energy optimization to reduce costs and emissions. It aligns with broader benefits like enhanced urban resilience, citizen engagement, and sustainable governance through adaptive learning systems. While basic, scaling this with real IoT data and advanced AI could revolutionize city operations; future work should address challenges like data privacy and integration for truly cognitive urban environments.