QUANTUM RISK
ANALYTICS, INC.

Pandemonium

Adaptive Socioeconomic-Epidemiological Model for Optimal Pandemic Response

Introduction: The problem

• Pandemics disrupt not only public health but also economic stability.

• Traditional models, such as compartimental epidemiological models and equilibrium macroeconomic models, fail to capture real-world cascading effects.

• We propose an adaptive model integrating epidemiology, supply chains, and behavioral economics.

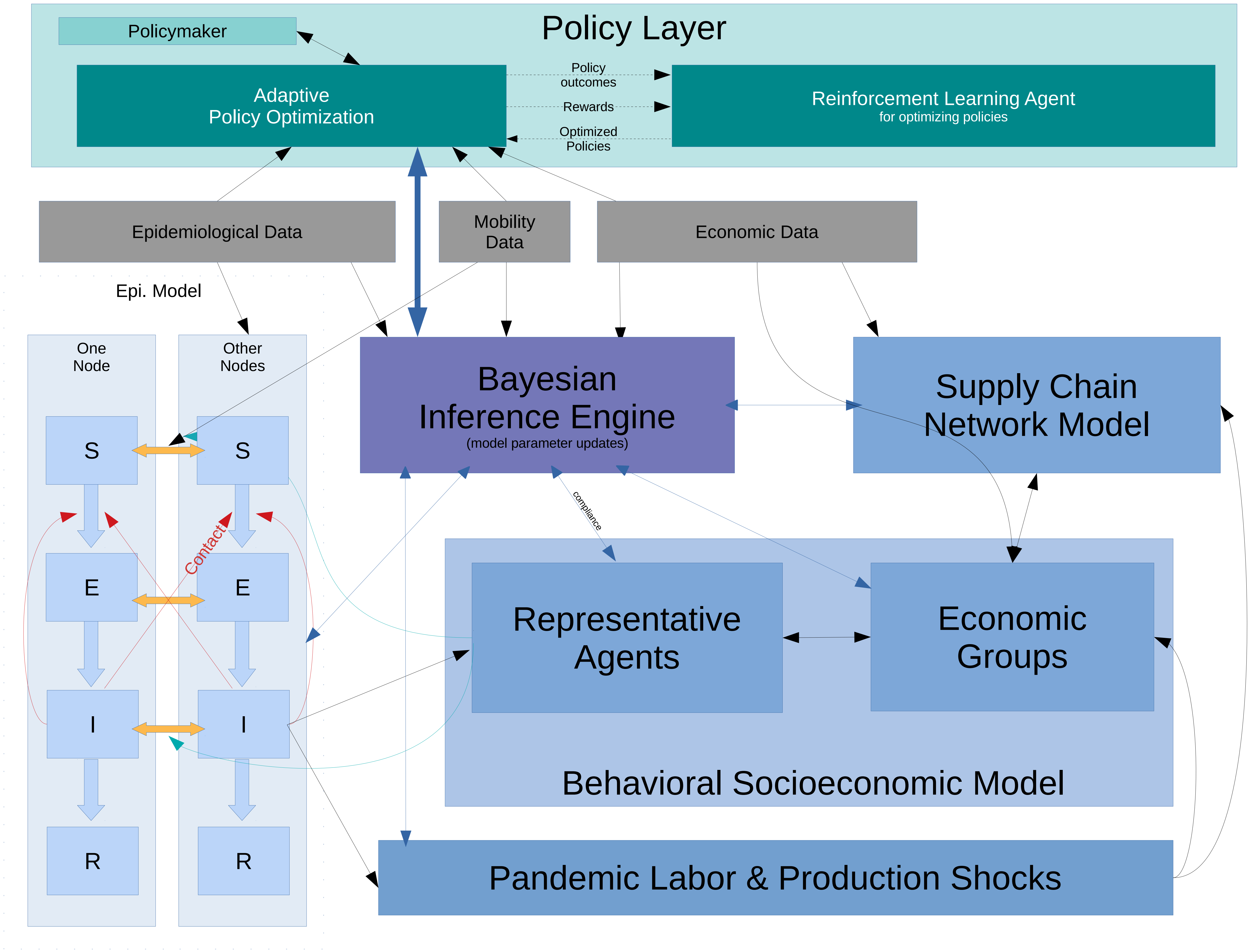
Limitations of existing models

- **Compartimental**, such as **Susceptible-Infected-Removed** (**SIR**): Only models disease spread, no economic integration.
- **Dynamic Stochastic General Equilibrium** (**DSGE**): Assumes economic equilibrium, ignores sudden shocks.
- **Hybrid models**: Lack dynamic behavioral and supply chain disruptions.
- No real-time adaptive policy optimization.

Our Model: A hybrid adaptive approach

- Nested agent-population structure for **epidemiological dynamics**.
- **Supply chain** network modeling with dynamic disruptions.
- **Behavioral economics** integration (panic buying, labor shifts).
- **Bayesian inference** updates real-time parameters.
- **Reinforcement Learning (RL)** optimizes intervention policies.

	Traditional SEIR model	DSGE economic Model	Proposed Adaptive Model
Epidemiological modeling	Basic SEIR compartments; assumes homogeneous population	Considers labor supply effects from pandemics	Stochastic Heterogeneous Regional SEIR with nested compartments by sector and risk group
Economic modeling	No economic modeling included	Equilibrium-based macroeconomic framework	Dynamic supply chain network, sectoral production shocks, representative agent groups
Behavioral economics	Not considered	Assumes rational agents, ignore panic behaviors	Includes adaptive behaviors (panic buying, labor shifts)
Supply chains disruptions	Not included	Models supply constraints but assumes smooth recovery	Explicitly models cascading supply chain failures
Policy adaptations	No adaptation	Predefined policy scenarios	Bayesian Inference +RL for real-time policy optimization
Scalability	Scales well but lacks economic realism	Scale well without sectoral granularity but not with	Scales across regional/national/global networks
Computational complexity	Low complexity, computationally efficient	Moderate-high complexity, relies on strong theoretical assumptions but often computationally optimized	Balanced: Computationally feasible with high adaptability



Policy Layer
Policymaker
Adaptive
Policy Optimization
Policy
outcomes
Rewards
Optimized
Policies
Reinforcement Learning Agent
for optimizing policies
Epidemiological Data
Mobility
Data
Economic Data
Epi. Model
One
Node
Other
Nodes
S
S
E
E
I
I
R
R
Contact
Bayesian
Inference Engine
(model parameter updates)
compliance
Supply Chain
Network Model
Representative
Agents
Economic
Groups
Behavioral Socioeconomic Model
Pandemic Labor & Production Shocks

Model Architecture: Key Components

- **Epidemiology**: Stochastic Heterogeneous Regional SEIR model with nested compartments and Bayesian Inference.
- **Economics**: Supply chain disruptions + adaptive labor market with Bayesian Inference, integrated with Epidemiological model.
- **Decision Layer**: RL for dynamic policies.

Expected Outcomes and Applications

- Improved pandemic response policies.
- Economic resilience by anticipating supply chain disruptions.
- Real-time decision support for policymakers and businesses.
- Scalable framework applicable to various crisis scenarios.