Formal Model to Integrate Multi-Agent System and Interactive Graphic Systems

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Abstract:

•A formal grammar-based model is presented to integrate the essential characteristics of a Multi-Agent System with the visualization given by an Interactive Graphic Systems.

•This model adds several advantages, such as the separation between the implementation of the system activity and the hardware devices, or the easy reusability of components.

Grammar

Let M=<Σ,N,R,s> a grammar where:

$\Sigma = P \cup T \cup O \cup A^{D}_{ST}$

N = { WORLD,OBJECTS, OBJECT, AGENT, TRANFOR, FIGURE}

s = WORLD

R is the set of grammar rules defined as:

1.WORLD → OBJECTS

2.OBJECTS → OBJECT | OBJECTS ·OBJECTS

3.OBJECT → FIGURE | TRANSFOR | AGENT

4.AGENT → a^{d}_{st}(OBJECTS), $a^{d}_{st} \in A^{D}_{ST}$, $d \in D$, $st \in ST$

5.TRANSFOR → t(OBJECTS), $t \in T$

6.FIGURE → p^{+}, $p \in P$

Evolution

Evolution function λ:

$$\lambda(a^{d}_{st}(v), e^{f}) = \begin{cases} u \in L(M) & \text{if } f = d \\ a^{d}_{st}(v) & \text{if } f \neq d \end{cases}$$

Function System Evolution η:

$$\eta(w, e^{v}) = \begin{cases} w & \text{if } w \in P \\ t(\eta(y, e^{v})) & \text{if } w = t(y) \\ \prod_{\forall f \in v} (\lambda(a^{f}_{st}(\eta(y, e^{v})), e^{f})) & \text{if } w = a^{f}_{st}(y) \\ \eta(s, e^{v}) \cdot \eta(t, e^{v}) & \text{if } w = s \cdot t \end{cases}$$

Visualization function θ:

$$\theta(a^{d}_{st}(v), e^{f}) = \begin{cases} u \in L(E) & \text{if } f = d \\ \epsilon & \text{if } f \neq d \end{cases}$$

Function System Visualization π:

$$\pi(w, e^{v}) = \begin{cases} w & \text{if } w \in P \\ t(\pi(y, e^{v})) & \text{if } w = t(y) \\ \prod_{\forall f \in v} (\theta(a^{f}_{st}(\pi(y, e^{v})), e^{f})) & \text{if } w = a^{f}_{st}(y) \\ \pi(x, e^{v}) \cdot \pi(y, e^{v}) & \text{if } w = x \cdot y \end{cases}$$

Events

D is the set of all type events

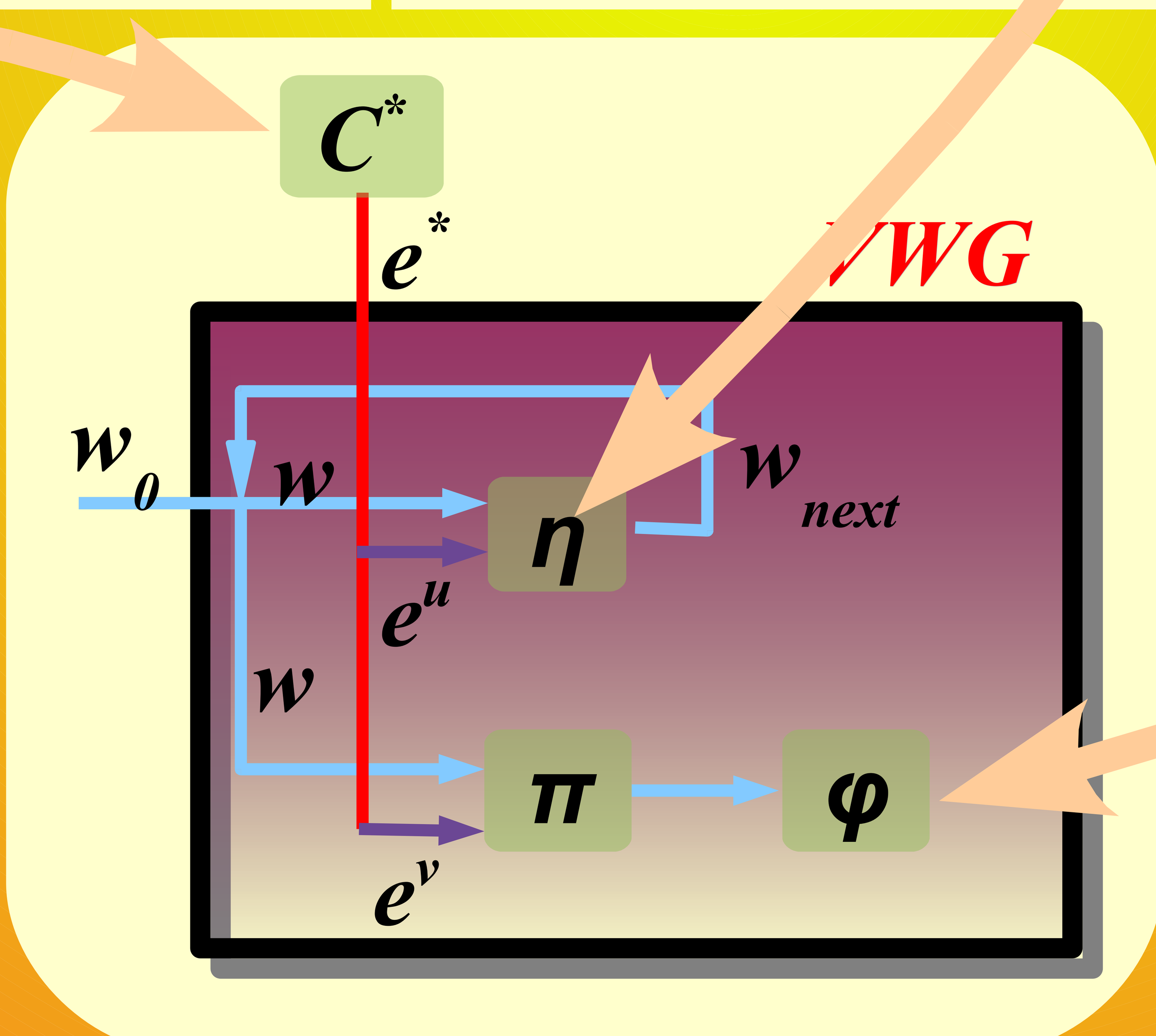
$C^{d}(t)$ generator which create events type of $d \in D$

C^{*} is the set of all event generators associated with input device

Type of event

e^{d}

Event data



Render

φ is render function defined as:

$$\varphi(w) = \begin{cases} \alpha(w) & \text{if } w \in P \\ \beta(t);\varphi(v);\delta(t) & \text{if } w = t(v) \wedge v \in L(M) \wedge t \in T \\ \varphi(s);\varphi(v) & \text{if } w = s \cdot v \wedge s, v \in L(M) \end{cases}$$

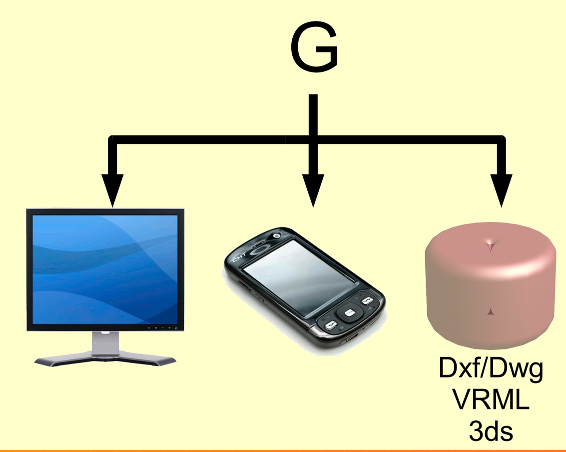
P: Primitives

T: Transfor.

α: P → G

β: T → G

δ: T → G



Case of Study

Evolution Functions

$$\lambda(BO^{cfe}, e^{i}) = \begin{cases} TR^{t=1}_{s_1} \cdot BO^{cfe} & i = c \\ FA^{t=1} \cdot BO^{cfe} & i = f \\ BO^{cfe} & i = e \\ BO^{cfe} & i \neq cfe \end{cases}$$

$$\lambda(FA^{t}_{\langle f+1 \rangle}, e^{i}) = \begin{cases} FA^{t}_{\langle f+1 \rangle} & i = t \wedge f+1 < N \\ \varepsilon & i = t \wedge f+1 \geqslant N \\ FA^{t}_{\langle f \rangle} & i \neq t \end{cases}$$

$$\lambda(TR^{tb}_{\langle s,f \rangle}, e^{i}) = \begin{cases} TR^{tb}_{\langle s,f+1 \rangle} & i = t \wedge f+1 < N \wedge s = s_1 \\ TR^{tb}_{\langle s2,N \rangle} & i = t \wedge f+1 \geqslant N \wedge s = s_1 \\ TR^{tb}_{\langle s3,N \rangle} & i = b \wedge s = s_2 \\ TR^{tb}_{\langle s3,f-1 \rangle} & i = t \wedge f \geqslant 0 \wedge s = s_3 \\ \varepsilon & i = t \wedge f = 0 \wedge s = s_3 \\ TR^{tb}_{\langle s,f \rangle} & i \neq b, t \end{cases}$$

Visualization Functions

$$\pi(BO^{v}, e^{i}) = \begin{cases} BO & i = v \\ \varepsilon & i \neq v \end{cases}$$

$$\pi(FA^{v}_{\langle f \rangle}, e^{i}) = \begin{cases} D_{(i,j)}(FA) & i = v \\ \varepsilon & i \neq v \end{cases}$$

$$\pi(TR^{v}_{\langle s,f \rangle}, e^{i}) = \begin{cases} D_{(i,j)}(S_{(f)}(TR)) & i = v \wedge s = s_1 \\ D_{(i,j)}(TR) & i = v \wedge s = s_2 \\ D_{(i,j)}(S_{(-f)}(TR)) & i = v \wedge s = s_3 \\ \varepsilon & i \neq v \end{cases}$$

This example is an application to simulate fires in forests caused by lightning