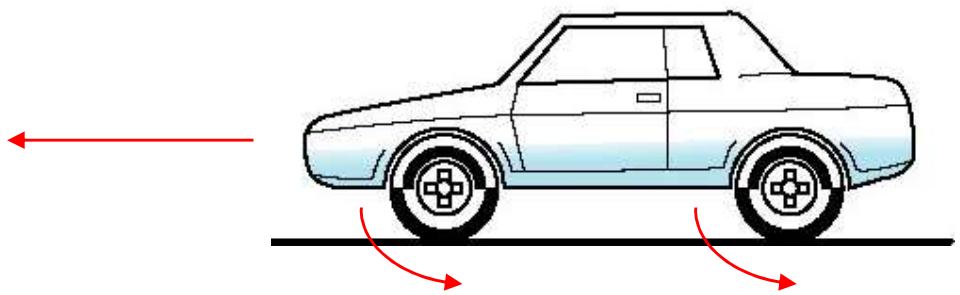
Grafo de Cena

Motivação:
Modelo de um carro

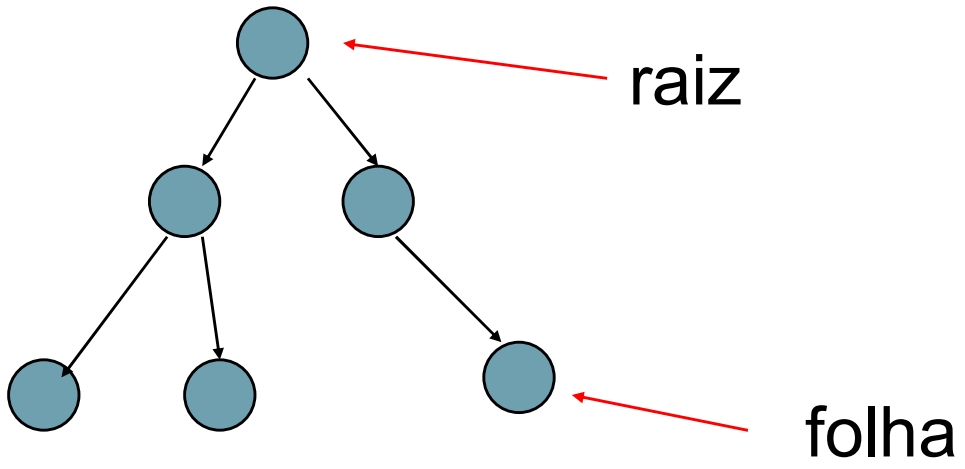
Chassis e quatro rodas

Movimento do carro e rotação das rodas relacionados

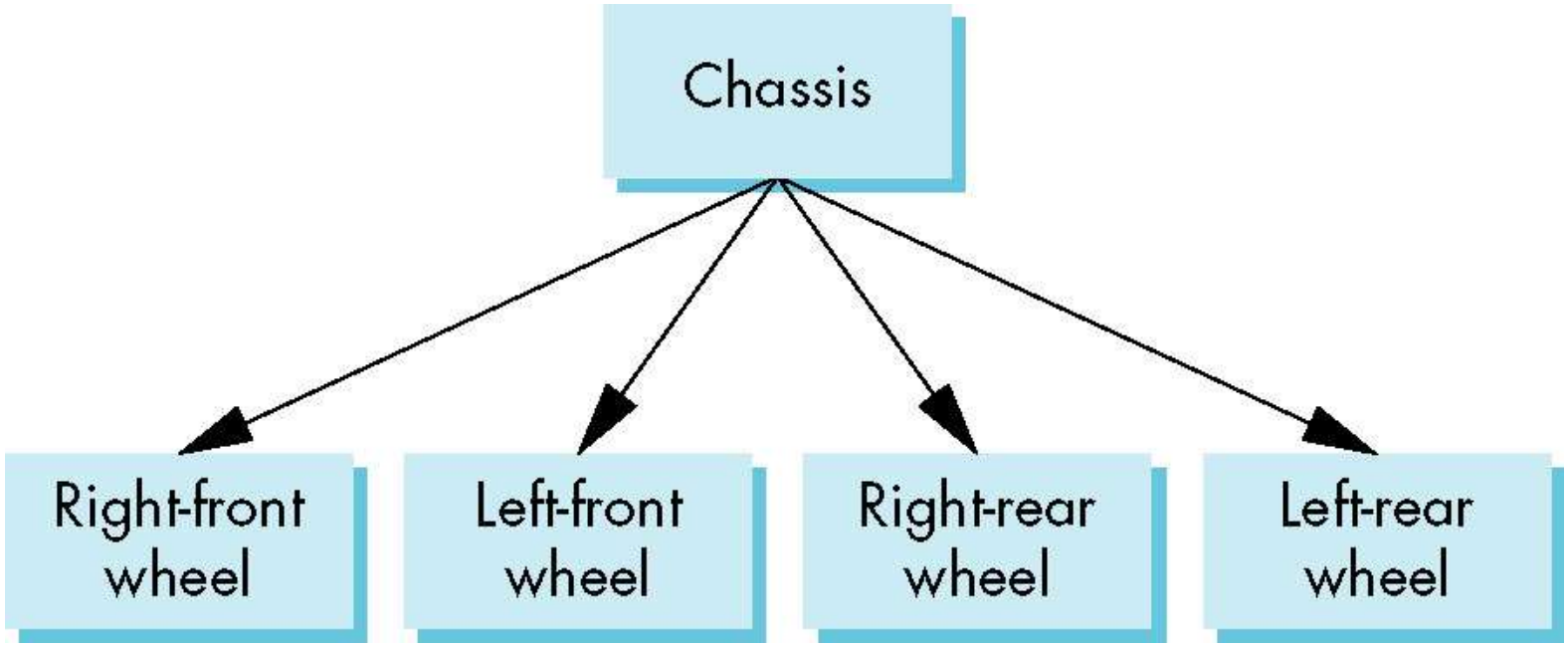


Grafo de Cena

- Cada nó (excepto raiz) tem exactamente um *parent*
  - Pode ter inúmeros filhos
  - Folha não tem filhos (usualmente é uma primitiva)

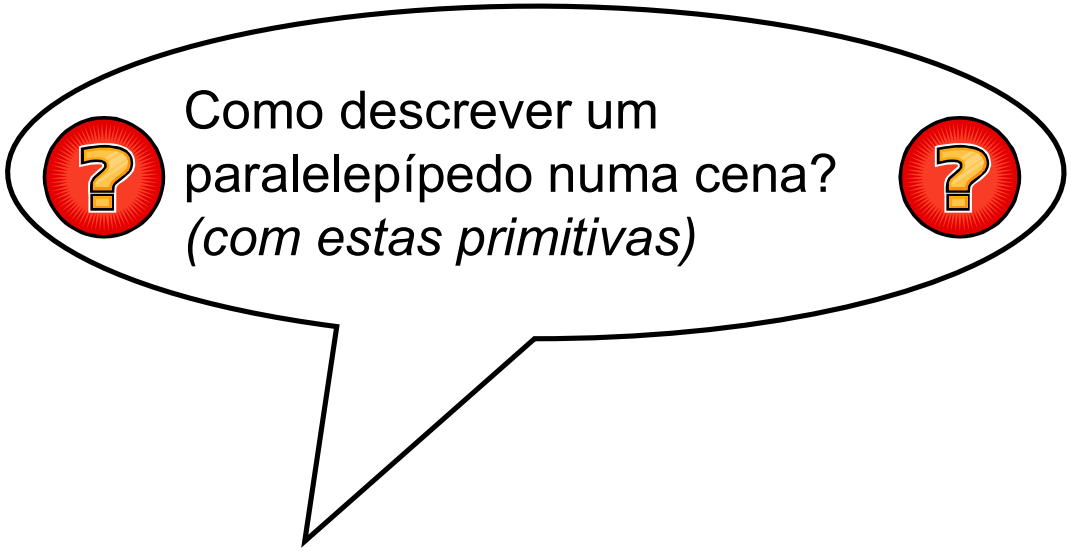


Grafo do Carro



Grafo de Cena

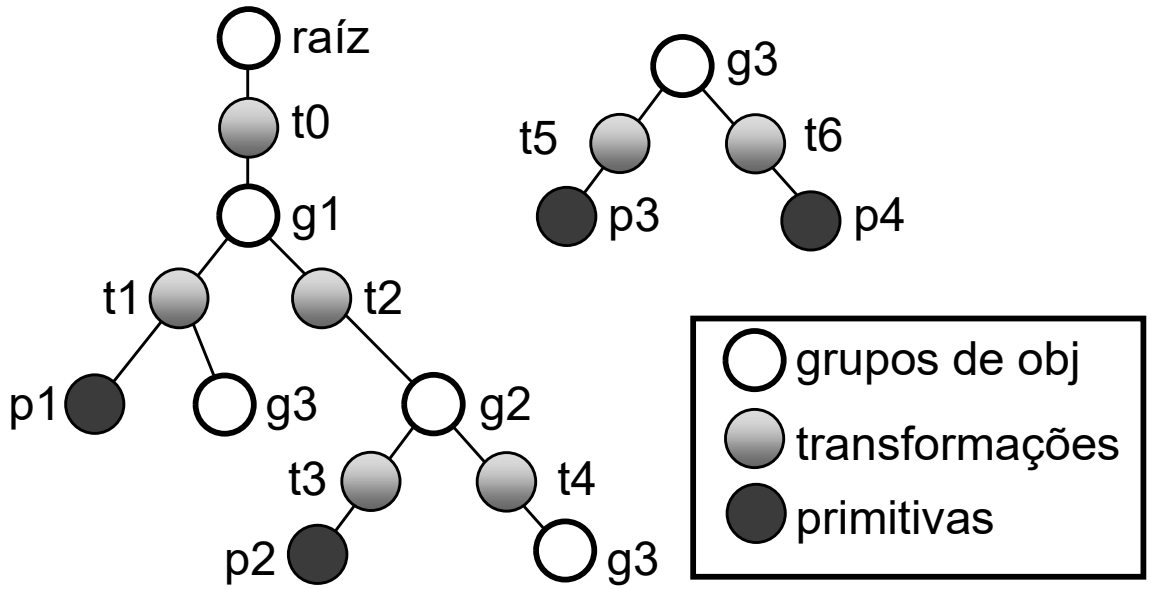
- Cenas 3D armazenadas em *DAG*
  - Grafo de Cena
    - Java3D
    - VRML
    - OpenSceneGraph
    - OpenSG



- Grafo de Cena contém
  - Objectos (primitivas gráficas)
    - Cubos, esferas, cones, superfícies,....
    - Atributos e Transformações

Transformações em Grafos de Cena

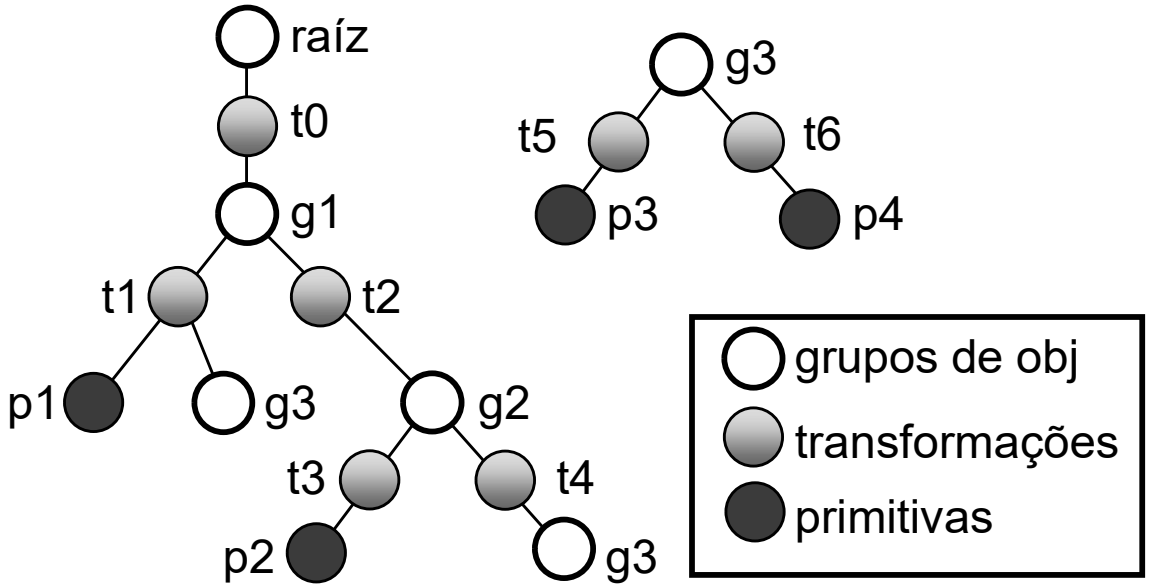
Exemplo de um Grafo de Cena



- Neste grafo de cena
  - A transformação *t0* afecta ***todos*** os objectos
  - Enquanto *t2* só afecta *p2* e uma instância do grupo *g3*
    - *t2* não afecta *p1* e a outra instância de *g3*

Múltipla Instanciação

Exemplo de um Grafo de Cena

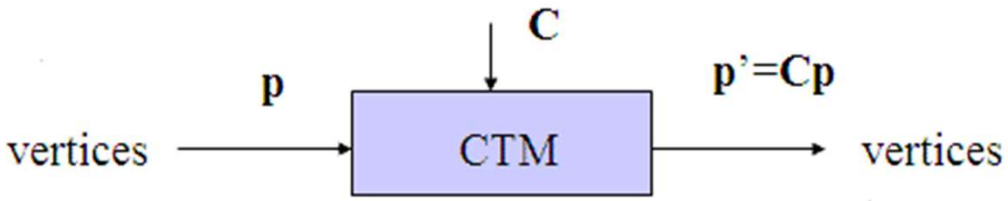


- Múltiplas instâncias de uma *sub-árvore*
  - Podem utilizar-se várias
  - É necessário *definir* antes de *instanciar*
    - Mais simples de concretizar

Transformações Hierárquicas (1/2)

Matriz de Transformação Corrente (CTM)

Matriz a aplicar a todos os vértices



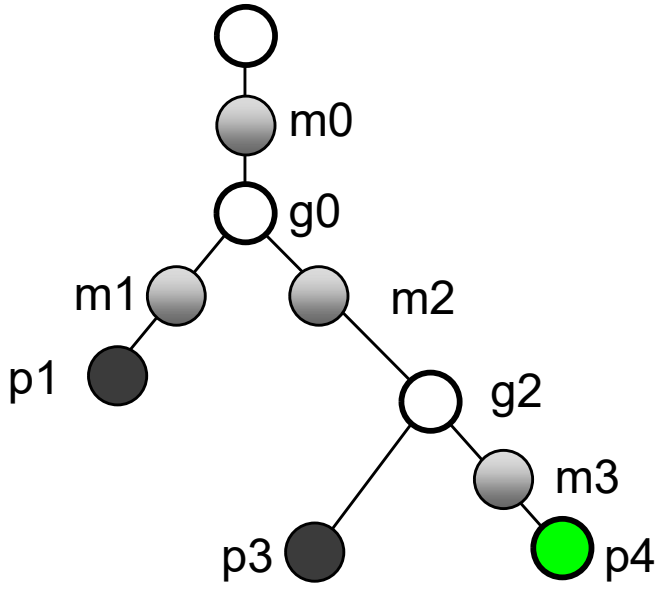
Cálculo da CTM

Concatenação de **todas** as transformações em nós superiores no caminho

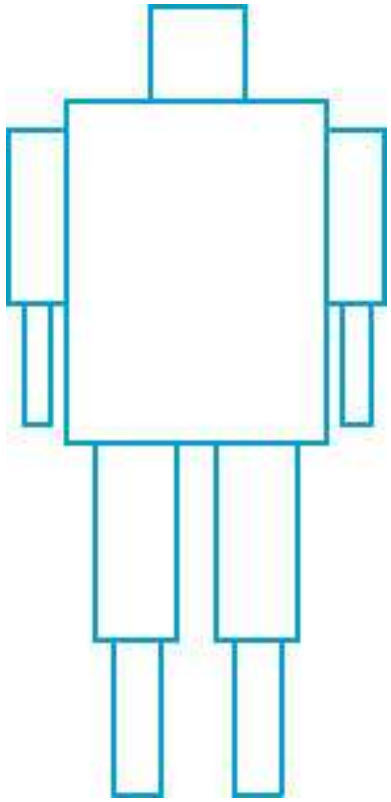
Transformações Hierárquicas (2/2)

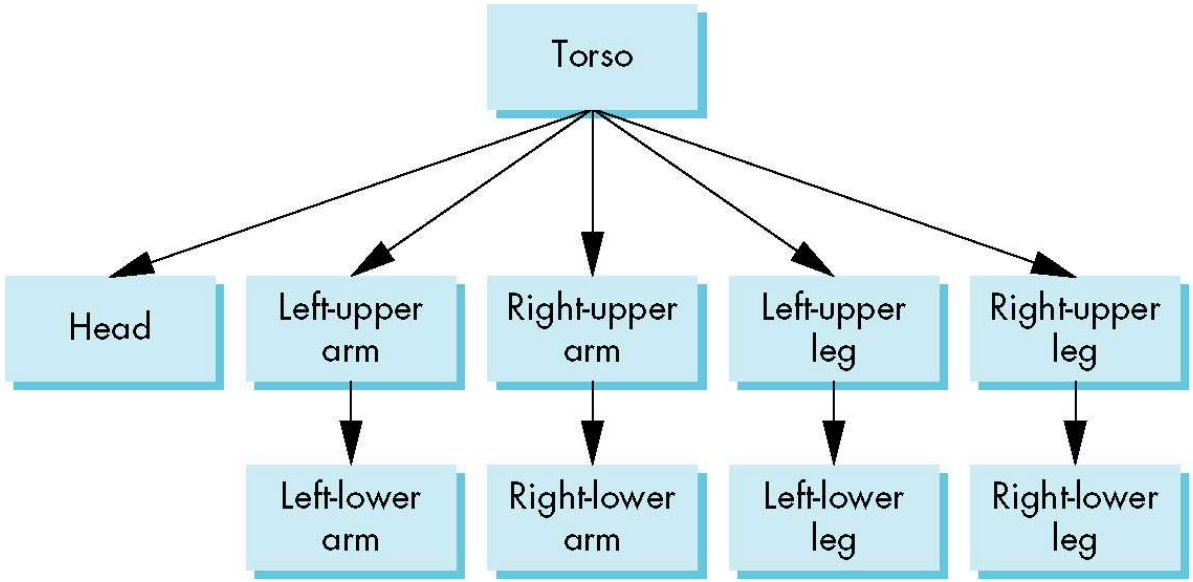
Exemplo

- No grafo
  - para g_0, temos MTC = m_0
  - para p_1, MTC = $m_0 * m_1$
  - para p_3, MTC = $m_0 * m_2$
  - para p_4, MTC = **?**
- Em que
  - m_i - matriz de transformação
  - p_i - primitiva associada ao nó i
  - g_i - sub-árvore com raíz em i



Grafo para um Robot



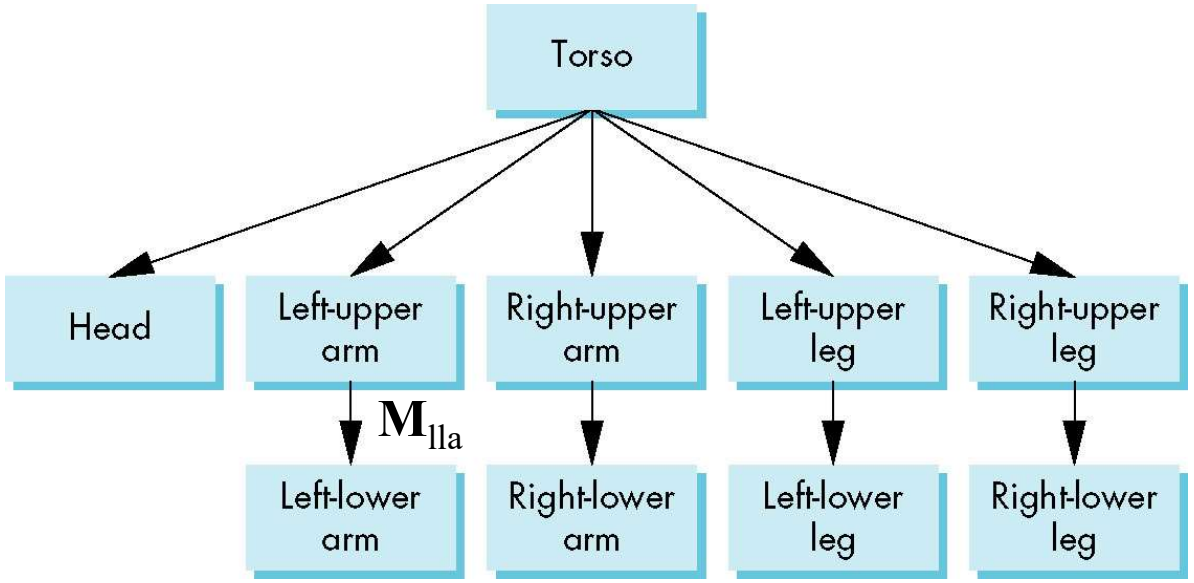


Realizar o Robot

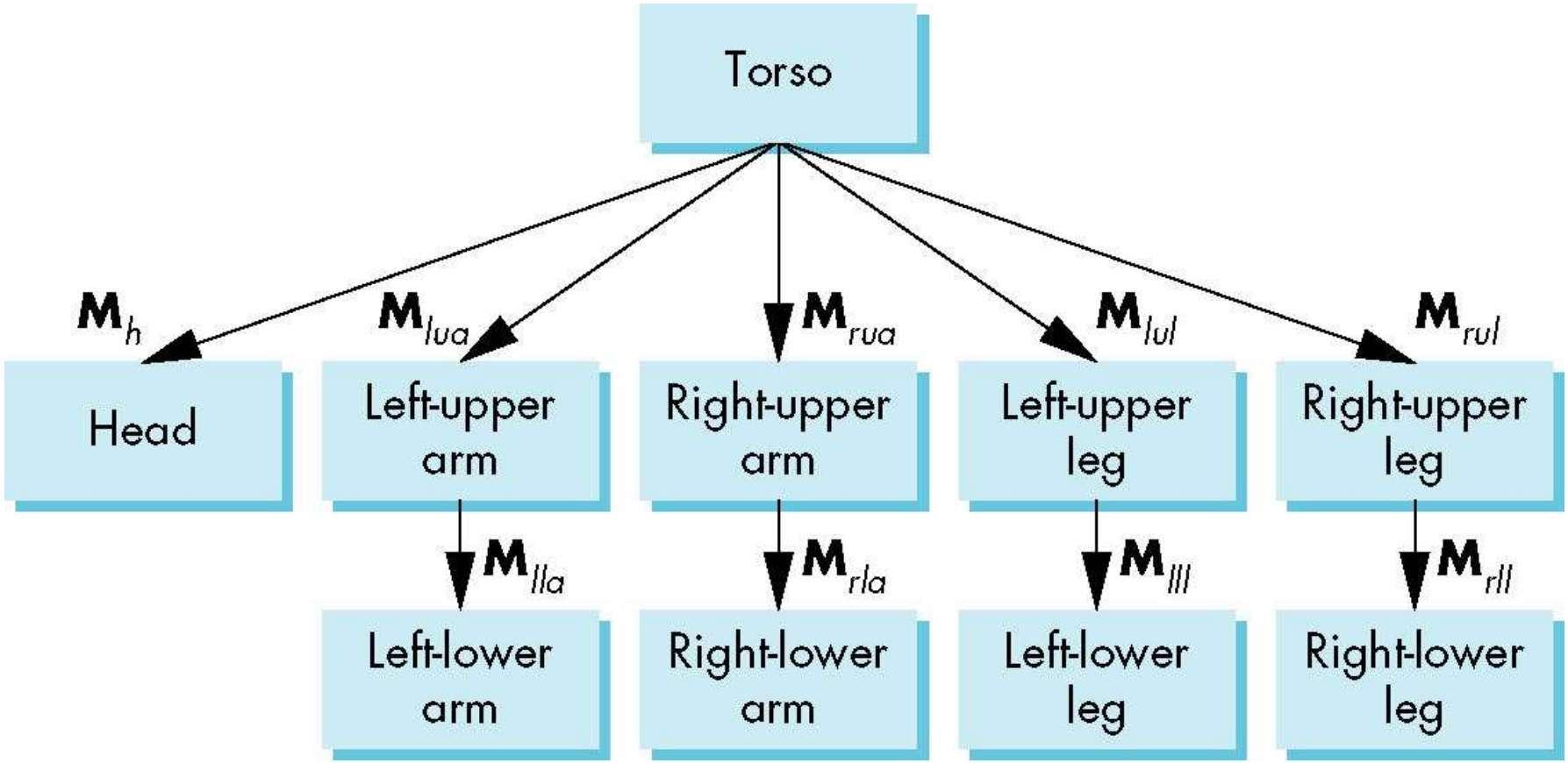
Primitivas Geométricas Simples (e.g. *boxes*)

Matrizes descrevem posição e orientação do nó relativamente ao seu *pai*

$\mathbf{M}_{lla}$ posiciona left lower arm relativamente ao left upper arm



Grafo com Matrizes

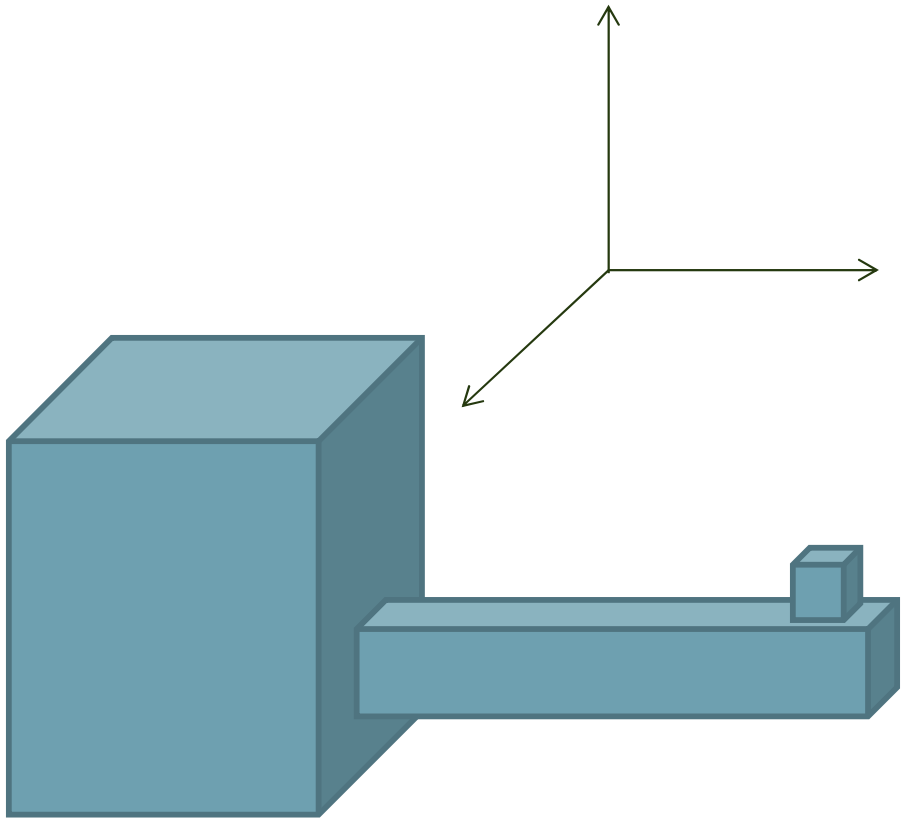


Transformações Geométricas

Construção de uma cena em Three.js

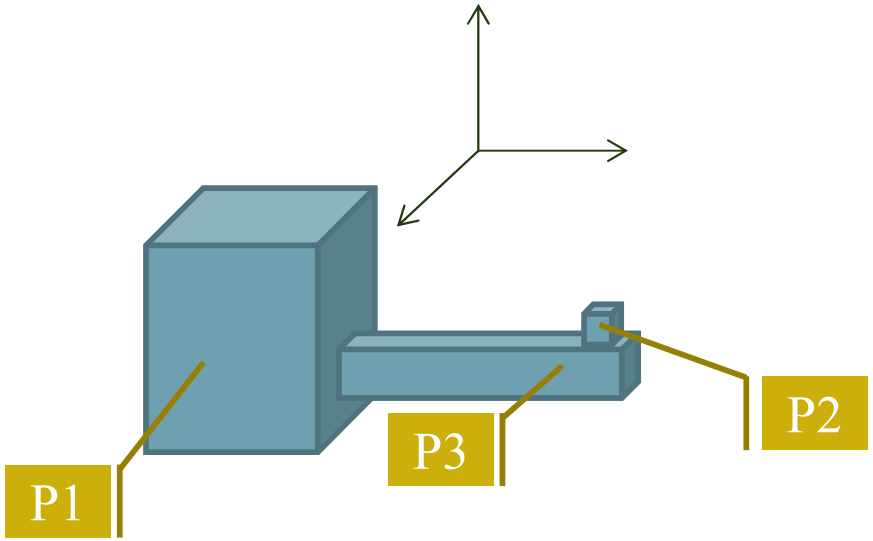
Modelação

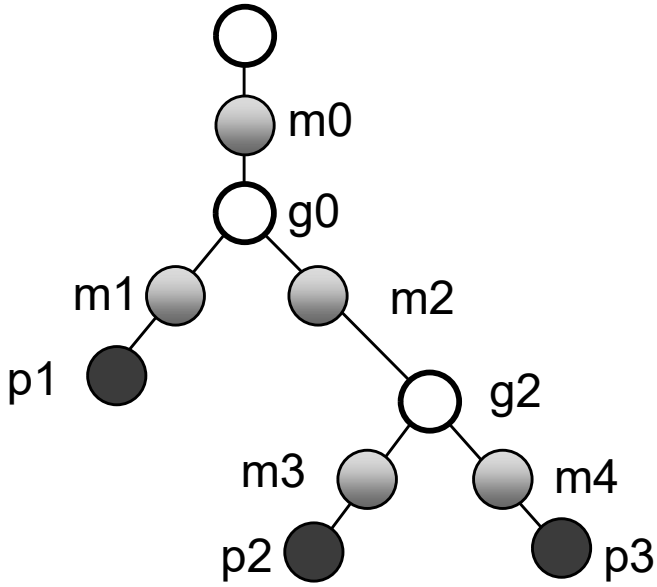
Um exemplo



Modelação

Um exemplo

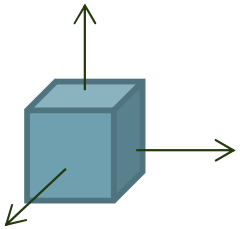


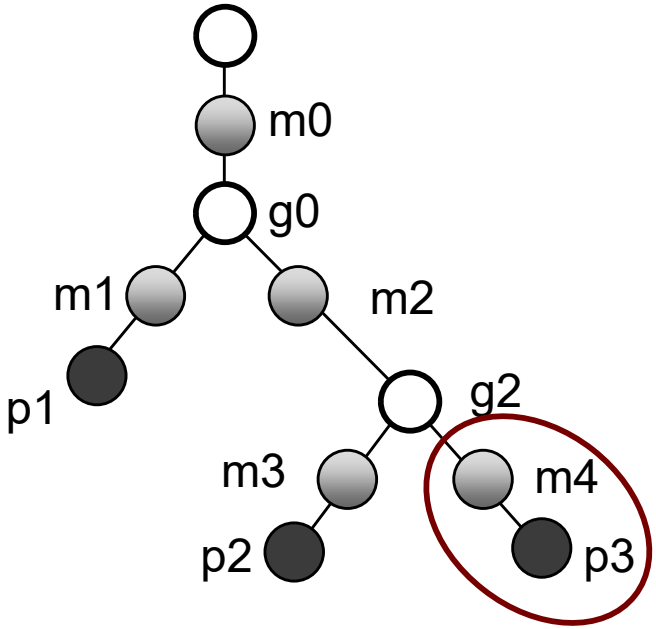


- Primitivas (***P1***, ***P2*** e ***P3***)
  - Cubo Unitário
- Transformações
  - Translação e Escala

Modelação

Um exemplo

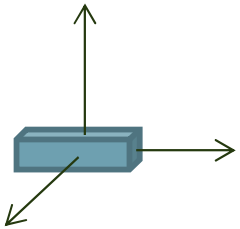


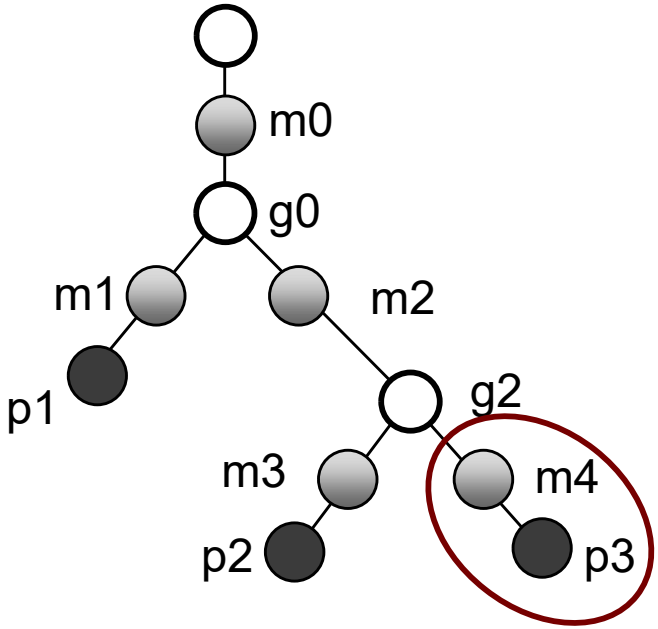


- P3 = Cubo Unitário
- M4 = Escala

Modelação

Um exemplo

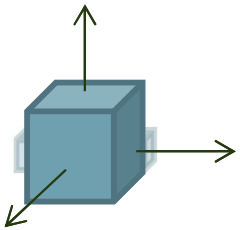


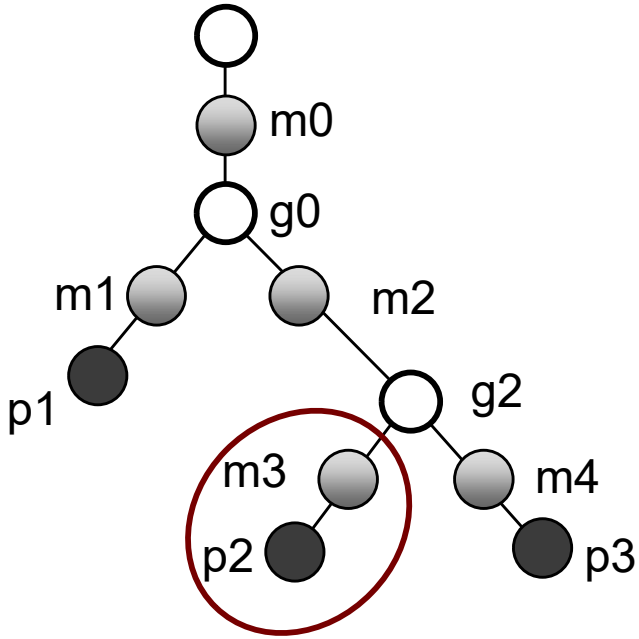


- P3 = Cubo Unitário
- M4 = Escala

Modelação

Um exemplo



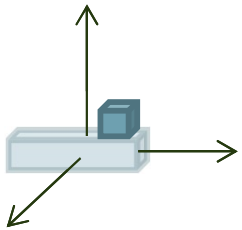


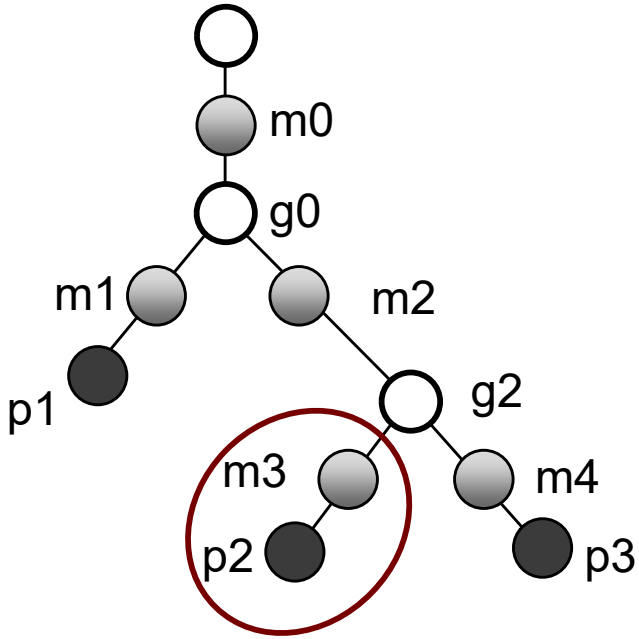
P2 = Cubo Unitário

M3 = Escala seguida de Translação

Modelação

Um exemplo



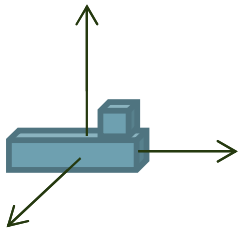


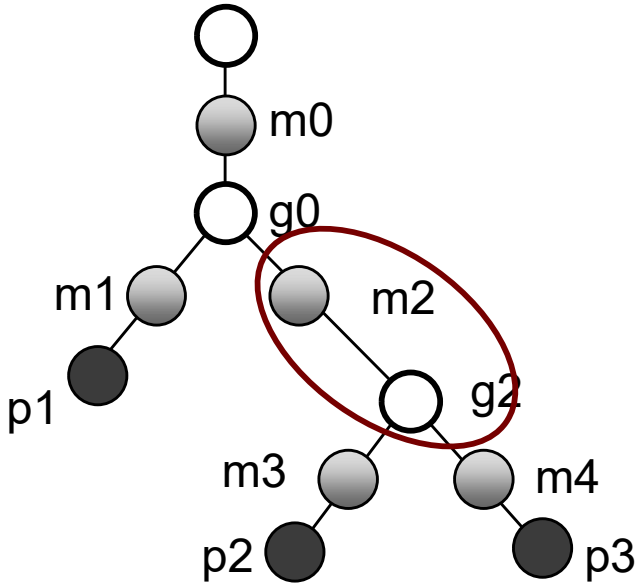
P2 = Cubo Unitário

M3 = Escala seguida de Translação

Modelação

Um exemplo



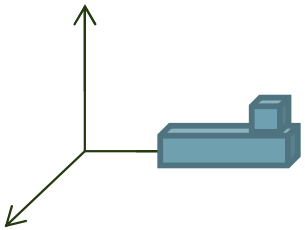


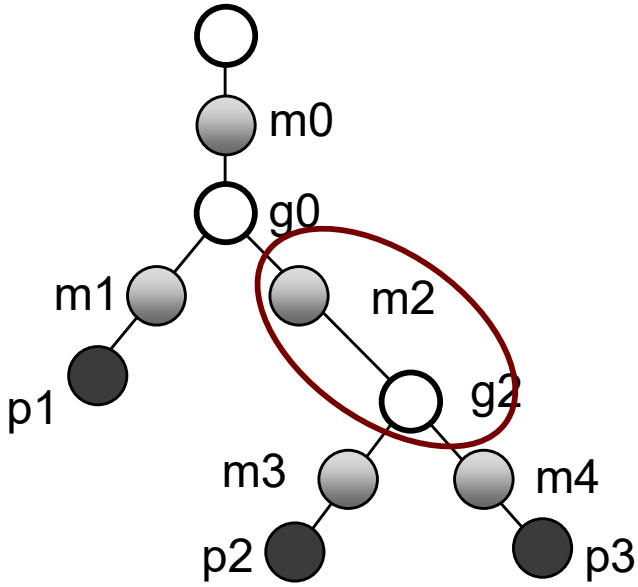
G2 = composição de duas primitivas

M2 = Translação

Modelação

Um exemplo



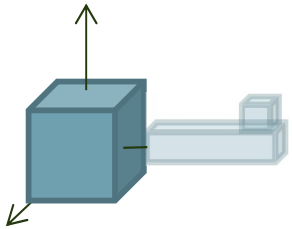


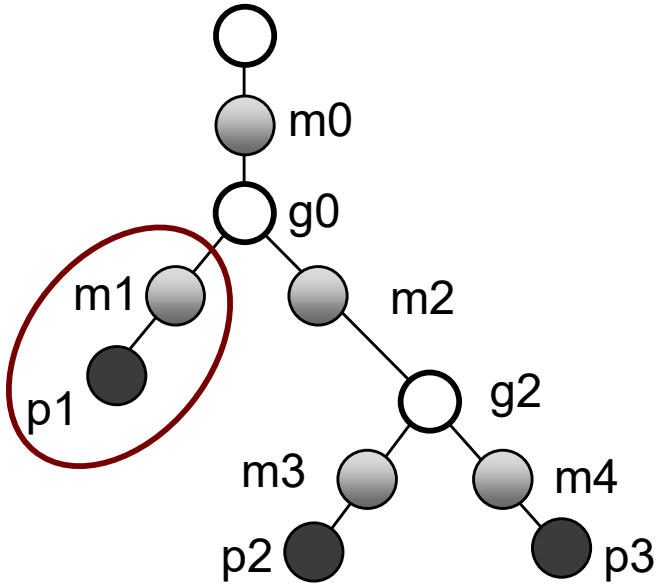
G2 = composição de duas primitivas

M2 = Translação

Modelação

Um exemplo

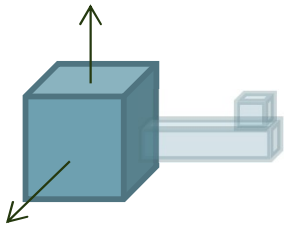


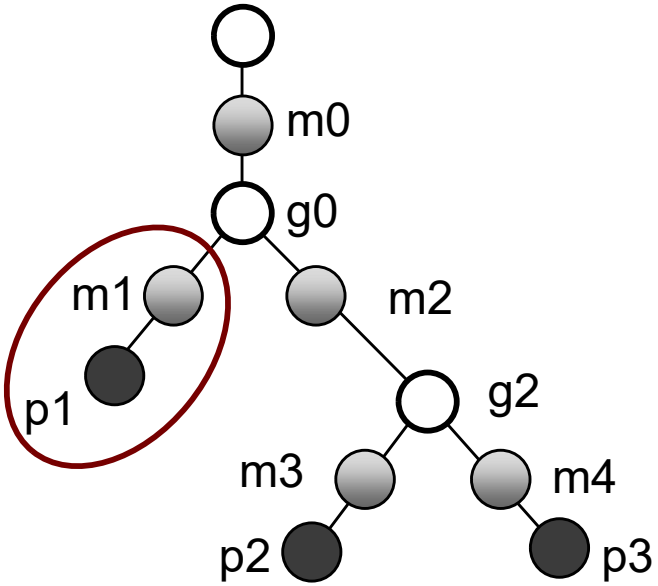


- P1 = Cubo Unitário
- M1 = Escala

Modelação

Um exemplo



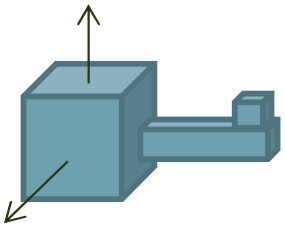


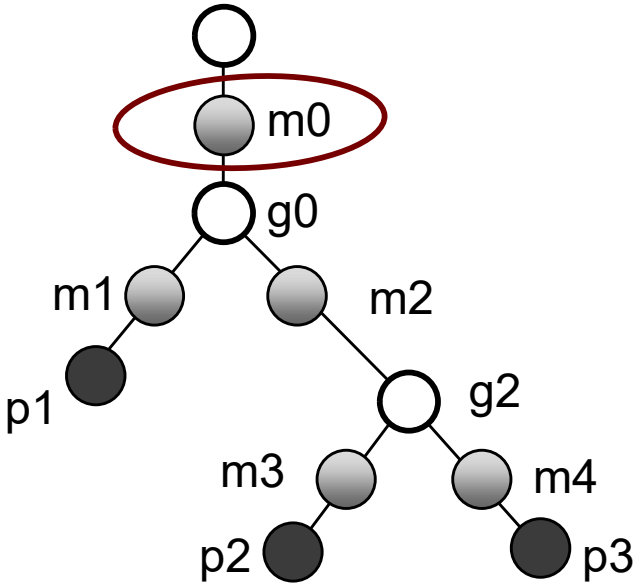
P1 = Cubo Unitário

M1 = Escala

Modelação

Um exemplo



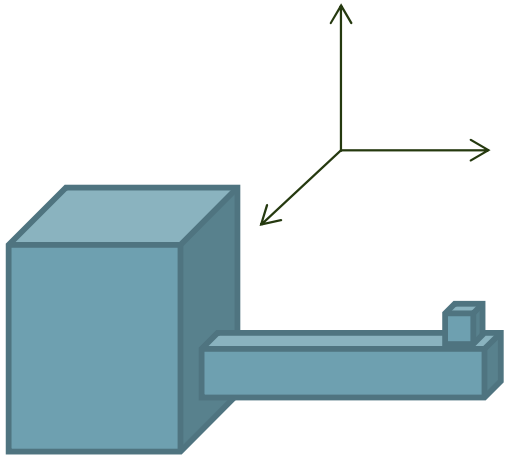


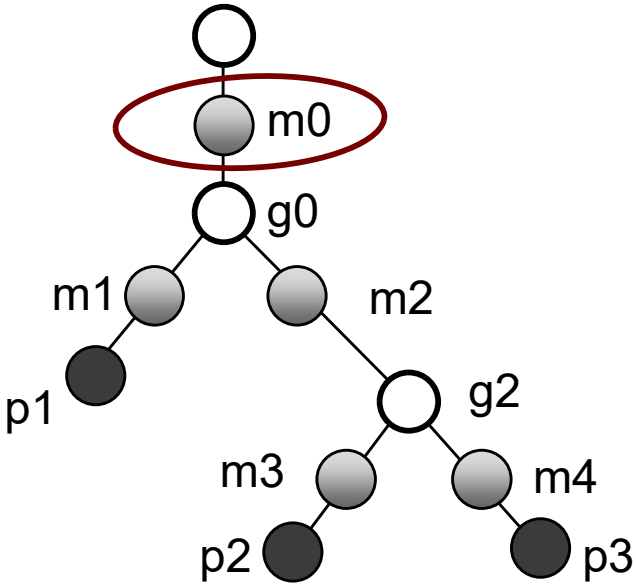
G0 = Objecto Composto

M0 = Translação

Modelação

Um exemplo



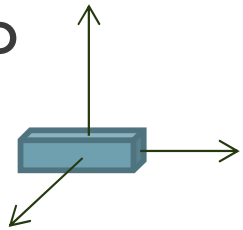


G0 = Objecto Composto

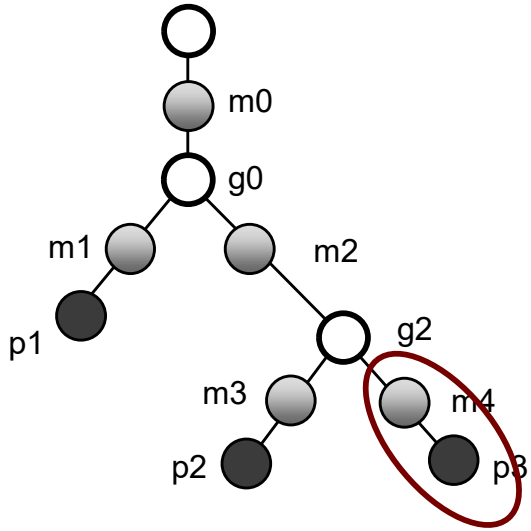
M0 = Translação

Modelação

Um exemplo

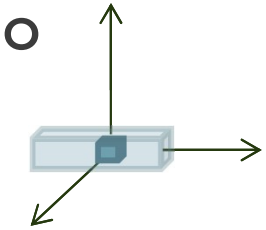


```
var g0, g2, p1, p2, p3;

p3 = new THREE.Mesh(new THREE.BoxGeometry(1.2, 0.2, 0.2), mat);
```

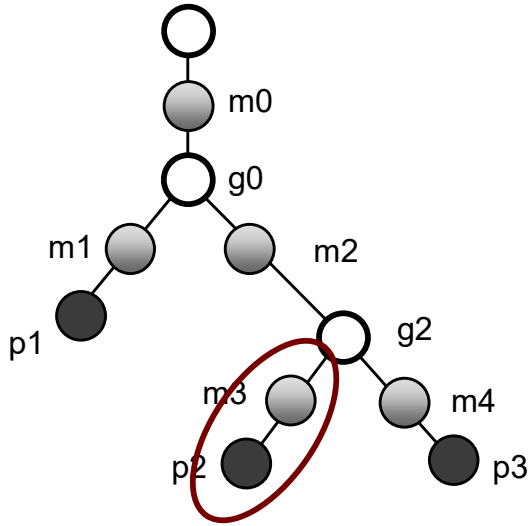


Modelação

Um exemplo

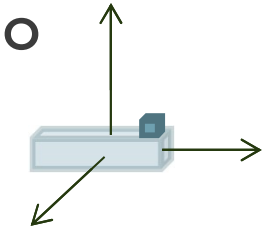


```
var g0, g2, p1, p2, p3;

p3 = new THREE.Mesh(new THREE.BoxGeometry(1.2, 0.2, 0.2), mat);

p2 = new THREE.Mesh(new THREE.BoxGeometry(0.1, 0.1, 0.1), mat);
```

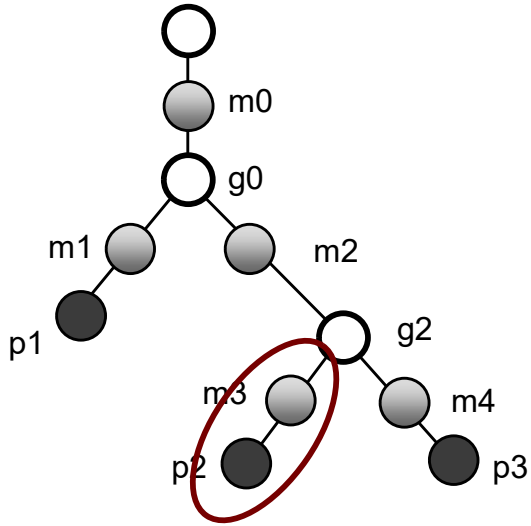


Modelação

Um exemplo

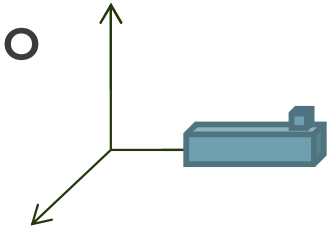


```
var g0, g2, p1, p2, p3;

p3 = new THREE.Mesh(new THREE.BoxGeometry(1.2, 0.2, 0.2), mat);

p2 = new THREE.Mesh(new THREE.BoxGeometry(0.1, 0.1, 0.1), mat);
p2.position.set(0.5, 0.1, 0.0);
```

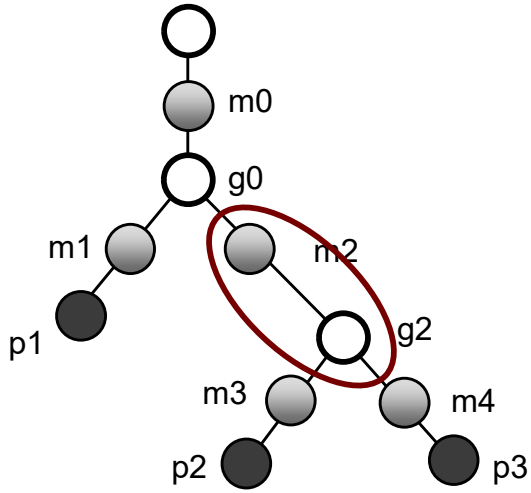


Modelação

Um exemplo

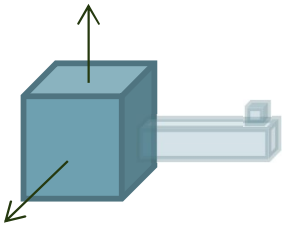


```
var g0, g2, p1, p2, p3;

p3 = new THREE.Mesh(new THREE.BoxGeometry(1.2, 0.2, 0.2), mat);

p2 = new THREE.Mesh(new THREE.BoxGeometry(0.1, 0.1, 0.1), mat);
p2.position.set(0.5, 0.1, 0.0);


g2 = new THREE.Object3D();
g2.add(p3);
g2.add(p2);
g2.position.set(1.2, 0.0, 0.0);
```

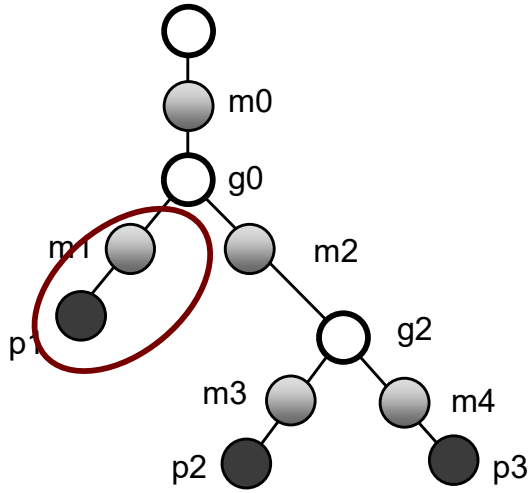


Modelação

Um exemplo

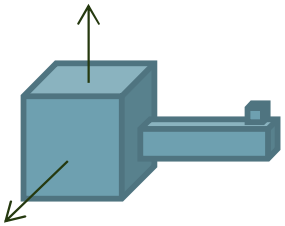


```
var g0, g2, p1, p2, p3;

p3 = new THREE.Mesh(new THREE.BoxGeometry(1.2, 0.2, 0.2), mat);

p2 = new THREE.Mesh(new THREE.BoxGeometry(0.1, 0.1, 0.1), mat);
p2.position.set(0.5, 0.1, 0.0);


g2 = new THREE.Object3D();
g2.add(p3);
g2.add(p2);
g2.position.set(1.2, 0.0, 0.0);

p1 = new THREE.Mesh(new THREE.BoxGeometry(1.5, 1.5, 1.5), mat);
```

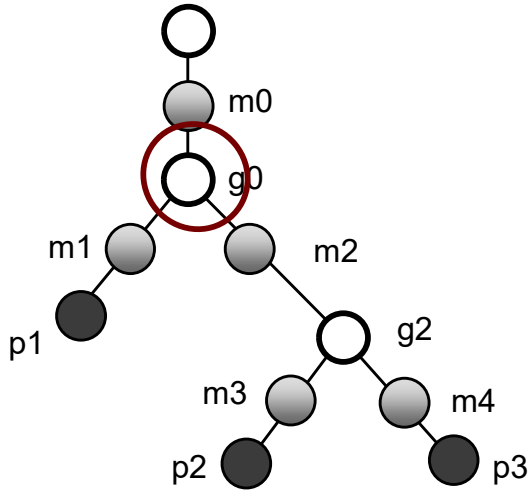


Modelação

Um exemplo

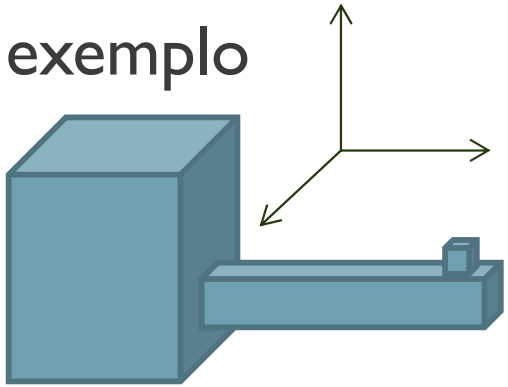


```
var g0, g2, p1, p2, p3;

p3 = new THREE.Mesh(new THREE.BoxGeometry(1.2, 0.2, 0.2), mat);

p2 = new THREE.Mesh(new THREE.BoxGeometry(0.1, 0.1, 0.1), mat);
p2.position.set(0.5, 0.1, 0.0);


g2 = new THREE.Object3D();
g2.add(p3);
g2.add(p2);
g2.position.set(1.2, 0.0, 0.0);

p1 = new THREE.Mesh(new THREE.BoxGeometry(1.5, 1.5, 1.5), mat);

g0 = new THREE.Object3D();
g0.add(p1);
g0.add(g2);
```

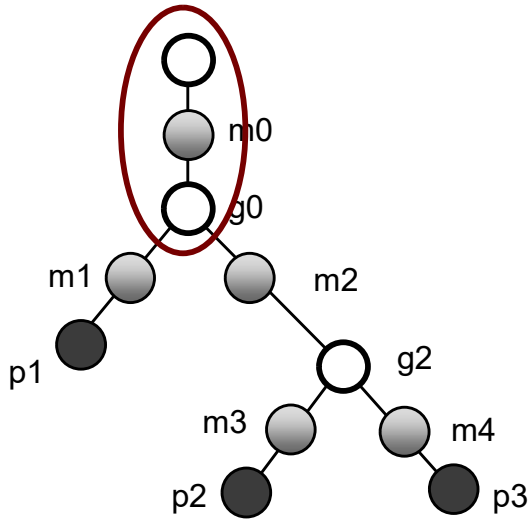


Modelação

Um exemplo

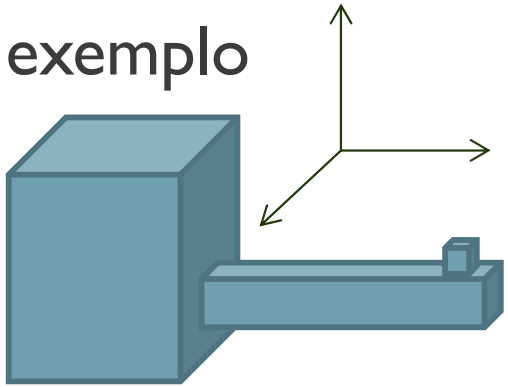


```
var g0, g2, p1, p2, p3;

p3 = new THREE.Mesh(new THREE.BoxGeometry(1.2, 0.2, 0.2), mat);

p2 = new THREE.Mesh(new THREE.BoxGeometry(0.1, 0.1, 0.1), mat);
p2.position.set(0.5, 0.1, 0.0);


g2 = new THREE.Object3D();
g2.add(p3);
g2.add(p2);
g2.position.set(1.2, 0.0, 0.0);

p1 = new THREE.Mesh(new THREE.BoxGeometry(1.5, 1.5, 1.5), mat);

g0 = new THREE.Object3D();
g0.add(p1);
g0.add(g2);

g0.position.set(0.0, 0.0, 2.0);
scene.add(g0);
```



Modelação

Um exemplo



```
var g0, g2, p1, p2, p3;

p3 = new THREE.Mesh(new THREE.BoxGeometry(1.2, 0.2, 0.2), mat);

p2 = new THREE.Mesh(new THREE.BoxGeometry(0.1, 0.1, 0.1), mat);
p2.position.set(0.5, 0.1, 0.0);


g2 = new THREE.Object3D();
g2.add(p3);
g2.add(p2);
g2.position.set(1.2, 0.0, 0.0);

p1 = new THREE.Mesh(new THREE.BoxGeometry(1.5, 1.5, 1.5), mat);

g0 = new THREE.Object3D();
g0.add(p1);
g0.add(g2);

g0.position.set(0.0, 0.0, 2.0);
scene.add(g0);
```