

## 1. MOTIVATION

- New planning domain based on numeric values to generate an upper-limb rehabilitation therapy plan
- STRIPS and HTN implementations

## 2. PROBLEM DESCRIPTION

**Problem goals:** Therapeutic Objectives Cumulative Levels (TOCLs)

1. Bimanual
2. Fine unimanual
3. Coarse unimanual
4. Arm positioning
5. Hand positioning

**Exercises:**

- Duration, intensity and difficulty
- Adequacy level for each TOCL
- Group of exercise

**Constraints:**

- Exercises cannot reappear in one session
- Exercises assorted throughout sessions
- Avoid a certain group of exercises
- Limit the cumulative intensity or difficulty

## 3. PLANNING MECHANISM

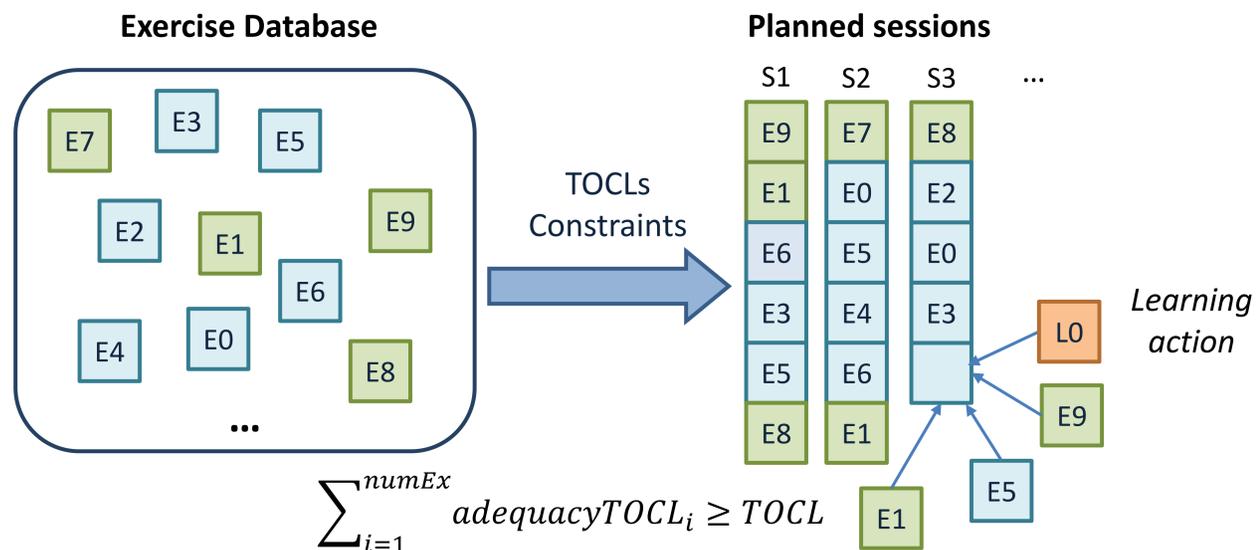


Figure 1: Planning the next exercise for session S3.

## 4. STRIPS

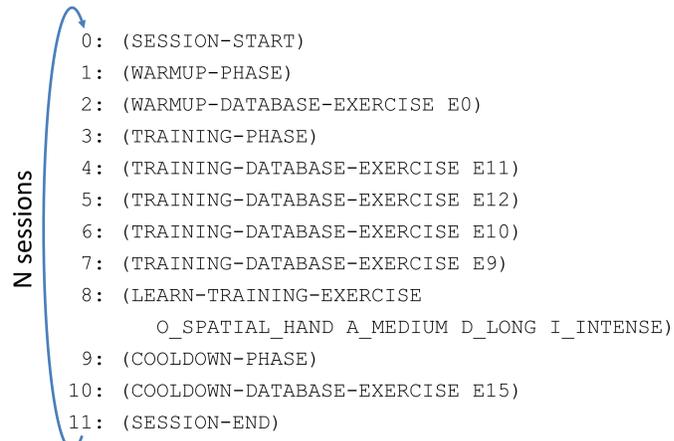


Figure 2: Output plan for one session.

- Action costs reduce learning priority
- Run planner one time per session (Figure 3)
- Quality plans without backtracking among sessions (Table 2)

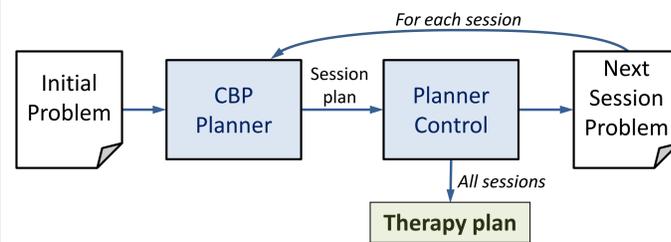


Figure 3: Divide-and-conquer strategy.

## 5. HTN

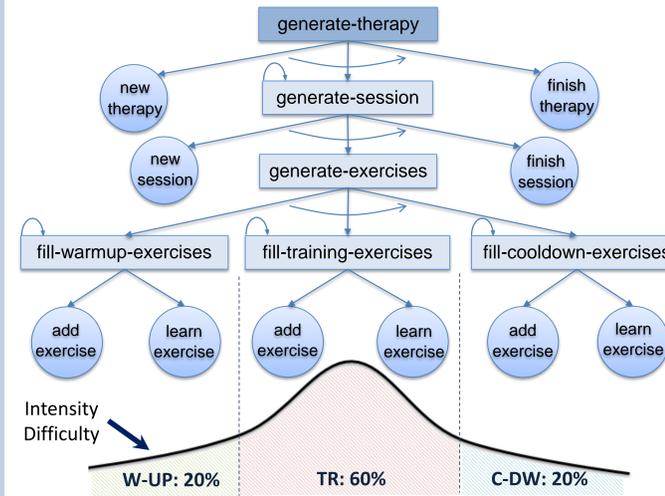


Figure 4: HTN planning schema.

Function to evaluate the exercise insertion according to TOCLs (Equation 1)

- Benefits high adequacy levels
- Penalizes exercise repetitions
- Phase change controlled by axioms

$$ht_{ex} = \sum_{i=1}^{n_{objectives}} \left( \frac{1}{d_i^2 + 1} - \frac{ex_{times\_used}}{num_{sessions}} \right) \quad (1)$$

## 6. COMPARISON

	STRIPS	HTN
<b>Search strategy</b>	• CBP planner task, limiting learnings with action costs	• Heuristic function to guide the search among the exercises
<b>Multiple sessions</b>	• Divide-and-conquer • Impedes backtracking among sessions	• Can plan as usual, in one run
<b>Avoids repeated exercises</b>	• In the last 3 sessions • In the same position than the last repetition	• In the same session • Penalizes repetitions, but allows them
<b>Learning</b>	• Suggests attributes • Prefers exercises which improve variability	• Adds new predefined exercises during planning time
<b>Phase parameterization</b>	• Controlled by predicates and functions	• Axioms allows to model expert knowledge easily

Table 1: Main pros and cons found while modelling both implementations.

## 7. EXPERIMENTS

Sessions	Planned exercises							
	1	2	3	4	5	6	7	8
1	e0	e9	e11	e12	e10	e7	e15	
2	e4	e2	e5	e6	L	L	L	e13
3	e1	e3	e8	L	L	L	L	e16
4	L	L	L	L	L	L	L	e17
5	e0	e11	e12	e10	e9	L	e15	
6	e4	e2	e6	L19	e7	e5	L20	e13
7	e1	e3	L24	e8	L23	L22	e16	
8	L25	L26	L30	L27	L28	L29	e17	
9	e0	e12	e10	L31	e11	e9	e15	
10	e4	e2	L19	L20	e6	e7	e13	
11	e1	e3	L22	L23	L24	e8	e16	
12	L	L25	L26	L29	L30	L27	L28	e17
13	e0	e10	L21	e12	e9	e11	e15	
14	e4	e2	e7	e6	L20	L19	e13	
15	e1	e3	L24	e8	L22	L23	e16	

Table 2: STRIPS therapy plan with few exercises in the database. Legend: e# initial exercise, L learning action, L# reused learnt exercise.

## 8. DOWNLOAD PAPER

