# Planning the Nursing Diagnosis with Project Scheduling Problem

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**ABSTRACT—** ***This research has been approached to use the Artificial Intelligence Technic Project Scheduling Problem (PSP) for generating a preliminary assignment of human resources based on skill assessment in each employee during the activity development of nursing diagnosis, based on estimate the best human resource for each task*.**

**Keywords—** Nursing Diagnosis, Project Scheduling Problem, Artificial Intelligence.

## 1. INTRODUCTION

Each health facility has an exponential combination of resources, where each scenario involves people, activities, development time of each activity, time distribution per activity / person, personnel assignment based on their skills, etc. If all resources are assigned initially based on personnel skills, minimizing the costs, minimizing the time, and so on, then we can optimize the available resources for the daily activities. The main target is to optimize the use of resources by performing an initial allocation to determine if there are available enough resources for the daily activities.

## 2. NURSING DIAGNOSIS

NANDA has presented a formal classification of nursing diagnosis. According to NANDA nursing diagnosis is a theory proposed by Yura and Walsh (1967) about how nurses organize to care for people, families and communities. A base of nursing diagnosis is that nurses must assess patient current situation, explain values into a scientific form to propose a diagnosis before planning, implementing and evaluating [3] [4] [5].

A nursing process differs from a medical diagnosis, the first one is approached to a person or people mainly, its major objective is to get their welfare and improvement. The nursing diagnosis requires competencies such as the intellectual, interpersonal and technical commands, development of tolerance for ambiguity and reflexive practice as personal strengths [3] [4] [5].

To prepare the plan of nursing care is important to consider the patient assessment and the nursing diagnoses: the analysis of self-care deficit and balance self-care. Once you have made all nursing diagnoses you will be passed to the next stage: planning the nurse's activities and the prioritized objectives for both the nurse and patient, where the objectives are already raised; then you can proceed to the implementation of nursing interventions based on the patient's needs [10].

## 3. PROJECT SCHEDULING PROBLEM (PSP)

Kelly [2] sets the concept of Critical Path Method (CPM) – previous to Project Scheduling Problem (PSP) – as a project modeling technique which includes a list of activities required to develop a project, the time they will take and the dependencies between activities. According to the definition shown in [8], the abbreviation PSP is considered a generic name to every sort of problem where it is necessary to program, time, costs and the resources of projects, efficiently.

Ruiz-Vanoye et al. classify PSP according to its objective of optimization: time, cost of project and use of resources besides suggest general parameters: resources and activities. Ruiz-Vanoye et al [9] describe PSP application areas such as: technical elements, managing elements and industry features. Huang et al show the following equations related to software projects which could be employed to any other project [7].

$$T_j(\xi, x) = x_j v \max\{T_j(\xi, x) + \xi_0\} \tag{1}$$

$$T_j(\xi, x) = \max_{(i,E)\in A}\{T_j(\xi, x) + \xi_{iE}\} \tag{2}$$

$$R = \sum_{(i,j)\in A} y_{ij} r_{ij} \tag{3}$$

$$\sum_{(i,j)\in A} k_{ij} - \sum_{(i,j)\in A} k_{ji} = \begin{cases} 1, & i = 1, \\ 0, & 2 \le i \le n-1, \\ -1 & 1 = n. \end{cases} \tag{4}$$

$$C(\xi, x) = \sum_{(i,j)\in A} c_{ij} + a * T(\xi, x) + (T(\xi, x) - T^0) * C \tag{5}$$

PSP is considered a sequence of activities related by $arcs_{(i,j)}$, where each arc represents duration $\xi_{ij}$ as a stochastic variable from transition of activity i to activity j. The human capital cost of the $activity_{(i,j)}$ is represented by $C_{ij}$ while the cost resources is denoted by $r_{ij}$. A Project development is shown in figure 1, where the sample shows a group of activities $A = \{a_1, a_2, a_3, a_4, a_5, a_6\}$. A sequence of activities is shown by $arc_{(i,j)}$ associated to the human capital cost and cost resources.

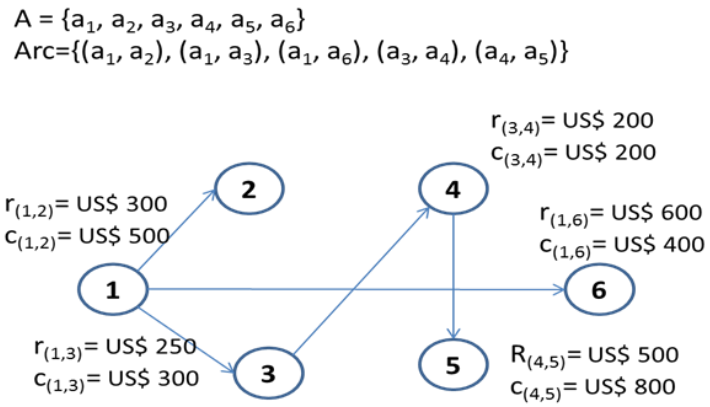


**Figure 1:** Project development scenario

## 4. MATHEMATICAL MODEL

This research proposes a model of lineal programming which consider decision variables with a lineal behave, as the objective function (Hernández, 2006) and the problem constraints for a preliminary assignment of human resources based on skill assessment in each employee during the activity development of nursing diagnosis [6].

### *4.1 Objective function*

The objective function is oriented to minimize the resources costs as a function objective expressed in table 1.

**Table 1**: Objective function.

| Objective function: | Minimize ctx |
|---|---|
| Constraints: | Subject to Ax = b |
| Variable of decision X in a range from l…u | l <= x <= u |

The proposed objective function (1) fulfills with the following principles

- Minimize time for developing a project based on estimated time a worker develop different activities.
- Minimize project costs based on the personnel skills to develop activities.
- Minimize developing time based in the assignment of activities to the personnel according to the relation developing time- number of errors.

$$\text{Minimize } z = \sum_{s1}\sum_{s2}\sum_{s} P_{s1} r_{s2} t_s \qquad (1)$$

Where:
Z= objective function
P= current project
R= Planned resources for developing a project.
T= Total time

### *4.2 Mathematical Optimization Model*

1. Determine the number of activities which will be done by a group of available nurses.

$$\forall p \in P \exists \sum_{req=1}^{n} activities \qquad (2)$$

$$\forall a_i \in A \exists clase_j \in \sum_{req=1}^{N_i} Activities \qquad (3)$$

2. Determine the number of activities which will be developed by class and it must fulfill characteristics of activities set a step before.
   a. List of activities: assesment, diagnosis, planning and ejecution.
   b. List of general activities.
   c. Assignment of activities in each class.

$$\forall a_i \in A \exists clase_j \in Clase \qquad (4)$$

$$\forall p_i \in P \exists A_j = \{a_1, a_2 ... a_n\} \mid a \in Clase_k \qquad (5)$$

3. Assignment average costs per activity/nurse based on determined classes and each nurse salary.

$$\forall a_i \in A \exists ct_j \mid \sum_{k=1}^{n} ct_k = C_{TP} \qquad (6)$$

4. Determine the ability level each nurse has developing activities in each class.

$$\forall t_i \in T_p \exists si \mid 1 <= si <= 10 \qquad (7)$$

5. Determine average time a nurse uses developing an activity in each class into a unit of time determined by the nursing manager.

$$\forall a_i \in A \exists t_j \in e_j \mid t_j <= t_a \qquad (8)$$

6. Determine the assessment done by the nursing manager into a rank from 1-10 where 10 means a nurse makes errors constantly.

$$\forall e \in E \exists \sum_{j=1}^{n} errores\_promedio_{clasej} \wedge clase_j \in Clase \qquad (9)$$

7. Determine total time each nurse will use in a work timetable.

$$\forall e_i \in A \exists t_j \in T_p \mid e_i <= T_{e_i} \tag{10}$$

8. Determine maximum of activities each nurse will develop into a work timetable.

$$\forall e_i \in E \exists \sum_{k=1}^{n} a \in A \tag{11}$$

9. Assignment activities to nurses according to their abilities and less number of errors.

$$e \in E \exists S_i = \{s_1, s_2 ... s_n\} \mid s_n \in Sp \tag{12}$$

$$\exists S_i = \{s_1, s_2 ... s_n\} \mid (S_i \in S_p) and (S_i = a_j) \tag{13}$$

$$\forall s_i \in S_p \exists clase_j \in Clases \tag{14}$$

$$\forall (a_i \in A_p) and (a_i \in clase_j) \exists S_p = \{s_1, s_2 \\ ...s_n\} \in clase_j \mid (e_l \in E_p) donde (S_p = S_e) \tag{15}$$

$$\forall (a_i \in A_p) and (a_i \in clase_j) \exists e_i \in E \\ \wedge \sum_{i=1}^{T_i e} errores <= e_j \in E \wedge \sum_{j=1}^{T_j e} errores \tag{16}$$

10. Determine estimated cost using human resources.

$$Min \sum_{a=1}^{n} \sum_{e=1}^{m} c_{(e,a)} * Cplex(e,a) \tag{17}$$

11. Determine estimated time to attend determined activities in step 1.

$$Min \sum_{a=1}^{n} \sum_{e=1}^{m} t_{(e,a)} * Cplex\_t(e,a) \tag{18}$$

12. Determine assignment activities to nurses according to an obtained evaluation developing activities by class

$$Min \sum_{clase=1}^{n} errores\_promedio_{(clase)} * \\ Cplex\_errores(t, clase) \tag{19}$$

13. Determine assignment activities based on level of knowledge each employee has into different kind of activities.

$$Max \sum_{e=1}^{m} \sum_{clase=1}^{n} habilidades_{(e,clase)} * Cplex\_habilidades(e, clase) \tag{20}$$

## 5. SIMULATION AND RESULTS

The figure 2 presents the Data Set (S), Parameters (P), Variables (V), Constraints (C) and Mathematical Program (PM) used to estimate the nurses scheduling assignation.

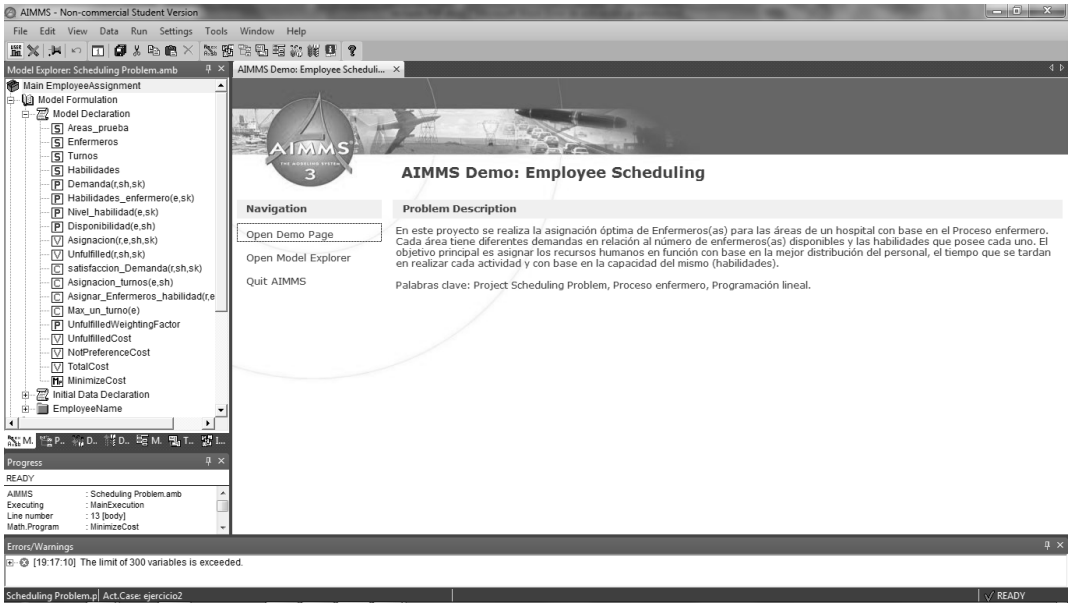


**Figure 2:** Modeling interface

The simulation interface (figure 3) presents the data random assignation: employee data (nurses names); shifts: morning, afternoon and night; Calculated schedule presents the assignation results.


**Figure 3:** Simulation interface

The figure 4 presents the Health Companies areas like: doctors' offices, intensive care, nursing office, preventive medicine office, emergency zone, etc.


**Figure 4:** Input parameters.

The Nursing Process Scheduling consists on estimate the preliminary assignment of human resources based on Project Scheduling Problem (PSP) technique (figure 5).

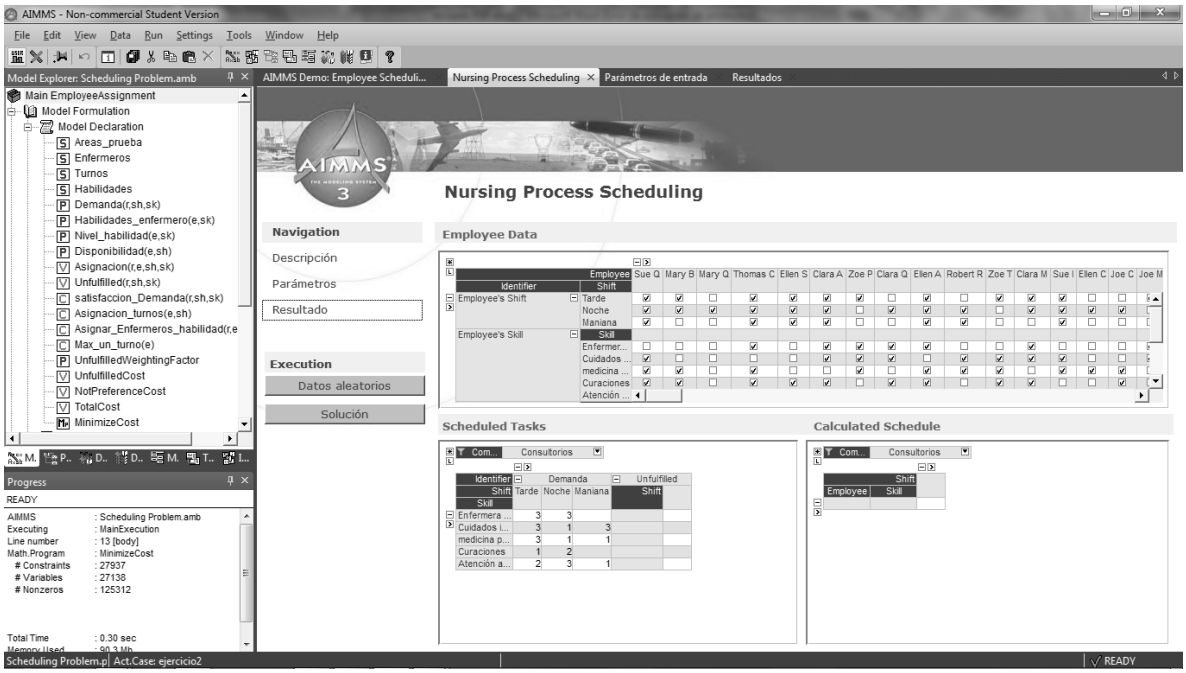


**Figure 5**: Random data

The figures 6, 7, 8 and 9 display the nurses assignation are based on PSP and linear programming. The result combination depends on the nurses skills, the activities time development and the input parameters.

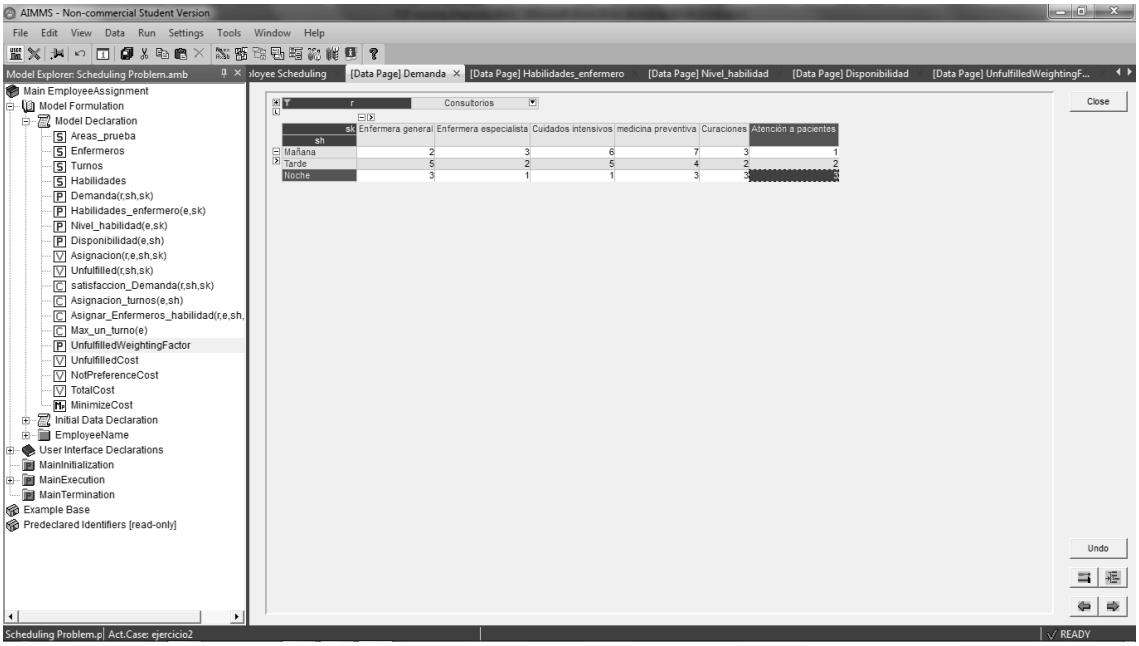


**Figure 6**: personnel required for the area and turn

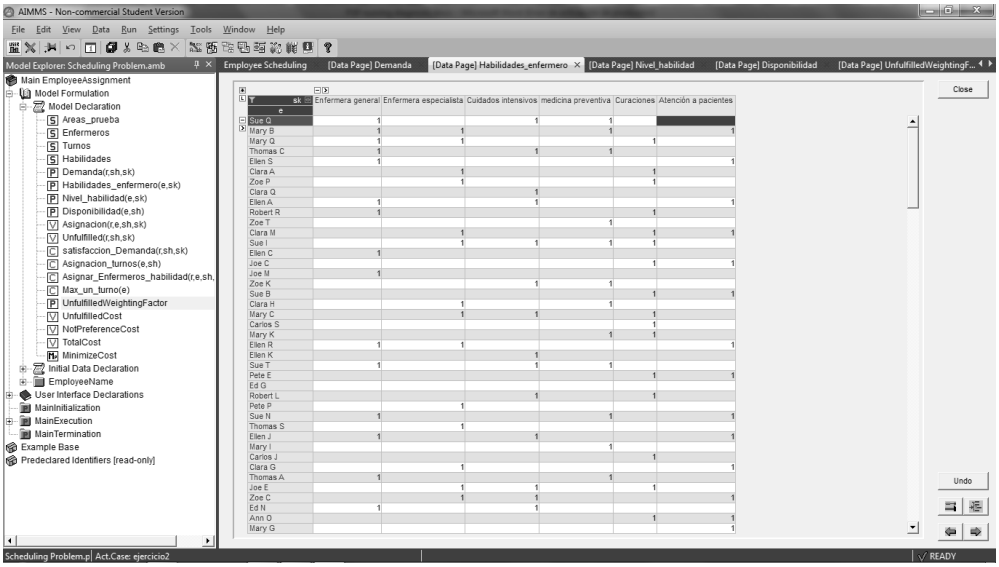


**Figure 7**: Skills per nurse

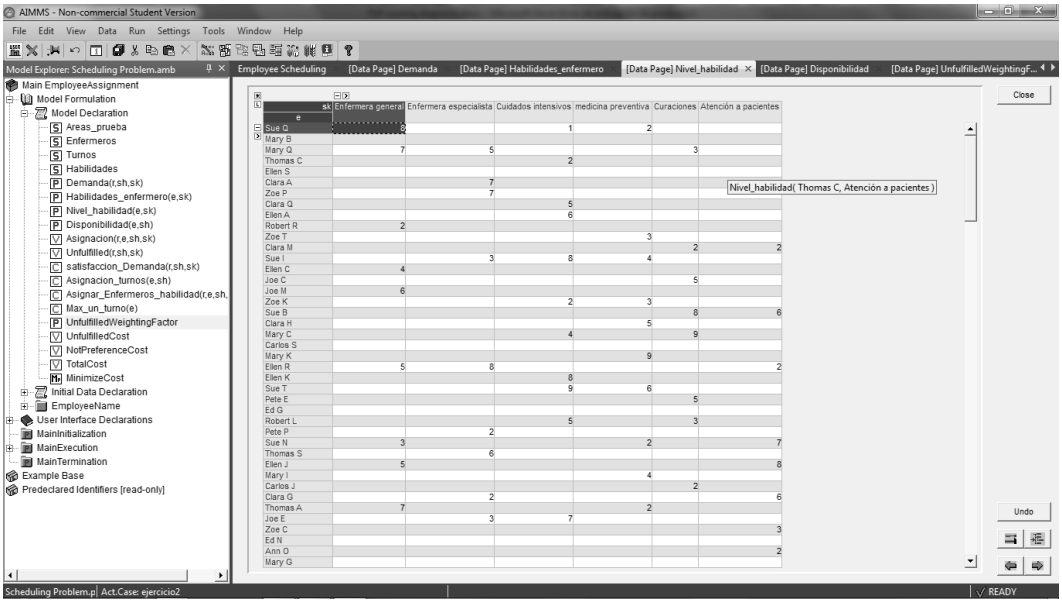


**Figure 8**: Skills level per nurse

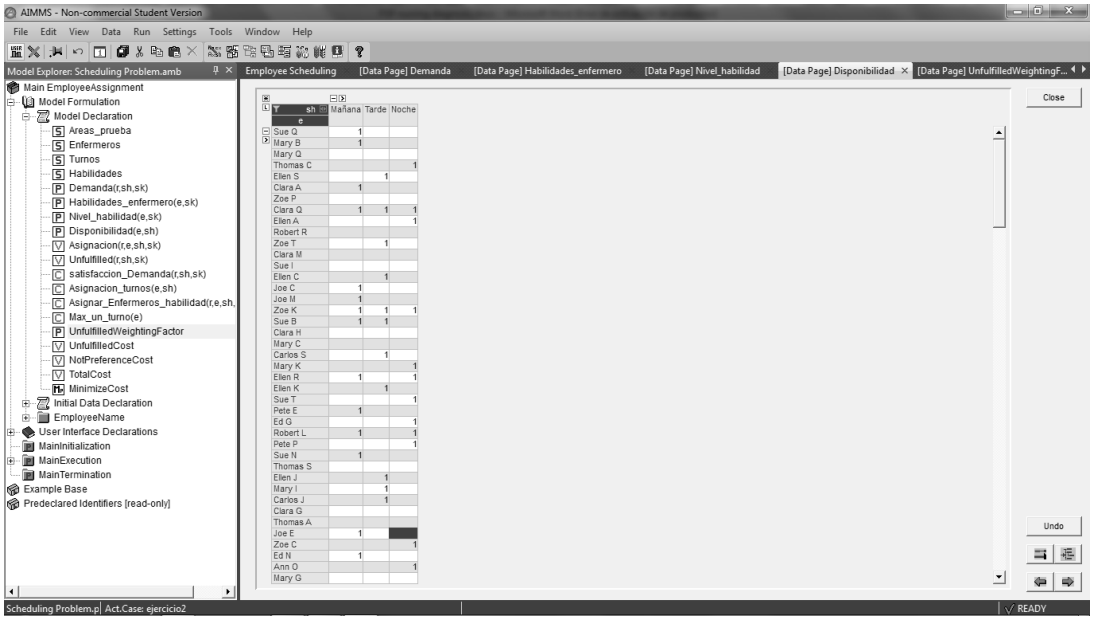


**Figure 9**: Calculated schedule

## 6. CONCLUSIONS

This article shows a proposal to assign nursing personnel according to their abilities and estimated time taken to do an activity, PSP is an artificial intelligence technique that allows to generate solutions to those people who have been immersed into a problematic related to variable cost, time and scope through generating tools with an automation level in which case results are based on historical activities and optimal solutions obtaining which don't include a large computer resources consumption during its estimation.

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