

Scrum Process Optimization Model

Gemini AI

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1 Sets (Entities)

The following sets represent the core entities of the Scrum domain model. Each set contains all instances of that entity.

- P : Set of all Projects (E0)
- T : Set of all Teams (E1)
- W : Set of all Workers (E2)
- F : Set of all Features (E3)
- S : Set of all Skills (E4)
- R : Set of all Roles (E5)
- PO : Set of all Product Owners (E6)
- SM : Set of all Scrum Masters (E7)
- PB : Set of all Product Backlogs (E8)
- SP : Set of all Sprints (E9)
- US : Set of all User Stories (E17)
- TSK : Set of all Tasks (E18)
- BL : Set of all Blockers (E20)
- SH : Set of all Stakeholders (E21)
- REP : Set of all Release Plans (E23)

2 Indices

The following indices are used to refer to specific elements within the sets defined above.

- $p \in P$: An individual project
- $t \in T$: An individual team
- $w \in W$: An individual worker
- $f \in F$: An individual feature
- $s \in S$: An individual skill
- $r \in R$: An individual role
- $po \in PO$: An individual product owner
- $sm \in SM$: An individual scrum master
- $sp \in SP$: An individual sprint
- $us \in US$: An individual user story
- $tsk \in TSK$: An individual task
- $bl \in BL$: An individual blocker
- $sh \in SH$: An individual stakeholder
- $rep \in REP$: An individual release plan

3 Goals (Objective Function)

The primary objective is to maximize a weighted sum of various performance indicators, representing the business goals.

$$\max Z = \sum_{i=0}^{11} w_i \cdot G_i \quad (1)$$

Where w_i and G_i are the weights and normalized goal functions derived from `Goals.csv`.

G0: maximize_project_priority: Maximize the priority of selected projects.

$$\max \sum_{p \in P} \text{priority}_p \cdot \text{DV5}_p$$

G1: maximize_feature_priority: Maximize the priority of features selected for release.

$$\max \sum_{f \in F} \sum_{rep \in REP} \text{priority}_f \cdot \text{DV3}_{f,rep}$$

G2: maximize_story_points_in_sprint: Maximize the total story points planned in sprints.

$$\max \sum_{us \in US} \sum_{sp \in SP} \text{story_points}_{us} \cdot \text{DV2}_{us,sp}$$

G4: minimize_task_effort: Minimize the total effort for all assigned tasks.

$$\min \sum_{tsk \in TSK} \sum_{w \in W} \text{effort}_{tsk} \cdot \text{DV4}_{tsk,w}$$

G6: maximize_team_velocity: Maximize the average story points output for teams.

$$\max \sum_{t \in T} \text{avg_story_points}_t$$

G7: minimize_blocker_severity: Minimize the severity of unresolved blockers.

$$\min \sum_{bl \in BL} \text{severity}_{bl} \cdot (1 - \text{DV6}_{bl})$$

4 Conditions (Constraints)

These constraints ensure that the solution adheres to the rules and limitations of the Scrum framework and the company's capacity.

C0: worker_status_active: A worker can only be assigned to a team if their status is 'active'. Let $\text{status}_w = 1$ if active, 0 otherwise.

$$\text{DV0}_{w,t} \leq \text{status}_w \quad \forall w \in W, t \in T$$

C2: team_size_limit: The number of workers assigned to a team cannot exceed the maximum size (e.g., 9).

$$\sum_{w \in W} \text{DV0}_{w,t} \leq 9 \quad \forall t \in T$$

C4: sprint_capacity_check: The total story points of user stories assigned to a sprint cannot exceed the team's velocity. Let V_t be the velocity of team t , and $t(sp)$ be the team conducting sprint sp .

$$\sum_{us \in US} \text{story_points}_{us} \cdot \text{DV2}_{us,sp} \leq V_{t(sp)} \quad \forall sp \in SP$$

C6: worker_availability: The sum of effort for tasks assigned to a worker cannot exceed their availability.

$$\sum_{tsk \in TSK} \text{effort}_{tsk} \cdot \text{DV4}_{tsk,w} \leq \text{availability}_w \quad \forall w \in W$$

C7: budget_is_positive: A project can only be started if it has a positive budget.

$$(\text{budget}_p > 0) \geq \text{DV5}_p \quad \forall p \in P$$

Assignment Uniqueness: Each worker is assigned to at most one team.

$$\sum_{t \in T} \text{DV0}_{w,t} \leq 1 \quad \forall w \in W$$

Task Assignment: Each task must be assigned to exactly one worker.

$$\sum_{w \in W} \text{DV4}_{tsk,w} = 1 \quad \forall tsk \in TSK$$

5 Decision Variables

These variables represent the decisions to be made by the optimization model.

DV0: assign_worker_to_team: Whether to assign worker w to team t .

$$\text{DV0}_{w,t} \in \{0, 1\} \quad \forall w \in W, t \in T$$

DV1: assign_team_to_project: Whether to assign team t to project p .

$$\text{DV1}_{t,p} \in \{0, 1\} \quad \forall t \in T, p \in P$$

DV2: assign_user_story_to_sprint: Whether to assign user story us to sprint sp .

$$\text{DV2}_{us,sp} \in \{0, 1\} \quad \forall us \in US, sp \in SP$$

DV3: select_feature_for_release: Whether to include feature f in release plan rep .

$$\text{DV3}_{f,rep} \in \{0, 1\} \quad \forall f \in F, rep \in REP$$

DV4: assign_task_to_worker: Whether to assign task tsk to worker w .

$$\text{DV4}_{tsk,w} \in \{0, 1\} \quad \forall tsk \in TSK, w \in W$$

DV5: start_project: Whether to start project p .

$$\text{DV5}_p \in \{0, 1\} \quad \forall p \in P$$

DV6: resolve_blocker: Whether to dedicate resources to resolve blocker bl .

$$\text{DV6}_{bl} \in \{0, 1\} \quad \forall bl \in BL$$