

# Scrum Process Optimization Model

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# 1 Sets (Entities)

Derived from `Entities.csv`, the following sets represent the core components of the Scrum domain model.

- $P$ : The set of all projects ( $E_0$ )
- $T$ : The set of all teams ( $E_1$ )
- $W$ : The set of all workers ( $E_2$ )
- $F$ : The set of all features ( $E_3$ )
- $S$ : The set of all skills ( $E_4$ )
- $R$ : The set of all roles ( $E_5$ )
- $PO$ : The set of all product owners ( $E_6$ )
- $SM$ : The set of all scrum masters ( $E_7$ )
- $PB$ : The set of all product backlogs ( $E_8$ )
- $SP$ : The set of all sprints ( $E_9$ )
- $SBL$ : The set of all sprint backlogs ( $E_{14}$ )
- $SG$ : The set of all sprint goals ( $E_{15}$ )
- $E$ : The set of all epics ( $E_{16}$ )
- $US$ : The set of all user stories ( $E_{17}$ )
- $TSK$ : The set of all tasks ( $E_{18}$ )
- $BL$ : The set of all blockers ( $E_{20}$ )
- $SH$ : The set of all stakeholders ( $E_{21}$ )
- $VEL$ : The set of all velocity measurements ( $E_{22}$ )
- $REP$ : The set of all release plans ( $E_{23}$ )

# 2 Indices

The following indices are used to iterate over the sets defined above.

- $p \in P$ : Index for a project
- $t \in T$ : Index for a team
- $w \in W$ : Index for a worker
- $f \in F$ : Index for a feature
- $sp \in SP$ : Index for a sprint
- $us \in US$ : Index for a user story
- $tsk \in TSK$ : Index for a task
- $bl \in BL$ : Index for a blocker
- $rep \in REP$ : Index for a release plan

### 3 Decision Variables

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

- $A_{w,tsk} \in \{0,1\}$ : 1 if worker  $w$  is assigned to task  $tsk$ , 0 otherwise (DV0)
- $B_{us,sp} \in \{0,1\}$ : 1 if user story  $us$  is assigned to sprint  $sp$ , 0 otherwise (DV1)
- $C_{f,rep} \in \{0,1\}$ : 1 if feature  $f$  is assigned to release plan  $rep$ , 0 otherwise (DV2)
- $D_{t,p} \in \{0,1\}$ : 1 if team  $t$  is assigned to project  $p$ , 0 otherwise (DV3)
- $P_f \in Z^+$ : Priority assigned to feature  $f$  (DV4)
- $SP_{us} \in Z^+$ : Story points assigned to user story  $us$  (DV5)
- $S_{tsk} \in \{\text{todo, progress, done}\}$ : Status of task  $tsk$  (DV9)

### 4 Goals (Objective Function)

The primary objective is to maximize a weighted sum of individual goals while minimizing penalties. Let  $W_g$  be the weight for goal  $g$ . The multi-objective function is:

$$\text{Maximize } \sum_{g \in \text{Goals}} W_g \cdot \text{Obj}_g - \sum_{g' \in \text{Goals}} W_{g'} \cdot \text{Obj}_{g'}$$

where the first term is for 'max' goals and the second for 'min' goals.

- **G0: maximize\_completed\_story\_points**

$$\text{Maximize } \sum_{us \in US} SP_{us} \cdot I(us)$$

where  $I(us) = 1$  if user story  $us$  is completed.

- **G1: minimize\_open\_blockers**

$$\text{Minimize } \sum_{bl \in BL} O_{bl}$$

where  $O_{bl} = 1$  if blocker  $bl$  has status 'open'.

- **G2: maximize\_feature\_priority**

$$\text{Maximize } \sum_{f \in F} P_f \cdot J(f)$$

where  $J(f) = 1$  if feature  $f$  is implemented.

- **G4: minimize\_task\_effort**

$$\text{Minimize } \sum_{tsk \in TSK} \text{effort}_{tsk}$$

### 5 Conditions (Constraints)

These are the constraints that the solution must satisfy.

- **C0: team\_size\_limit** The size of any given team must be within a specific range.

$$3 \leq \text{team\_size}_t \leq 9 \quad \forall t \in T$$

- **C2: sprint\_load\_le\_velocity** The sum of story points for all user stories in a sprint must not exceed the team's velocity. Let  $v_t$  be the velocity for team  $t$ .

$$\sum_{us \in US} SP_{us} \cdot B_{us,sp} \leq v_{t(sp)} \quad \forall sp \in SP$$

where  $t(sp)$  is the team assigned to sprint  $sp$ .

- **C3: budget\_not\_exceeded** The total cost derived from tasks cannot exceed the project budget. Let  $c_{tsk}$  be the cost of a task.

$$\sum_{tsk \in TSK_p} c_{tsk} \leq \text{budget}_p \quad \forall p \in P$$

where  $TSK_p$  is the set of tasks for project  $p$ .

- **C4: worker\_is\_available** A worker can only be assigned to a task if their availability is greater than zero.

$$A_{w,tsk} \leq \text{availability}_w \cdot M \quad \forall w \in W, \forall tsk \in TSK$$

where  $M$  is a large number (Big-M notation) and availability is scaled to be  $> 0$  for assignment.

- **C9: sprint\_start\_before\_end** The start date of a sprint must be earlier than its end date.

$$\text{start\_date}_{sp} < \text{end\_date}_{sp} \quad \forall sp \in SP$$