

# Optimization Model for a SCRUM-Based Software Development Company

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## 1 Sets (Entities)

- Project =  $\{p_1, p_2, \dots, p_n\}$  (P)
- Team =  $\{t_1, t_2, \dots, t_n\}$  (T)
- Worker =  $\{w_1, w_2, \dots, w_n\}$  (W)
- Feature =  $\{f_1, f_2, \dots, f_n\}$  (F)
- Skill =  $\{s_1, s_2, \dots, s_n\}$  (S)
- Role =  $\{r_1, r_2, \dots, r_n\}$  (R)
- ProductOwner =  $\{po_1, po_2, \dots, po_n\}$  (PO)
- ScrumMaster =  $\{sm_1, sm_2, \dots, sm_n\}$  (SM)
- ProductBacklog =  $\{pb_1, pb_2, \dots, pb_n\}$  (PB)
- Sprint =  $\{sp_1, sp_2, \dots, sp_n\}$  (SP)
- SprintGoal =  $\{sg_1, sg_2, \dots, sg_n\}$  (SG)
- UserStory =  $\{us_1, us_2, \dots, us_n\}$  (US)
- Task =  $\{tsk_1, tsk_2, \dots, tsk_n\}$  (TSK)
- Blocker =  $\{bl_1, bl_2, \dots, bl_n\}$  (BL)
- Stakeholder =  $\{sh_1, sh_2, \dots, sh_n\}$  (SH)
- Velocity =  $\{vel_1, vel_2, \dots, vel_n\}$  (VEL)

## 2 Indices

- $p \in \text{Project}$
- $t \in \text{Team}$
- $w \in \text{Worker}$
- $f \in \text{Feature}$
- $s \in \text{Skill}$
- $r \in \text{Role}$

- $po \in \text{ProductOwner}$
- $sm \in \text{ScrumMaster}$
- $sp \in \text{Sprint}$
- $sg \in \text{SprintGoal}$
- $us \in \text{UserStory}$
- $tsk \in \text{Task}$
- $bl \in \text{Blocker}$
- $sh \in \text{Stakeholder}$
- $vel \in \text{Velocity}$

### 3 Goals

- **G0: maximize\_team\_availability**  
 Logical: Maximize the overall availability of all team members.  
 Mathematical:  $\max \sum_{w \in \text{Worker}} \text{availability}(w)$
- **G1: minimize\_project\_budget**  
 Logical: Minimize the total budget spent across all projects.  
 Mathematical:  $\min \sum_{p \in \text{Project}} \text{budget}(p)$
- **G2: maximize\_feature\_priority**  
 Logical: Maximize the average priority of features developed.  
 Mathematical:  $\max \frac{1}{|\text{Feature}|} \sum_{f \in \text{Feature}} \text{priority}(f)$
- **G3: minimize\_blocker\_severity**  
 Logical: Minimize the severity of active blockers.  
 Mathematical:  $\min \sum_{bl \in \text{Blocker} | \text{status}(bl)=\text{active}} \text{severity}(bl)$
- **G4: maximize\_sprint\_goal\_achievement**  
 Logical: Maximize the achievement status of sprint goals.  
 Mathematical:  $\max \sum_{sg \in \text{SprintGoal}} \text{achievement\_status}(sg)$
- **G5: maximize\_velocity**  
 Logical: Maximize the average velocity of teams.  
 Mathematical:  $\max \sum_{vel \in \text{Velocity}} \text{avg\_story\_points}(vel)$

- **G6: minimize\_task\_effort**  
Logical: Minimize the total effort of tasks in the sprint backlog.  
Mathematical:  $\min \sum_{tsk \in \text{Task}} \text{effort}(tsk)$
- **G7: maximize\_stakeholder\_satisfaction**  
Logical: Maximize the satisfaction level of stakeholders.  
Mathematical:  $\max \sum_{sh \in \text{Stakeholder}} \text{influence\_level}(sh)$
- **G8: minimize\_sprint\_duration**  
Logical: Minimize the duration of sprints.  
Mathematical:  $\min \sum_{sp \in \text{Sprint}} (\text{end\_date}(sp) - \text{start\_date}(sp))$

## 4 Conditions

- **C0: condition\_team\_cross\_functional**  
Logical: Ensure a team has all required roles covered.  
Mathematical:  $\forall t \in \text{Team}, \exists w \in \text{Worker}$  assigned to  $t$  for each  $r \in \text{essential\_roles}$
- **C1: condition\_worker\_certified**  
Logical: Critical features must be developed by certified workers.  
Mathematical:  $\forall f \in \text{Feature} | \text{priority}(f) = \text{critical}, \forall tsk \in \text{Task}(f), \text{certified}(\text{worker}(tsk)) = \text{True}$
- **C2: condition\_project\_on\_budget**  
Logical: Project budget must not be exceeded.  
Mathematical:  $\forall p \in \text{Project}, \text{actual\_cost}(p) \leq \text{budget}(p)$
- **C3: condition\_no\_critical\_blockers**  
Logical: No active blockers with 'critical' severity are allowed.  
Mathematical:  $\nexists bl \in \text{Blocker} | \text{status}(bl) = \text{active} \wedge \text{severity}(bl) = \text{critical}$
- **C4: condition\_sprint\_goal\_defined**  
Logical: Every sprint must have a defined goal.  
Mathematical:  $\forall sp \in \text{Sprint}, \text{objective\_description}(\text{SprintGoal}(sp)) \neq \emptyset$
- **C5: condition\_user\_story\_estimated**  
Logical: All user stories in a sprint must have story points.  
Mathematical:  $\forall us \in \text{UserStory} | \text{status}(us) = \text{in\_sprint}, \text{story\_points}(us) > 0$

- **C6: condition\_task\_status\_valid**  
 Logical: All tasks must have a valid status.  
 Mathematical:  $\forall tsk \in \text{Task}, \text{status}(tsk) \in \{\text{todo}, \text{in\_progress}, \text{done}\}$
- **C7: condition\_feature\_high\_priority**  
 Logical: Features with 'critical' priority must be included in the next release.  
 Mathematical:  $\forall f \in \text{Feature} | \text{priority}(f) = \text{critical}, f \in \text{next\_release}$
- **C8: condition\_scrum\_master\_experienced**  
 Logical: The Scrum Master must have sufficient experience for the team size.  
 Mathematical:  $\forall t \in \text{Team}, \text{experience}(\text{ScrumMaster}(t)) \geq k \cdot \text{team\_size}(t)$

## 5 DecisionVariables

- **DV0: assign\_worker\_to\_team**  
 $x_{w,t} \in \{0, 1\} \quad \forall w \in \text{Worker}, \forall t \in \text{Team}$   
 Binary variable indicating if worker  $w$  is assigned to team  $t$ .
- **DV1: select\_feature\_for\_sprint**  
 $y_{f,sp} \in \{0, 1\} \quad \forall f \in \text{Feature}, \forall sp \in \text{Sprint}$   
 Binary variable indicating if feature  $f$  is selected for sprint  $sp$ .
- **DV2: assign\_story\_points**  
 $z_{us} \in \{1, 2, 3, 5, 8, 13, 20, 40, 100\} \quad \forall us \in \text{UserStory}$   
 Integer variable for the story points assigned to user story  $us$ .
- **DV3: set\_task\_priority**  
 $p_{tsk} \in \{1, 2, 3\} \quad \forall tsk \in \text{Task}$   
 Integer variable for the priority level of task  $tsk$ .
- **DV4: allocate\_budget**  
 $b_f \in \mathbb{R}, 0.0 \leq b_f \leq 1,000,000.0 \quad \forall f \in \text{Feature}$   
 Continuous variable for the budget allocated to feature  $f$ .
- **DV5: team\_size**  
 $n_t \in \mathbb{Z}^+, 3 \leq n_t \leq 9 \quad \forall t \in \text{Team}$   
 Integer variable for the number of workers in team  $t$ .
- **DV6: sprint\_duration**  
 $d_{sp} \in \mathbb{Z}^+, 7 \leq d_{sp} \leq 30 \quad \forall sp \in \text{Sprint}$   
 Integer variable for the duration of sprint  $sp$  in days.

- **DV7: worker\_availability**

$$a_w \in \mathbb{R}, 0.0 \leq a_w \leq 1.0 \quad \forall w \in \text{Worker}$$

Continuous variable for the percentage availability of worker  $w$ .

- **DV8: feature\_development\_order**

$$o_f \in \mathbb{Z}^+, 1 \leq o_f \leq 100 \quad \forall f \in \text{Feature}$$

Integer variable for the sequential development order of feature  $f$ .