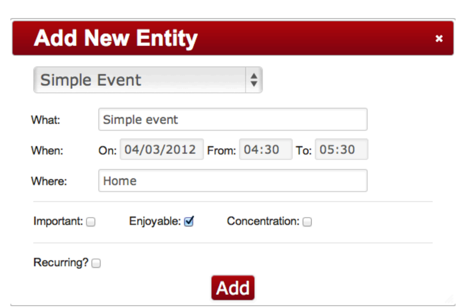
The Intelligent Personal Calendar

Abstract

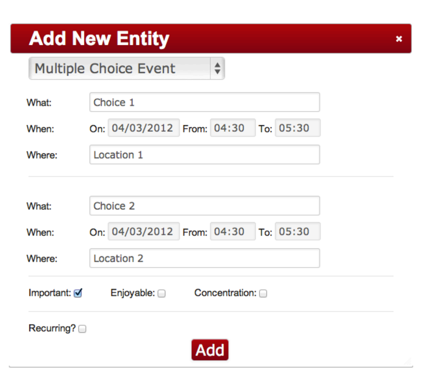
Despite their wide use, personal calendars have evolved little, remaining essentially static lists of manually scheduled events. Guided by logical theories of intention, experimental results on human productivity and psychology, and optimization algorithms, we seek to improve the usefulness of digital calendars and transform the digital calendar from a passive repository of events into an active scheduling assistant.

Calendar Entities

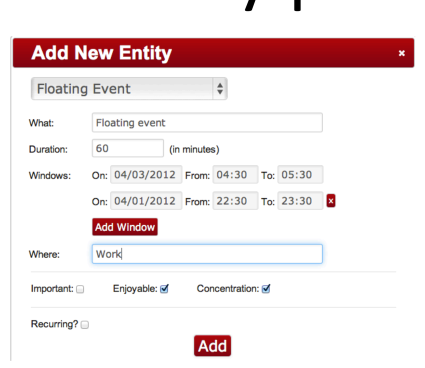
Simple Events: standard calendar entries



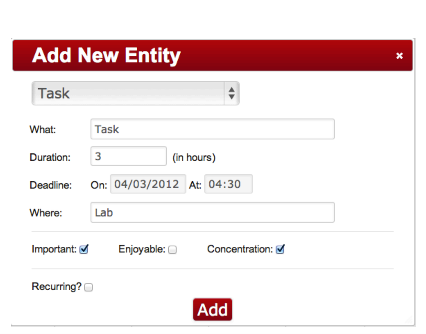
Multiple Choice Events: multiple options



Floating Events: many possible windows



Tasks: ToDo items with or without deadlines



Productivity Considerations

- Important tasks are prioritized
- No wasted travel time
- Work difficulty follows circadian rhythms
- Incubation for creative tasks
- Task segments are of proper length
- Tasks are ordered for best state of mind

Scheduling Problem/Algorithm

Given: Set of N entities $E=e_1,\ldots,e_n$

Matrix of temporal distances between all location pairs

Output: S, a schedule of entities, e_i

Each e_i has p_i , number of parts, t_{ij} the start time of each part, and dur_{ij}, the duration of each part.

$$\text{maximize}: \sum_{e \in E} U(e) - D(e)$$

$$\text{where } U(e) = \begin{cases} \dfrac{R}{\text{travel}(e)} & \text{if the entity is flextime or multiple choice} \\ \dfrac{\text{satisfying}(e) * \text{time}(e) * \text{priority}(e)}{\text{travel}(e)} & \text{if the entity is a task} \end{cases}$$

subject to:

$$\text{C1. } \forall T_{ij}, \sum_{j=1}^{p_i} dur_{ij} = \text{duration}(e_i)$$

$$\text{C2. } \forall T_{ij}, \text{minpart}(e_i) \le dur_{ij} \le \text{maxpart}(e_i)$$

$$\text{C3. } \forall T_{ij}, T_{ik}, j < k \Rightarrow t_{ij} + dur_{ij} + \text{incubation}(e_i) \le t_{ik}$$

$$\text{C4. } \forall T_{ij}, \text{start}(e_i) \le t_{ij} \le \text{deadline}(e_i) - dur_{ij}$$

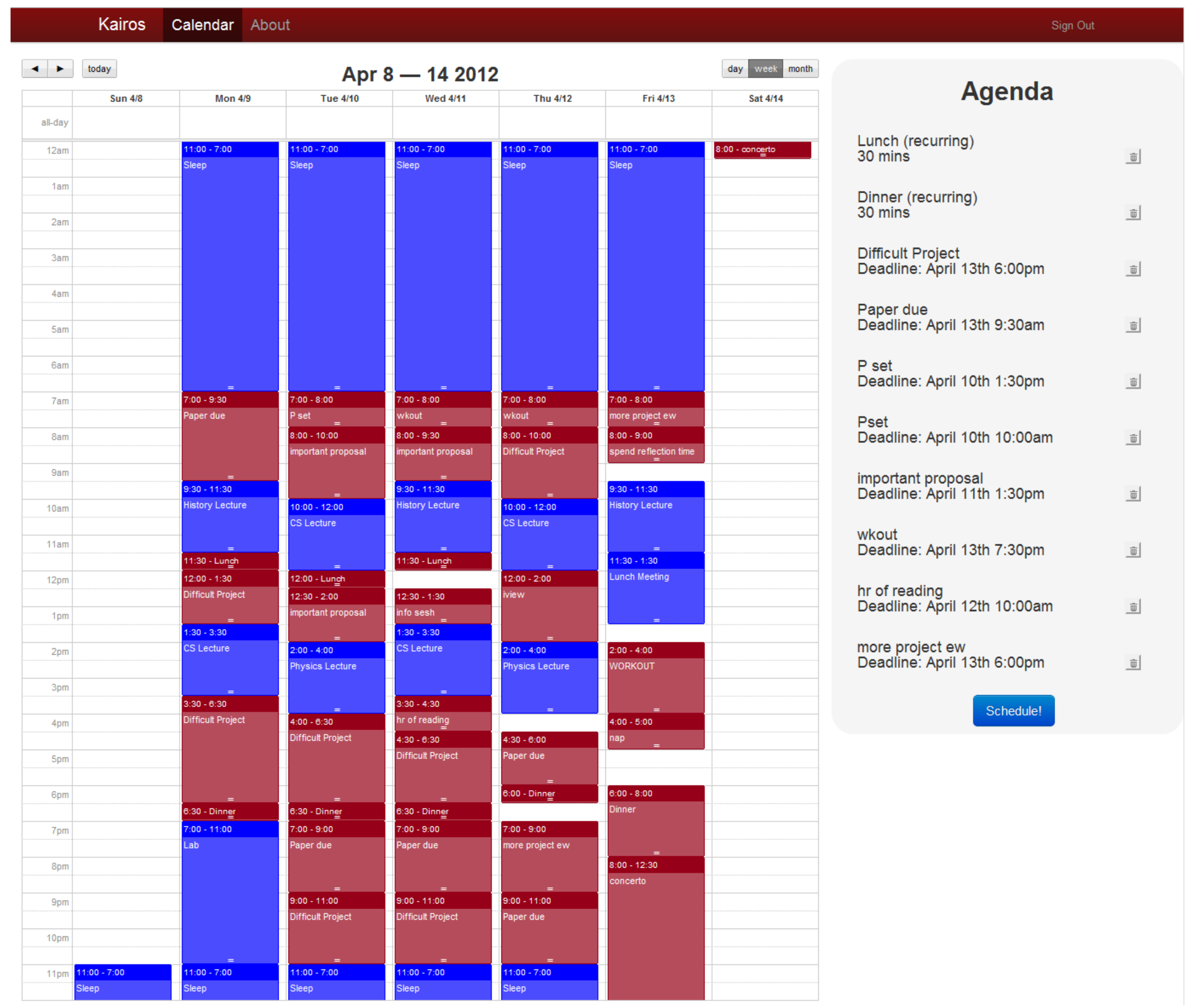
$$\text{C5. } \forall T_{ij}, T_{mn}, T_{ij} \neq T_{mn} \Rightarrow (\text{Dist}(l_{ij}, l_{mn}) > 0) \Rightarrow (t_{ij} + dur_{ij} + \text{Dist}(l_{ij}, l_{mn}) \le t_{mn}) \vee (t_{mn} + dur_{mn} + \text{Dist}(l_{ij}, l_{mn}) \le t_{ij}$$

Note: The search space for this problem is exponential. We use heuristics such as a modification of the Squeaky Wheel Optimization to solve this problem.

Prototype

We have prototyped a calendar system built on these concepts, using the Google Calendar API.

The system supports all calendar entity types in a convenient agenda view.



We use the scheduling algorithm to optimally schedule events and tasks defined in Google Calendar.

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