Echoes From Space:
Grouping Commands with Large-Scale Telemetry Data

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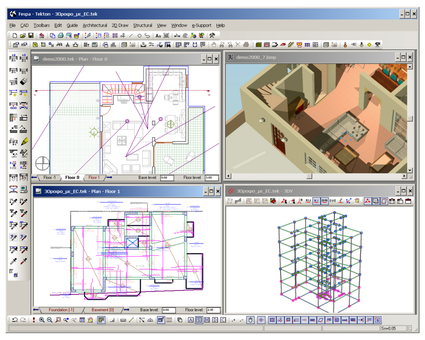
The Command Grouping Problem

Evolving desktop applications continuously accrue new features and grow denser user interfaces with deeply-nested commands. Existing ***search-based software engineering*** studies on user performance prediction and command grouping optimization lack evidence-based answers on choosing a systematic grouping method.



Command Grouping: Systematic method for grouping commands into multi-level menus and toolbars for:
- ✔ End-user usability and efficiency
- ✔ Improved GUI design process

Model and Data

Based on the KLM model [1] for user perfomance time, in our ***model*** we additionally differentiate between the time needed when clicking commands in the currently open menu (*Same*), in a currently hidden nested menu (*Different*) and in an always open menu (*Toolbar*).

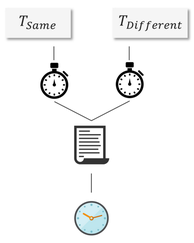
$$T_{Total} = T_{Same} \times (N_{Same} + N_{Toolbar}) + T_{Different} \times N_{Different}$$

With ***telemetry data*** of CAD program runs, we find real usage scenarios, with which we evaluate our models:
- → 32 million commands,
- → 200 thousand sessions,
- → 2000 users.

With controlled ***experiments***, we calculate T_{Same} and $T_{Different}$, with which the scenarios are objectively evaluated for each optimization algorithm.

Optimization Algorithms

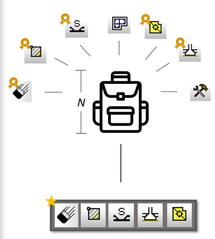
`CURRENT`:
Measurement with the GUI at the current setup.



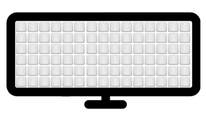
`NAIVE`:
N most frequent commands always available on an extra toolbar.

`MRU-B`:
N most frequent commands always available on a toolbar. For each user, from a small batch.
`MRU-O`:
For each user, online.

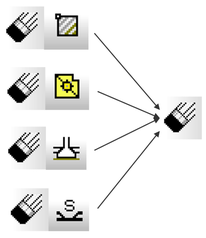
`OPT(KS)`:
N best commands always available on a toolbar, using a heuristic approximation of the Knapsack algorithm.



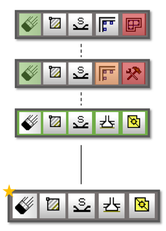
`ALL`:
All commands available directly on the screen. Establishes the theoretical optimum.



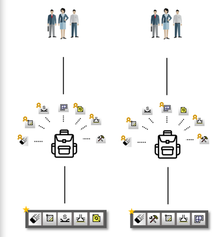
`GROUP`:
Group together similar commands between entities.



`OPT(GA)`:
N best commands always available on a toolbar, using a stochastic Genetic Algorithm.



`CLUSTER`:
Make clusters (kmeans) of users. Run OPT(KS) for each cluster. Show best N commands to each.

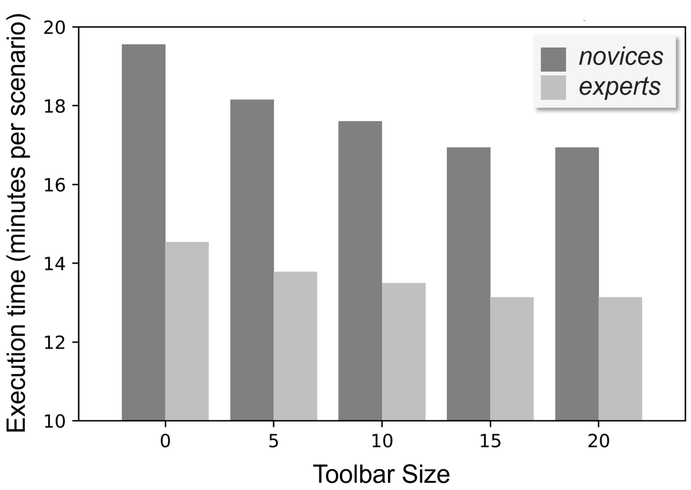


Results

When introducing an ***extra toolbar***, more than 15 of the best (`NAIVE`, `OPT(KS)`, `CLUSTER`) commands add no value.

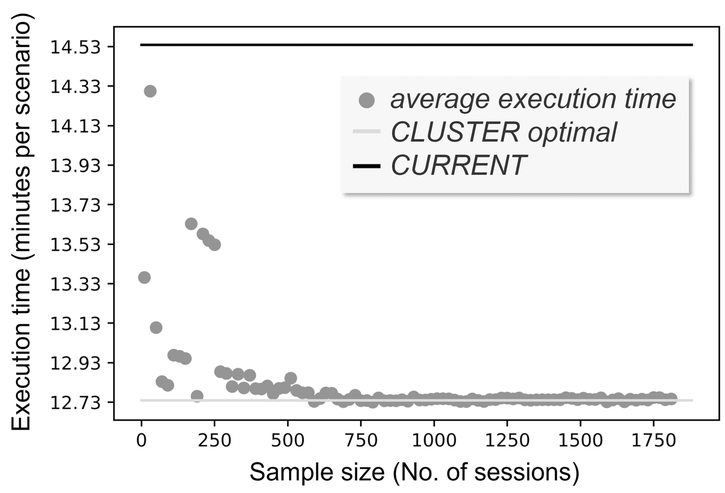
`OPT(KS)` and `CLUSTER` achieve optimal results. `GROUP` fails and `OPT(GA)` needs much training. `NAIVE` and `MRUs` good for quick solutions.

`CLUSTER` needs about 500 user sessions to optimize, `NAIVE` and `OPT(KS)` need about 2000, making **`CLUSTER`** ***the best algorithm.***



Method	Novices	Training Time (s)
ALL	18.5%	-
GROUP	0.6%	-
NAIVE	13.2%	7.8
MRU-B	10.4%	74.2
MRU-O	13.5%	1.2*
OPT(KS)	17.43%	1,946
OPT(GA)	17.40%	19,749*
CLUSTER	17.43%	2035

good
optimal
bad



References:
[1] Stuart K. Card, Thomas P. Moran, and Allen Newell. 1980. The Keystroke-Level Model for user performance time with interactive systems. *Commun. ACM 23,* 7 (1980), 396-410.

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