ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

Distributed Systems Seminar 2012

Using T-Patterns to Derive Stress Factors of Routine Tasks

Brdiczka et al. CHI 2009

Presentation by Andreas Tschofen

The Papers

- Using T-Patterns to Derive Stress Factors of Routine Tasks (Brdiczka et al.)

  CHI 2009, Work in progress

- The Routineness of Routines: Measuring Rhythms of Media Interaction

  Human Computer Interaction (journal)

Overview

- Study
  - Shadowed 10 knowledge workers for 3 days each
  - Recorded computer activity,...
- Approach
  - Use T-pattern analysis to find temporal patterns (fine granularity routines) in a participant‘s work
  - Investigate correlation between features of the discovered patterns and perception of workload, autonomy and productivity

How does this fit into our seminar?

- Detect routines
- Understand routine work

  → Find ways to support routine work with computer systems
- Quantify routineness of tasks
- Understand routineness and psychology

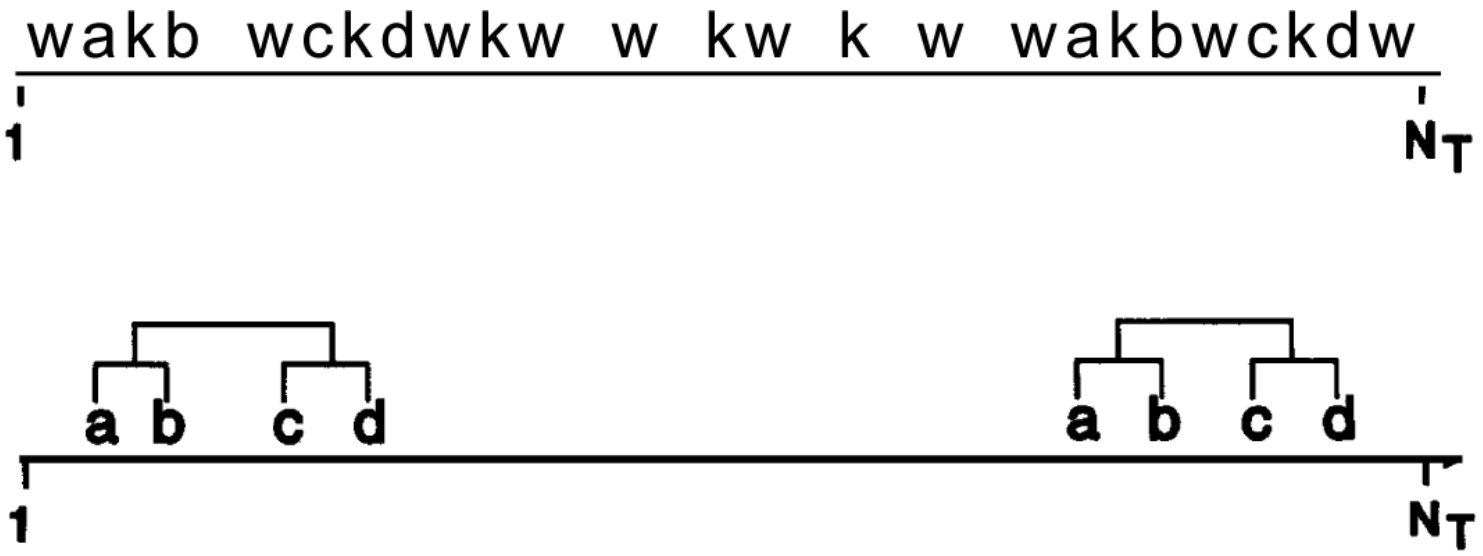
T-patterns (Magnusson)

- Patterns of events occuring approximately within a certain temporal configuration
- Traditional techniques...
  - focus on sequential patterns (eg., „it is a pattern that event B occurs right after event A“)
  - do not incorporate time (eg., „it is a pattern that event B occurs within roughly 10 minutes after event A, although there might be different events in between“)

T-patterns Algorithm

- Given: A sequence of events with start- and end-times
- Initialize: Each event is one pattern
- While not found all patterns with length <= l, do for each pair of patterns:
  - CI test: check whether the temporal distances between the pairs of instances of the patterns are random
  - If not: Add composite pattern with critical interval CI, instances are the pairs within CI

Example



Data

- Logging software
  - Application, window type and position, active document, e-mail (sender and recipient)
- Observer
  - Activities‘ start/end times, artifcats used, interactions, goals, relevant quotes
  - Video and audio

Media Interactions (Journal paper)

- Units of activity, e.g.
  - Word
  - Browser
  - Stationery
  - Face-to-face
  - Phone
  - Self
- Media interactions are the events for the T-pattern algorithm

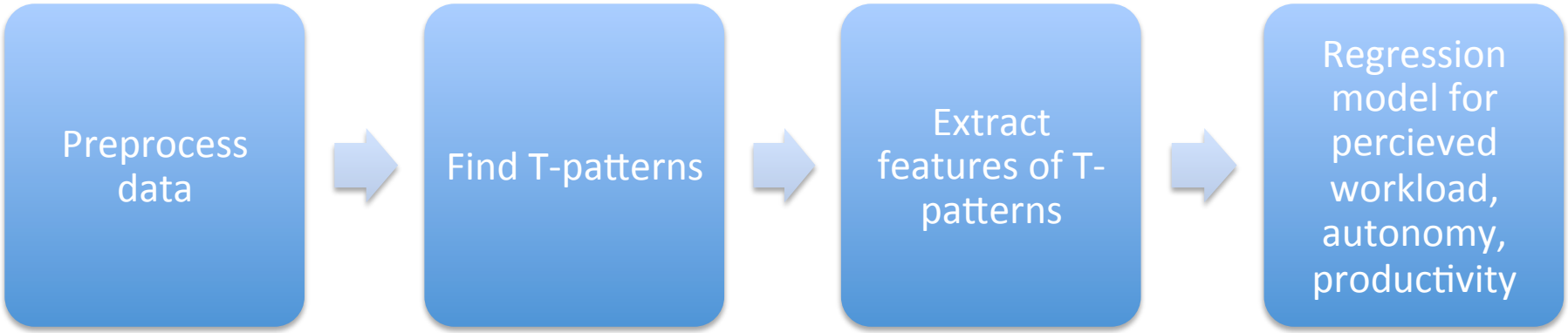
Working Spheres (Journal paper)

- A working sphere is a project/task modeled as a network of humans and artifacts
  - E.g. report status of project, close company revenues, gather and summarize IT metrics
  - May be paused and resumed
- Journal paper: Data was analyzed per working sphere

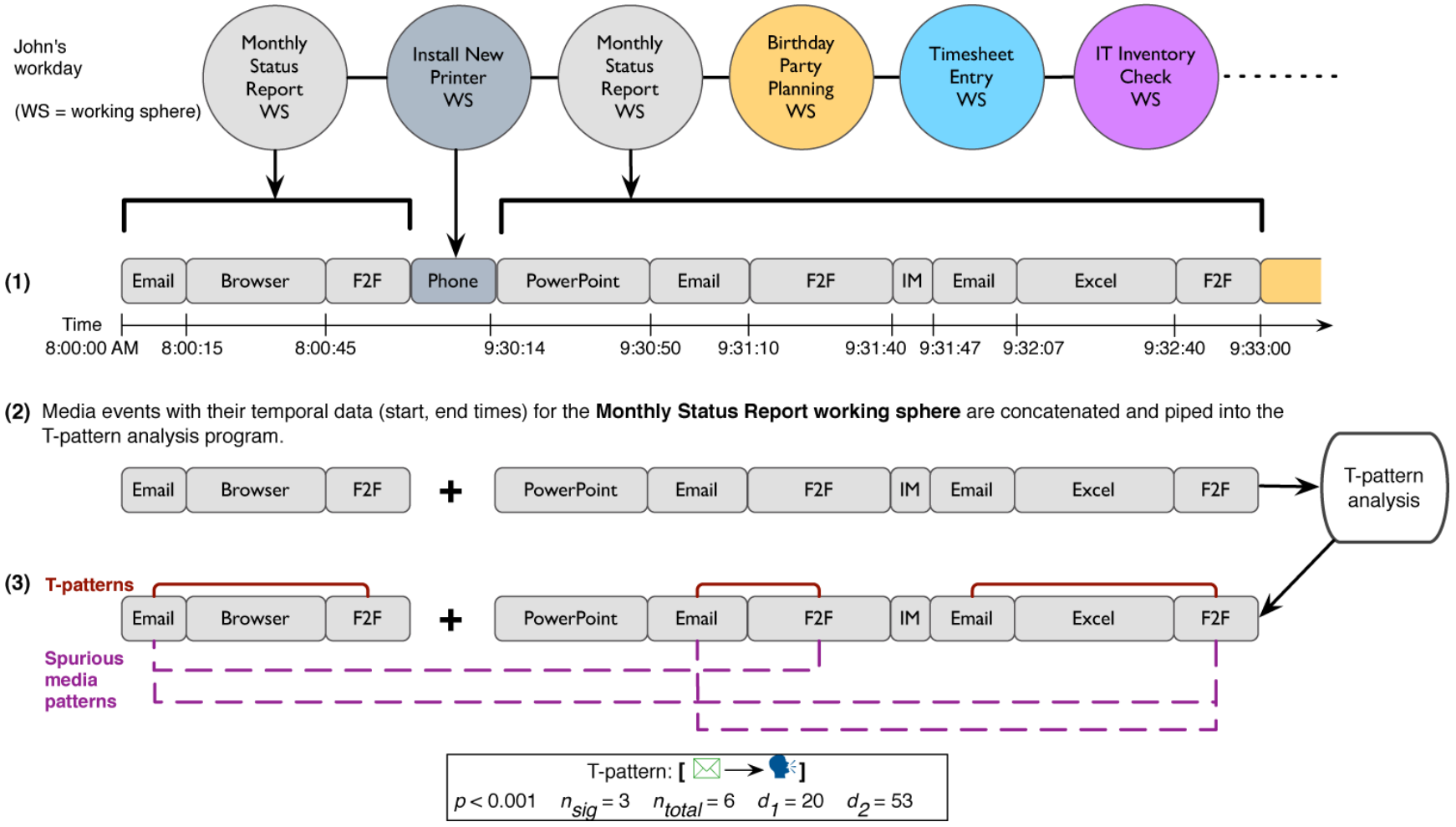
Perception Surveys

- Task Load Index (NASATLX)
  - Measure stress as a composite of workload, time pressure, effort and frustration
- Questions from Job Diagnostic Survey (JDS)
  - Job autonomy
- Healt and Work Questionnaire (HWQ)
  - Productivity

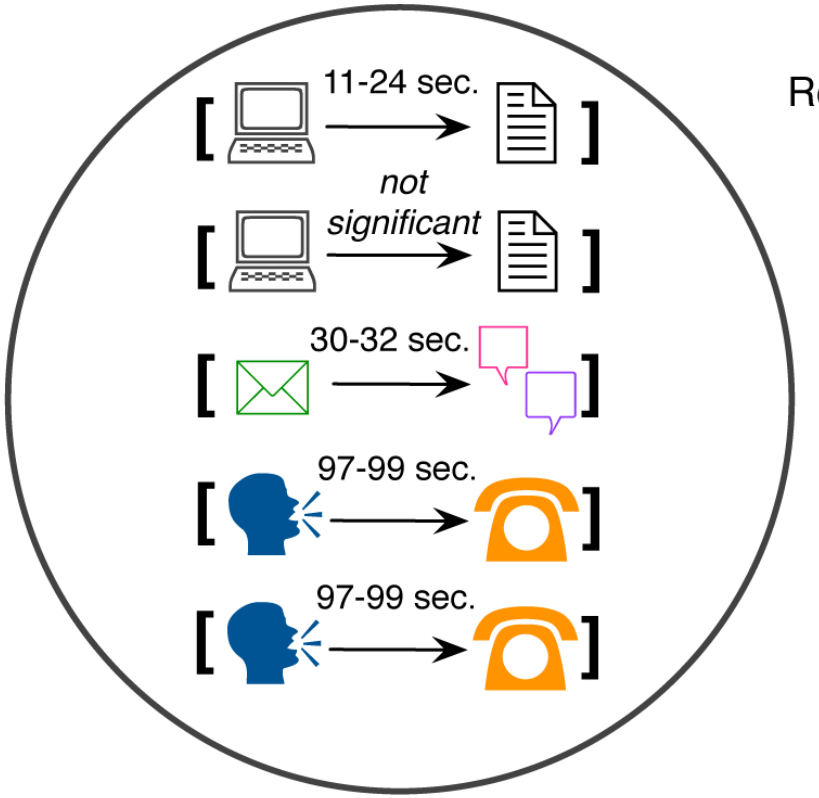
Analysis Pipeline



T-patterns and Working Spheres



T-pattern Statistics



Routineness of a Working Sphere

(1) $N_T = 3$

(2) $X_T = \frac{1+1+2}{3} = 1.\bar{3}$

(3) $Ratio_T = \frac{\frac{1}{2}+\frac{1}{1}+\frac{2}{2}}{3} = 0.8\bar{3}$

(4) $D_T = \frac{11+30+97\times 2}{4} = 56.25 \text{ sec.}$

(5) $VarD_T = sd(11, 30, 97, 97) \approx 44.84 \text{ sec.}$

Features that should characterize routineness

Only (1) and (4) used in CHI 2009 paper

Correlations in CHI 2009 Paper

		Workload	Autonomy	Productivity
appw class	N_t	0.33 (0.10)	0.07 (0.73)	0.07 (0.72)
	minL	-0.06 (0.75)	-0.15 (0.47)	-0.16 (0.43)
pos	N_t	0.24 (0.25)	0.09 (0.67)	-0.01 (0.95)
	minL	-0.20 (0.33)	-0.03 (0.88)	-0.15 (0.46)
doc	*N*	**0.45 (0.04)**	0.35 (0.12)	0.35 (0.12)
	minL	0.13 (0.58)	0.18 (0.43)	0.12 (0.59)
email	N_t	-0.18 (0.39)	0.08 (0.70)	-0.03 (0.87)
	minL	-0.20 (0.33)	-0.34 (0.10)	**-0.48 (0.02)**

Correlati 2009 Paper

More (repetitive) application window patterns – more workload

			my	Productivity
appw class	N_t	0.33 (0.10)	0.07 (0.73)	0.07 (0.72)
	minL	-0.06 (0.75)	-0.15 (0.47)	-0.16 (0.43)
pos	N_t	0.24 (0.25)	0.09 (0.67)	-0.01 (0.95)
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	minL	-0.20 (0.33)	-0.34 (0.10)	**-0.48 (0.02)**

More (repetitive) document usage patterns – more workload

Correlations in CHI 2009 Paper

		Workload	Autonomy	Productivity
appw class	N_t	0.33 (0.10)	0.07 (0.73)	0.07 (0.72)
	minL	-0.06 (0.75)	-0.15 (0.47)	-0.16 (0.43)
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email	N_t	-0.18 (0.39)	0.08 (0.70)	
	minL	-0.20 (0.33)	-0.34 (0.10)	**-0.48 (0.02)**

Longer minimal length of sender-recipient patterns – less productivity

Correlations in Journal Paper

	Workload	Autonomy	Productivity
Intercept	61.30^{***} (5.61)	21.69 (13.91)	30.26^{**} (12.25)
N_T	—	—	-0.87^{*} (0.50) 31.84%
X_T	-2.74^{**} (1.07) 42.37%	—	—
$Ratio_T$	—	34.69^{**} (17.18) 32.13%	21.01 (13.94) 27.62%
D_T	—	—	—
$VarD_T$	$1.71\times10^{-4**}$ (7.52×10^{-5}) 37.37%	-0.0001^{***} (0.00004) 43.19%	—
R^2	0.30	0.34	0.24

Standard errors are in parenthesis. *, **, *** indicates significance at 90%, 95%, 99%, respectively. Relative importance (LMG metric) are in percentages. The routineness metrics were averaged over working spheres averaged over days.

Correlations in Journal Paper

			Productivity
Intercept			30.26^{**} (12.25)
N_T			-0.87^{*} (0.50) 31.84%
X_T	-2.74^{**} (1.07) 42.37%	—	—
$Ratio_T$	—	34.69^{**} (17.18) 32.13%	21.01 (13.94) 27.62%
D_T	—	—	—
$VarD_T$	$1.71\times10^{-4**}$ (7.52×10^{-5}) 37.37%	-0.0001^{***} (0.00004) 43.19%	—
R^2	0.30	0.34	0.24

More reused T-pattern instances – less workload

Standard errors are in parenthesis. *, **, *** indicates significance at 90%, 95%, 99%, respectively. Relative importance (LMG metric) are in percentages. The routineness metrics were averaged over working spheres averaged over days.

Correlations in Journal Paper

	Workload	Autonomy	Productivity
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D_T	—	—	—
$VarD_T$	$1.71\times10^{-4**}$ (7.52×10^{-5}) 37.37%	-0.0001^{***} (0.00004) 43.19%	—
R^2	0.30	0.34	0.24

Higher significant T-pattern proportion – more autonomy

Standard errors are in parenthesis. *, **, *** indicates significance at 90%, 95%, 99%, respectively. Relative importance (LMG metric) are in percentages. The routineness metrics were averaged over working spheres averaged over days.

Correlations in Journal Paper

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R^2	0.30	0.34	0.24

More T-pattern classes – less productivity

Standard errors are in parenthesis. *, **, *** indicates significance at 90%, 95%, 99%, respectively. Relative importance (LMG metric) are in percentages. The routineness metrics were averaged over working spheres averaged over days.

Correlations in Journal Paper

	Workload	Autonomy	Productivity
Intercept	61.30^{***} (5.61)	21.69 (13.91)	30.26^{**} (12.25)
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X_T	-2.74^{**} (1.07) 42.37%	—	—
$Ratio_T$	—	34.69^{**} (17.18) 32.13%	21.01 (13.94) 27.62%
D_T	—	—	—
$VarD_T$	$1.71\times10^{-4**}$ (7.52×10^{-5}) 37.37%	-0.0001^{***} (0.00004) 43.19%	—
R^2	0.[illegible]		0.24

More variability in temporal distances – more workload, less autonomy

Standard errors are in parenth[illegible] 90%, 95%, 99%, respectively. Relative importa[illegible] he routineness metrics were averaged over working spheres averaged over days.

Interesting Differences

CHI 2009

- The more T-patterns detected, the higher the workload (and productivity for #docs)
- The lower the time between e-mails, the higher the productivity

Journal

- The more T-patterns detected, the lower the productivity
- No significant correlations with minimum temporal length

Causality?

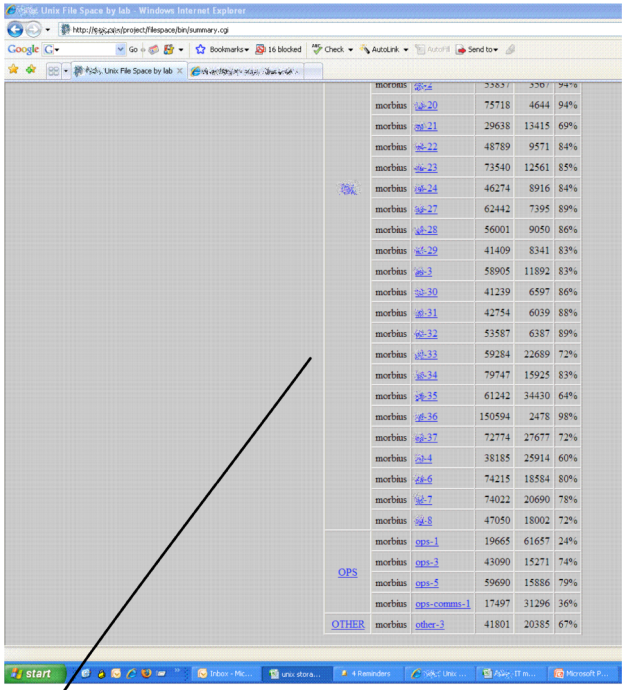
„Thus, it seems that the reuse of routine temporal patterns reduces stress, but variability in the actual distance in events increases stress.“

Causality?

„This might indicate that people who are able to use a variety of media with relatively stable temporal durations (e.g., productivity software vs. interruptions from interactions) have more control over how they work.”

Journal Paper: Clustering

- Clustering of working spheres of participants
  - Based on T-pattern features
  - Authors chose 4 clusters



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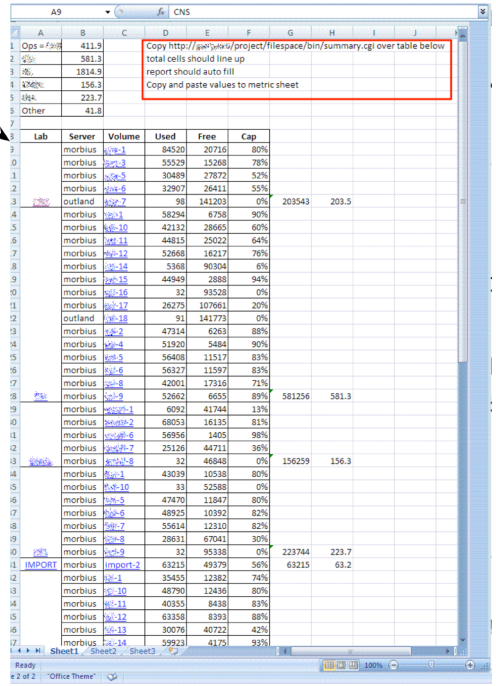
	morbius	[illegible]-20	75718	4644	94%
	morbius	[illegible]-21	29638	13415	69%
	morbius	[illegible]-22	48789	9571	84%
	morbius	[illegible]-23	73540	12561	85%
[illegible]	morbius	[illegible]-24	46274	8916	84%
	morbius	[illegible]-27	62442	7395	89%
	morbius	[illegible]-28	56001	9050	86%
	morbius	[illegible]-29	41409	8341	83%
	morbius	[illegible]-3	58905	11892	83%
	morbius	[illegible]-30	41239	6597	86%
	morbius	[illegible]-31	42754	6039	88%
	morbius	[illegible]-32	53587	6387	89%
	morbius	[illegible]-33	59284	22689	72%
	morbius	[illegible]-34	79747	15925	83%
	morbius	[illegible]-35	61242	34430	64%
	morbius	[illegible]-36	150594	2478	98%
	morbius	[illegible]-37	72774	27677	72%
	morbius	[illegible]-4	38185	25914	60%
	morbius	[illegible]-6	74215	18584	80%
	morbius	[illegible]-7	74022	20690	78%
	morbius	[illegible]-8	47050	18002	72%
	morbius	ops-1	19665	61657	24%
OPS	morbius	ops-3	43090	15271	74%
	morbius	ops-5	59690	15886	79%
	morbius	ops-comms-1	17497	31296	36%
OTHER	morbius	other-3	41801	20385	67%



	A	B	C	D	E	F	G	H	I	J
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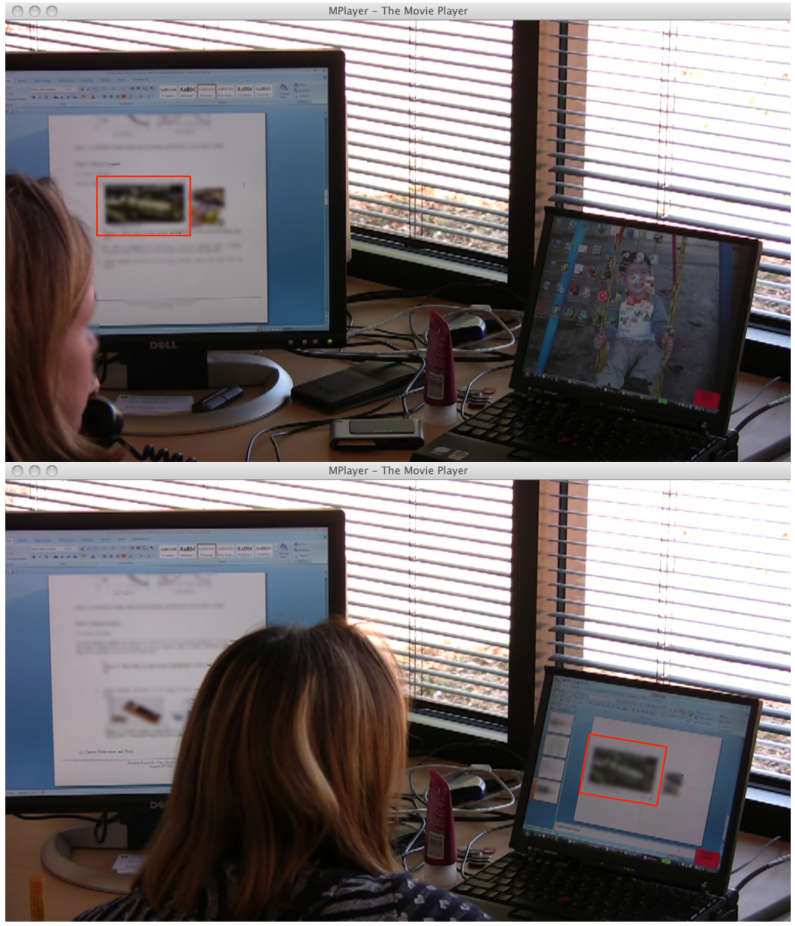
2	[illegible]	581.3		total cells should line up						
3	[illegible]	1814.9		report should auto fill						
4	[illegible]	156.3		Copy and paste values to metric sheet						
5	[illegible]	223.7								
6	Other	41.8								
7										
8	Lab	Server	Volume	Used	Free	Cap				
9		morbius	[illegible]-1	84520	20716	80%				
10		morbius	[illegible]-3	55529	15268	78%				
11		morbius	[illegible]-5	30489	27872	52%				
12		morbius	[illegible]-6	32907	26411	55%				
13	[illegible]	outland	[illegible]-7	98	141203	0%	203543	203.5		
14		morbius	[illegible]-1	58294	6758	90%				
15		morbius	[illegible]-10	42132	28665	60%				
16		morbius	[illegible]-11	44815	25022	64%				
17		morbius	[illegible]-12	52668	16217	76%				
18		morbius	[illegible]-14	5368	90304	6%				
19		morbius	[illegible]-15	44949	2888	94%				
20		morbius	[illegible]-16	32	93528	0%				
21		morbius	[illegible]-17	26275	107661	20%				
22		outland	[illegible]-18	91	141773	0%				
23		morbius	[illegible]-2	47314	6263	88%				
24		morbius	[illegible]-4	51920	5484	90%				
25		morbius	[illegible]-5	56408	11517	83%				
26		morbius	[illegible]-6	56327	11597	83%				
27		morbius	[illegible]-8	42001	17316	71%				
28	[illegible]	morbius	[illegible]-9	52662	6655	89%	581256	581.3		
29		morbius	[illegible]-1	6092	41744	13%				
30		morbius	[illegible]-2	68053	16135	81%				
31		morbius	[illegible]-6	56956	1405	98%				
32		morbius	[illegible]-7	25126	44711	36%				
33	[illegible]	morbius	[illegible]-8	32	46848	0%	156259	156.3		
34		morbius	[illegible]-1	43039	10538	80%				
35		morbius	[illegible]-10	33	52588	0%				
36		morbius	[illegible]-5	47470	11847	80%				
37		morbius	[illegible]-6	48925	10392	82%				
38		morbius	[illegible]-7	55614	12310	82%				
39		morbius	[illegible]-8	28631	67041	30%				
40	[illegible]	morbius	[illegible]-9	32	95338	0%	223744	223.7		
41	IMPORT	morbius	import-2	63215	49379	56%	63215	63.2		
42		morbius	[illegible]-1	35455	12382	74%				
43		morbius	[illegible]-10	48790	12436	80%				
44		morbius	[illegible]-11	40355	8438	83%				
45		morbius	[illegible]-12	63358	8393	88%				
46		morbius	[illegible]-13	30076	40722	42%				
47		morbius	[illegible]-14	59923	4175	93%				

Cluster 1

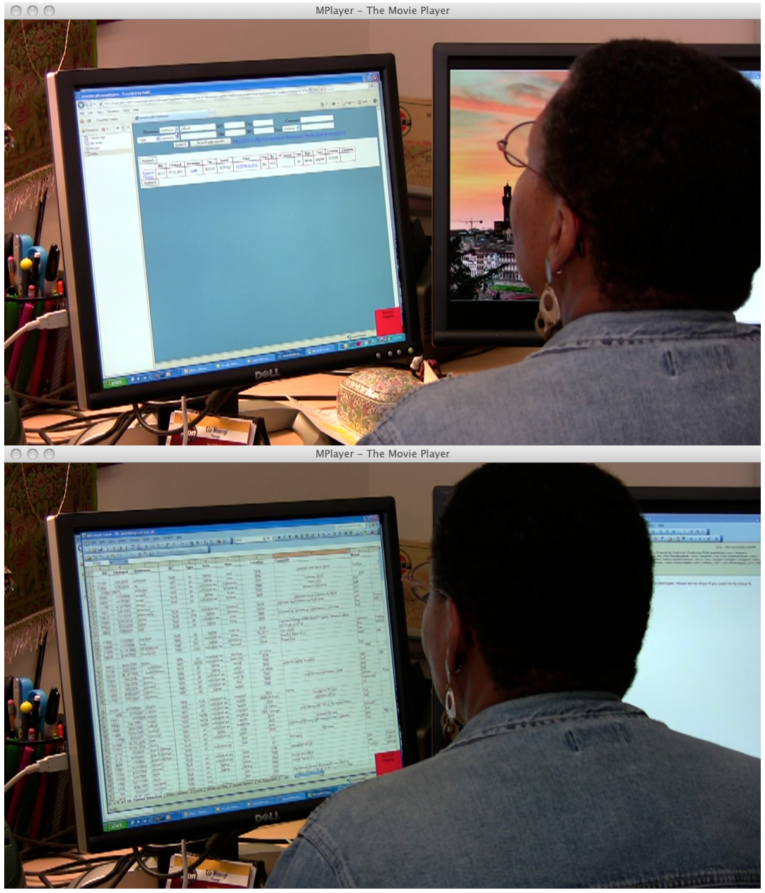
- Typical routine tasks
- High number of T-pattern classes and instances, high variability in temporal distance
- Example:
  - Head of IT updating IT metrics
  - Various sources: browser, e-mail, calculator, Windows Explorer, Word as intermediate processing tool

Cluster 3



- High temporal distance and variability
- Example:
  - Research manager assembling status report to funding agency
  - Collect reports from subordinates

Cluster 4



- Average routineness, fewer significant instances, less variability in time
- Example:
  - Administrative assistant checking which computers are defunct
  - Different sources (IT e-mail, own spreadsheet, IT inventory website)
  - Location of data is not known with precision

Contributions

- Considering organization and routines from a temporal point of view
- Routineness measures based on media interaction (journal paper only)
- Exploring qualitative data about patterns
- Relationships between routineness features and psychological/mental state

Limitations

- Generalizability?
- Media interaction granularity
- Parameters?

  Maximum pattern length = 4 „to filter only reasonable pattern sizes“
- Unclear how a measure of routineness could increase tools

Thank you for your Attention!