USING LOG FILES TO IDENTIFY SEQUENTIAL PATTERNS IN PIAAC PROBLEM SOLVING ENVIRONMENTS BY U.S. ADULTS' EMPLOYMENT STATUS

MAKING RESEARCH RELEVANT

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Introduction

- As one of the innovation pioneers in international large-scale assessments, PIAAC is the first international household survey of adult skills that includes **measures of ICT literacy skills, digital reading, and problem solving in technology-rich environments** **(PSTRE)** , besides traditional core assessments in numeracy and literacy.
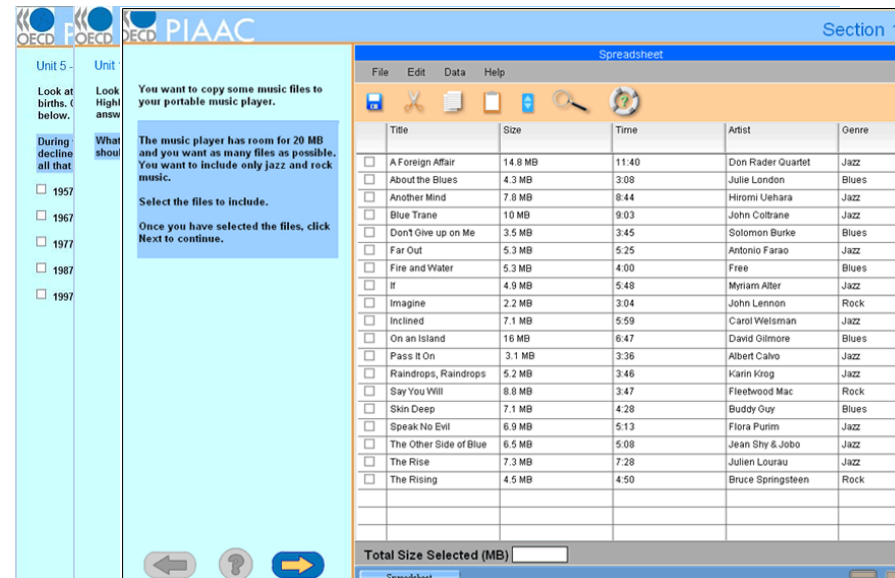
Introduction

- The use of computers as the delivery platform as PIAAC enables data collection not just on whether test takers are able to solve the tasks **(response data)** but how they approach the solution and how much time their efforts take **(process data from log files)**.

- Such a new data source is especially valuable in PSTRE, which provides the possibility in **deeper understanding** about people's problem solving behaviors, **tracking the problem solving sequence**, thus, help in **detecting the reasons** of success or failure in an digital task.

PIAAC Main Study
PSTRE Average Scores & Achievement-level Percentages

Legend: ■ <Level 1   ■ Level 1   ■ Level 2   ■ Level 3

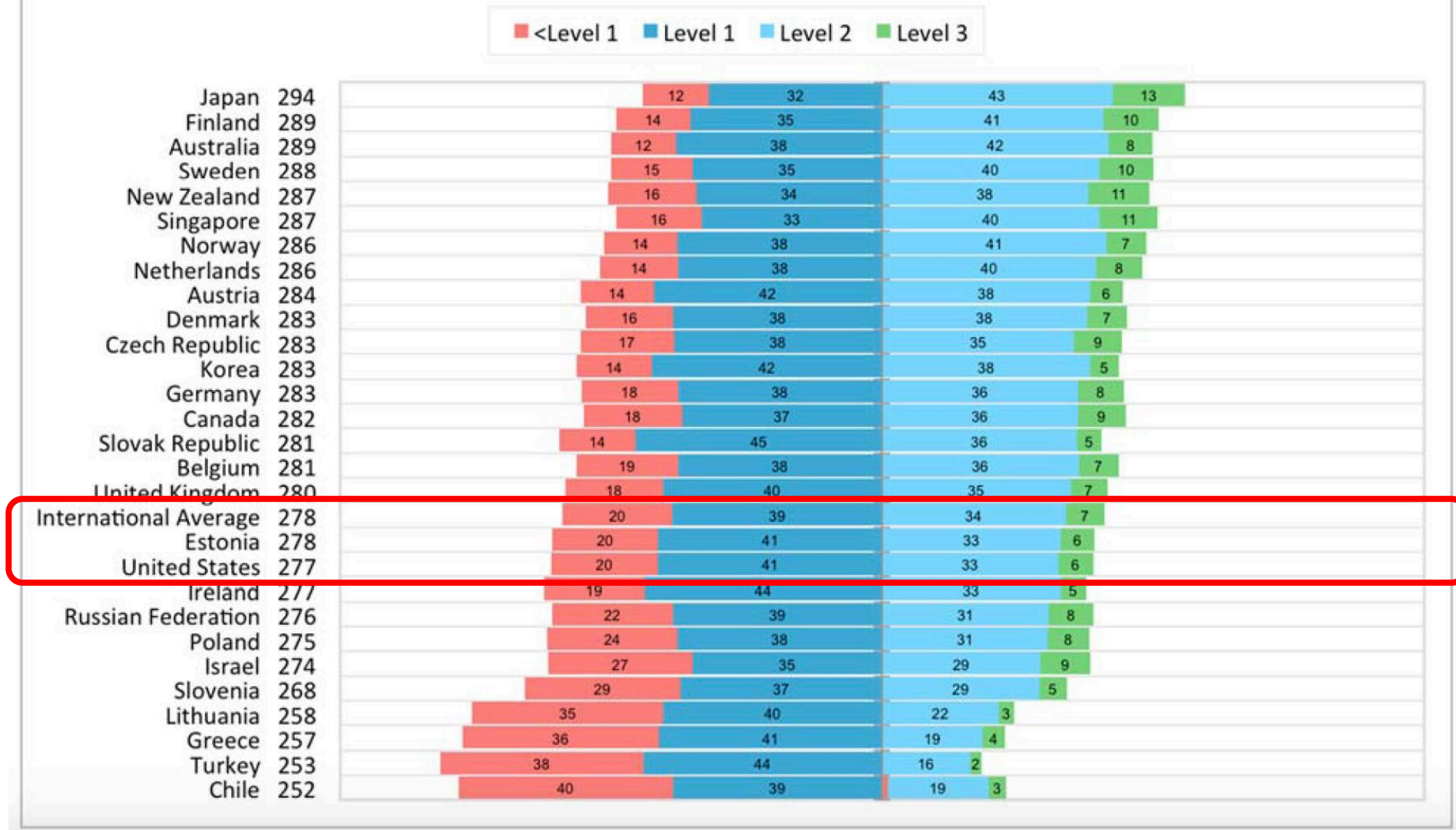| Country	Score	<Level 1	Level 1	Level 2	Level 3
Japan	294	12	32	43	13
Finland	289	14	35	41	10
Australia	289	12	38	42	8
Sweden	288	15	35	40	10
New Zealand	287	16	34	38	11
Singapore	287	16	33	40	11
Norway	286	14	38	41	7
Netherlands	286	14	38	40	8
Austria	284	14	42	38	6
Denmark	283	16	38	38	7
Czech Republic	283	17	38	35	9
Korea	283	14	42	38	5
Germany	283	18	38	36	8
Canada	282	18	37	36	9
Slovak Republic	281	14	45	36	5
Belgium	281	19	38	36	7
United Kingdom	280	18	40	35	7
International Average	278	20	39	34	7
Estonia	278	20	41	33	6
United States	277	20	41	33	6
Ireland	277	19	44	33	5
Russian Federation	276	22	39	31	8
Poland	275	24	38	31	8
Israel	274	27	35	29	9
Slovenia	268	29	37	29	5
Lithuania	258	35	40	22	3
Greece	257	36	41	19	4
Turkey	253	38	44	16	2
Chile	252	40	39	19	3

Figure 18.7 from OECD (2016)

US PSTRE Results

- These results are disappointing, especially when evaluated against the significant financial investment we provide for learners in our national education system and relatively easy access to digital technology in this country.

What is wrong?

Which group is lagged behind?

The Current Study

- This research project aims at identifying **malleable factors** associated with problem solving skills that can be of use in improving these competences in adult education.

- We take advantage of new methods for analyzing **process data in log files** to identify key factors associated with PSTRE.

- We compare patterns in problem solving derived from a closer examination of the different strategies used by groups that vary in **employment-related background profiles** (e.g., job category, learning at work, salary).

Research Questions

1. What features can be extracted from process data by different employment status?

- **Top-down**: extract sequential features by subgroups with different employment statuses.

Research Questions

2. **Clustering test takers based on features extracted from process data, what do test takers in each cluster have in common regarding employment-related variables?**

- **Bottom-up**: cluster test takers by sequential features and explore the characteristics of the clusters.

Research Questions

3. **What are the differences between test takers whose response behaviors are consistent vs. inconsistent?**

- **Consistency**: investigate the characteristics of test takers whose response behaviors are consistent vs. inconsistent.

Data

- Public-use data file (5,010 U.S. test takers):
  - Background questionnaire (BQ)
  - cognitive response data
  - response time

- Log file from PIAAC 2012 study (2,014 U.S. test takers)

- Representative items:
  - U02 (Meeting Room Assignment Item)
  - U19a (Bike Club ID Item)

CNTRYID	SEQID	booklet_id	item_id	event_name	event_type	timestamp	event_description
ZA6712_US.data	4	PS2	4	taoPIAAC	START	0	TEST_TIME=357
ZA6712_US.data	4	PS2	4	stimulus	MAIL_VIEWED	23272	id=u02_item101
ZA6712_US.data	4	PS2	4	stimulus	MAIL_VIEWED	30686	id=u02_item102
ZA6712_US.data	4	PS2	4	stimulus	MAIL_VIEWED	33439	id=u02_item103
ZA6712_US.data	4	PS2	4	stimulus	MAIL_VIEWED	39795	id=u02_item104
ZA6712_US.data	4	PS2	4	stimulus	MAIL_VIEWED	58766	id=u02_item101
ZA6712_US.data	4	PS2	4	stimulus	MAIL_VIEWED	60168	id=u02_item102
ZA6712_US.data	4	PS2	4	stimulus	MAIL_VIEWED	61630	id=u02_item103
ZA6712_US.data	4	PS2	4	stimulus	MAIL_VIEWED	65616	id=u02_item104
ZA6712_US.data	4	PS2	4	stimulus	ENVIRONMENT	72955	environment=WB
ZA6712_US.data	4	PS2	4	stimulus	HISTORY_ADD	77366	pageid=unit02page1|*$title=View Calendar|*$url=htt...
ZA6712_US.data	4	PS2	4	stimulus	HISTORY_ADD	79163	pageid=unit02page2
ZA6712_US.data	4	PS2	4	stimulus	HISTORY_ADD	82387	pageid=unit02page3
ZA6712_US.data	4	PS2	4	stimulus	HISTORY_ADD	87596	pageid=unit02page1|*$title=View Calendar|*$url=htt...
ZA6712_US.data	4	PS2	4	stimulus	ENVIRONMENT	92367	environment=MC
ZA6712_US.data	4	PS2	4	stimulus	MAIL_VIEWED	101802	id=u02_item101
ZA6712_US.data	4	PS2	4	stimulus	ENVIRONMENT	112145	environment=WP
ZA6712_US.data	4	PS2	4	stimulus	ENVIRONMENT	113393	environment=MC
ZA6712_US.data	4	PS2	4	stimulus	ENVIRONMENT	115926	environment=WB

RQ1 – Features of Different Employment Statuses

Phase 1: Regression Analysis

Select variables from BQ → Regression analyses → Identify significant predictors & levels to correctness of item U02

Phase 2: Feature Identification

Identify robust features by subgroups ← Extract sequential features from process data ← Form subgroups based on significant levels
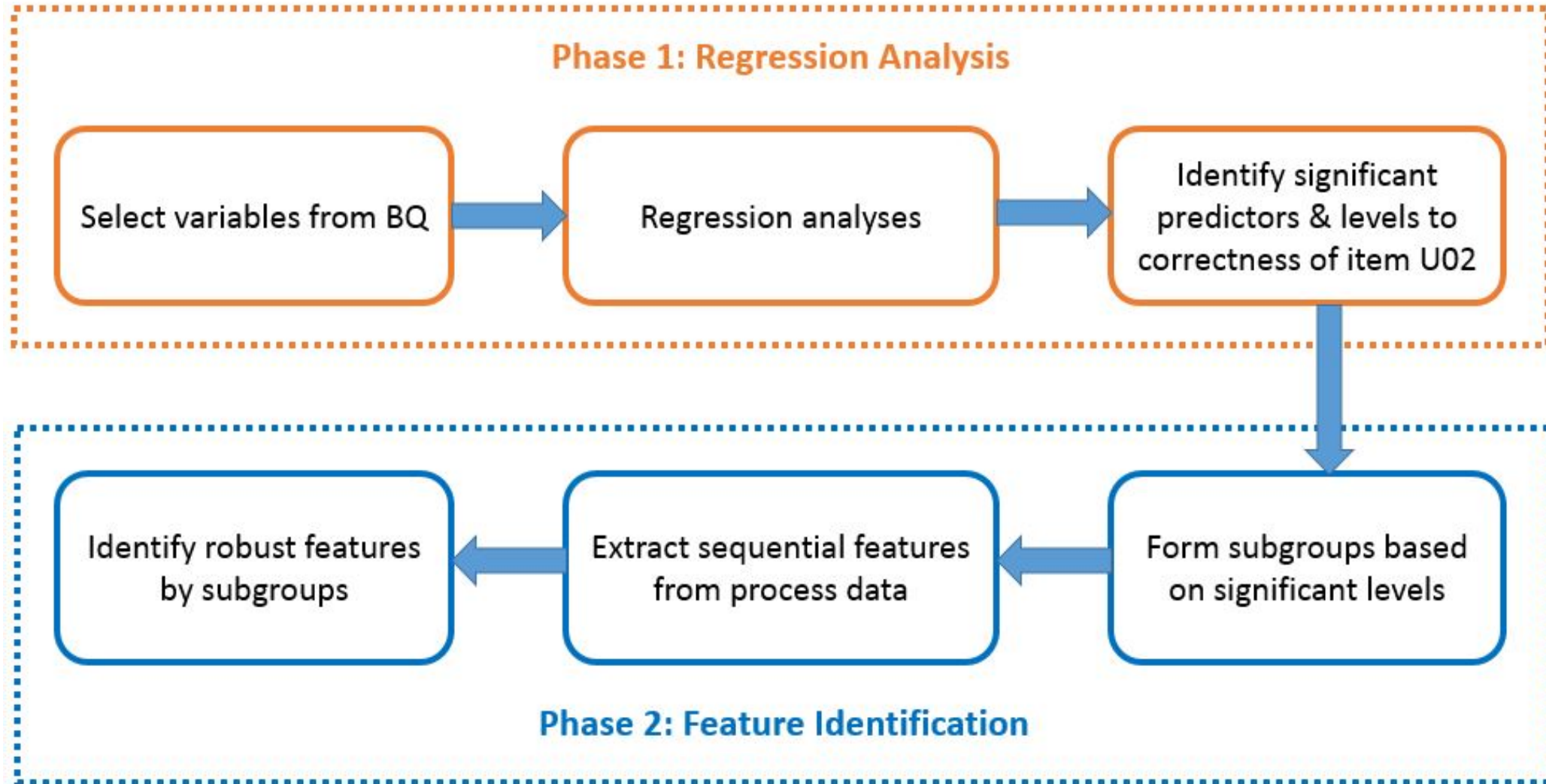
RQ1 – Features of Different Employment Statuses

- Higher PSTRE scores and odds of success on U02: well-educated young test takers with more work experience and higher work-related skill use.

- Unique significant variable for PSTRE—index of reading skill use at work.

Actions used in higher reading skill use group	Actions used in lower reading skill use group
MAIL_VIEWED	MAIL_MOVE
COMBOBOX	FOLDER_VIEWED
CHANGE_RESERVATION	SUBMIT_RESERVATION_FAILURE

RQ2 – Cluster Analyses

- Apply k-means clustering on 36 features from process data on U02.

- 34 unigrams, number of actions and response time on U02.

- Cluster test takers into three clusters by their effort on U02.

Cluster Centroids of A Three-Cluster Solution
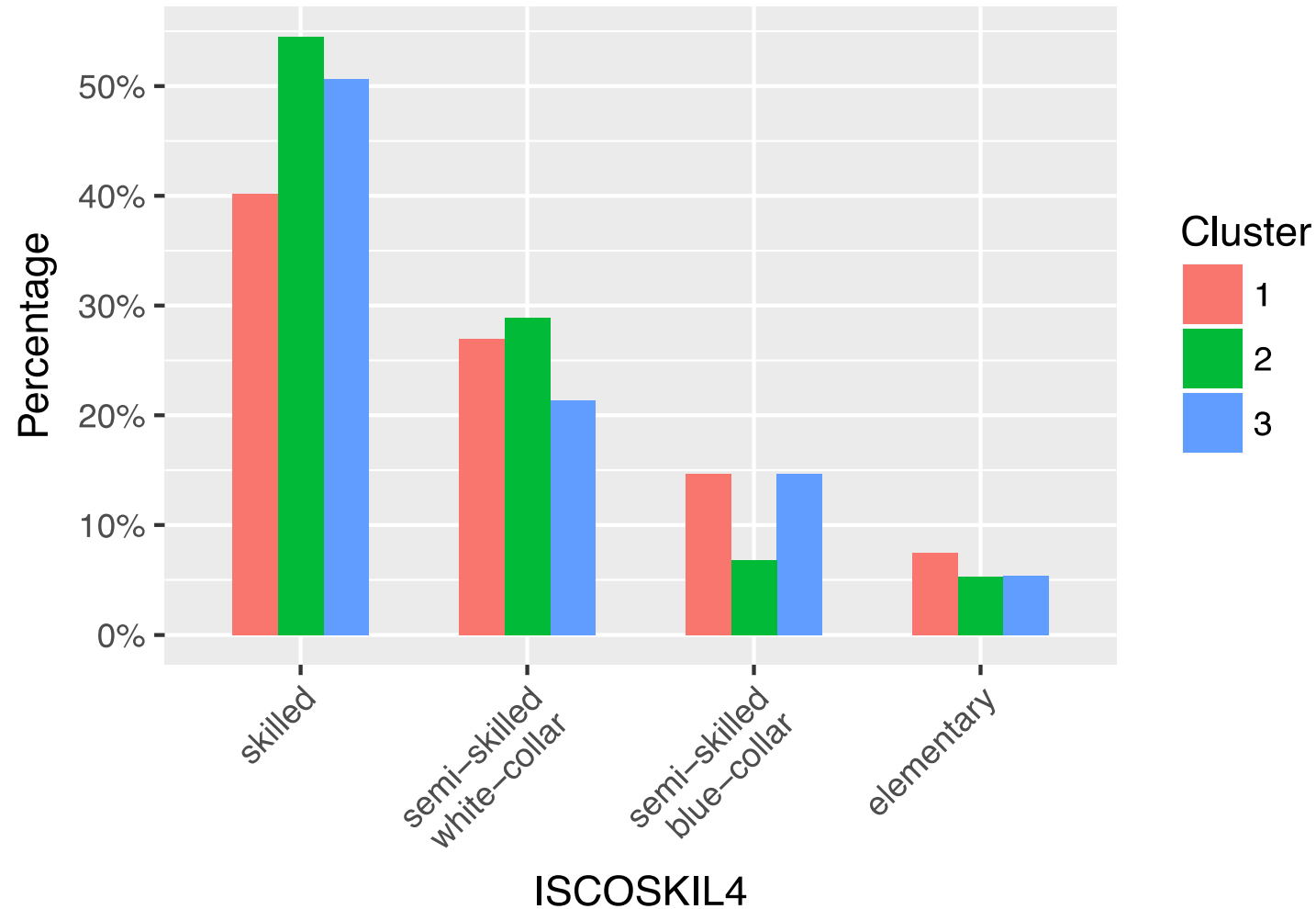## (Rescaled by 1000)

	MAIL_VIEWED_1	No. of Actions	Response Time	Sample Size
■ Cluster 1	8.6	453.7	58.4	853
■ Cluster 2	23.6	2241.6	244.4	398
■ Cluster 3	42.7	5225.4	475.3	75
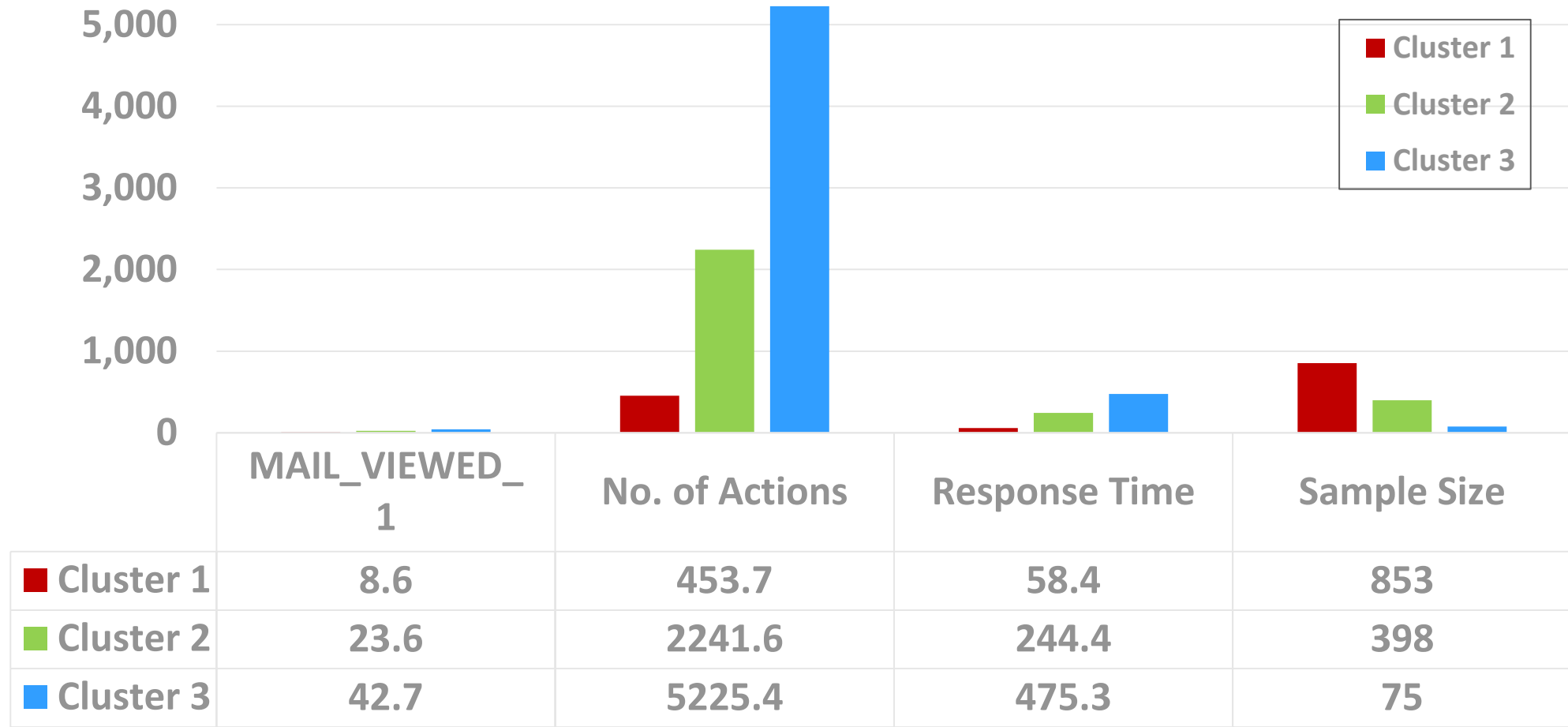
RQ2 – Cluster Analyses
Relationship between Cluster Membership and PSTRE Scores
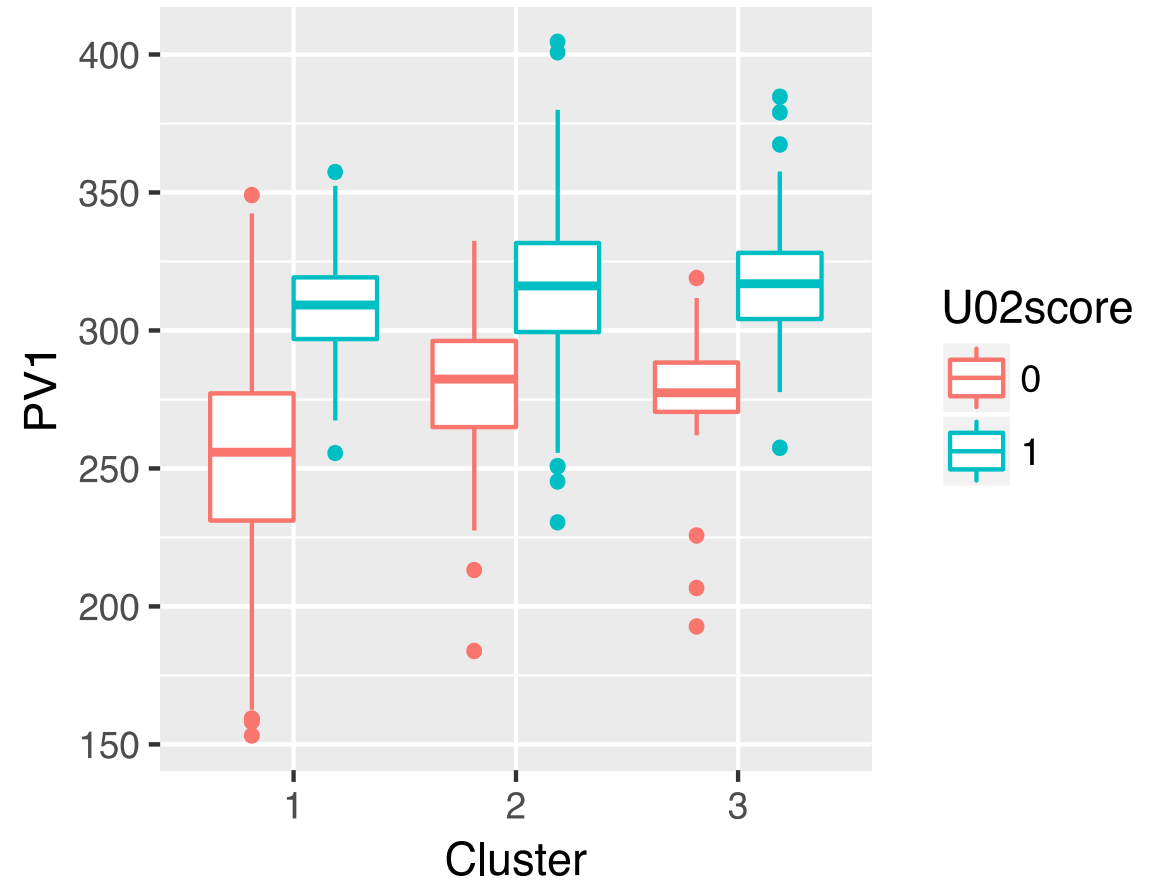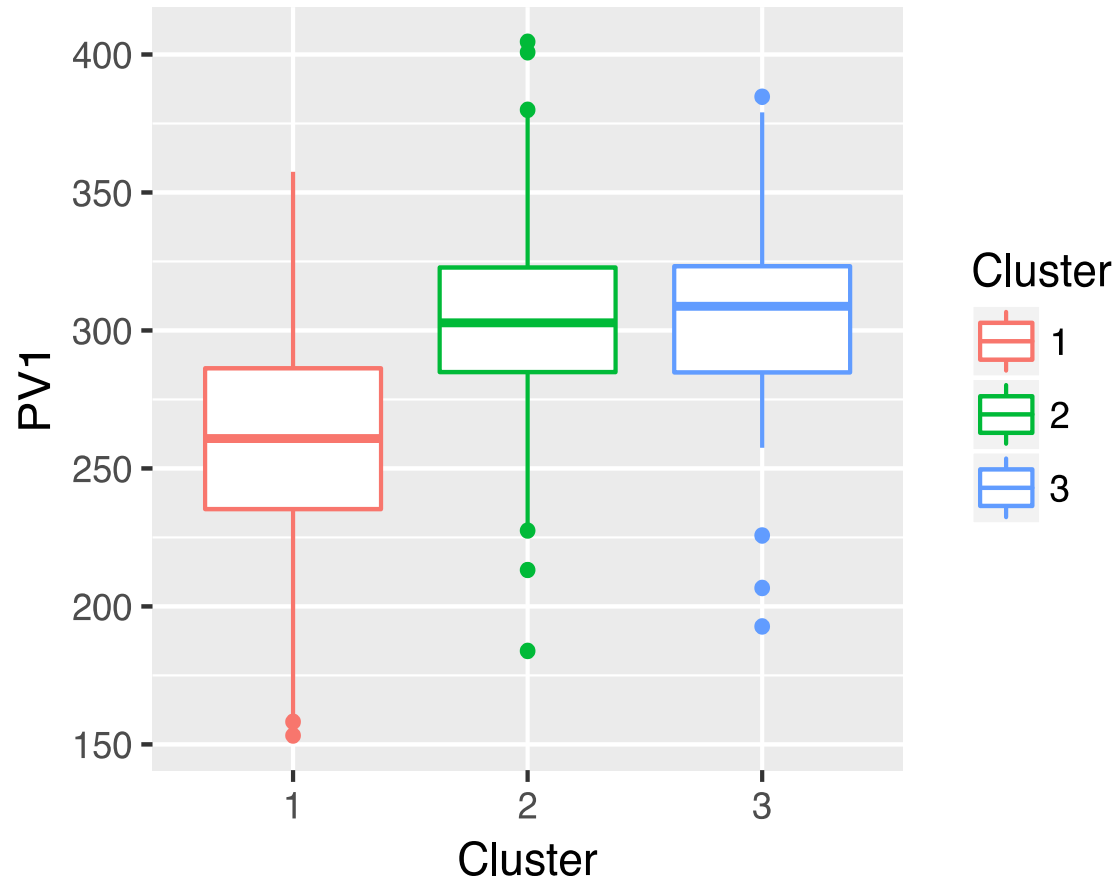
RQ2 – Cluster Analyses
Relationship between Cluster Membership and Occupation Types
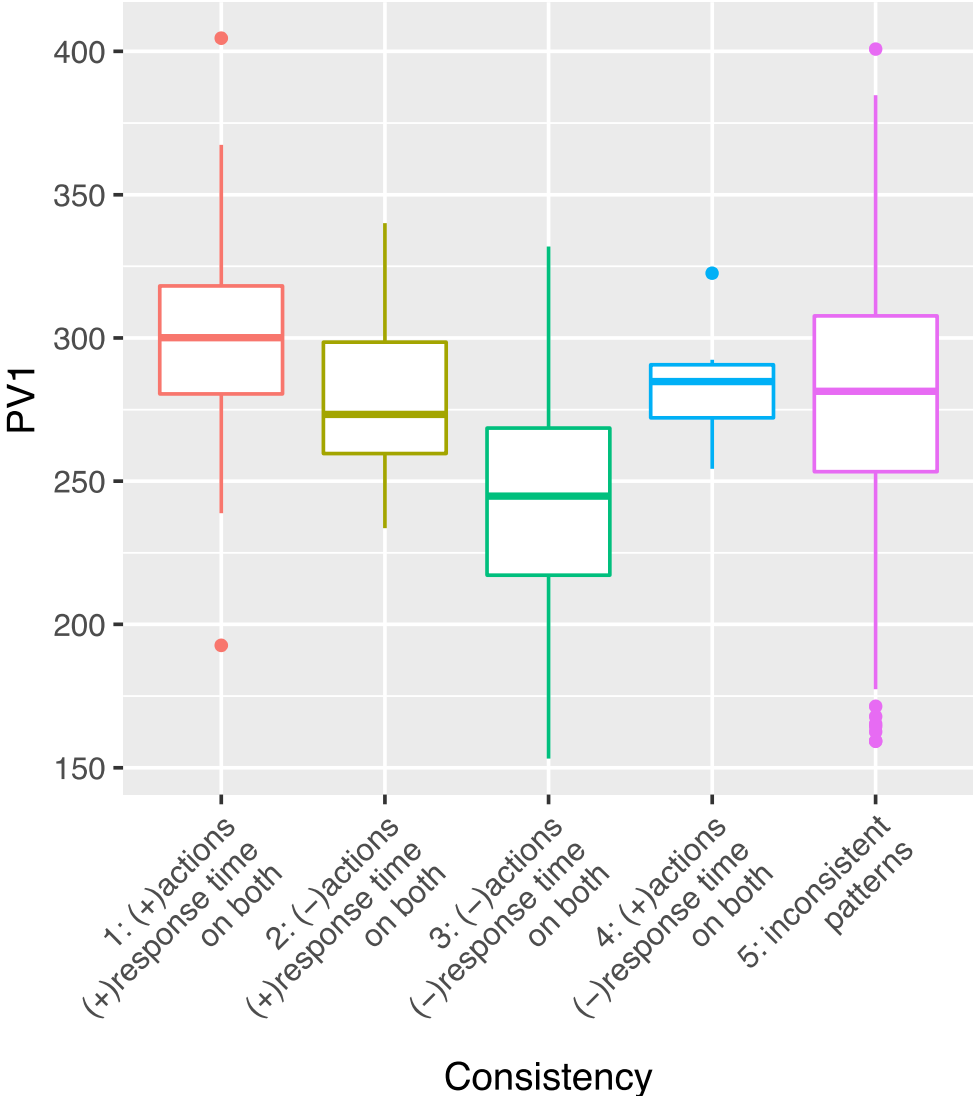
RQ3 – Consistency Analyses

- Divide test takers into four quadrants based on the medians of number of actions and response time from U02 and U19a.

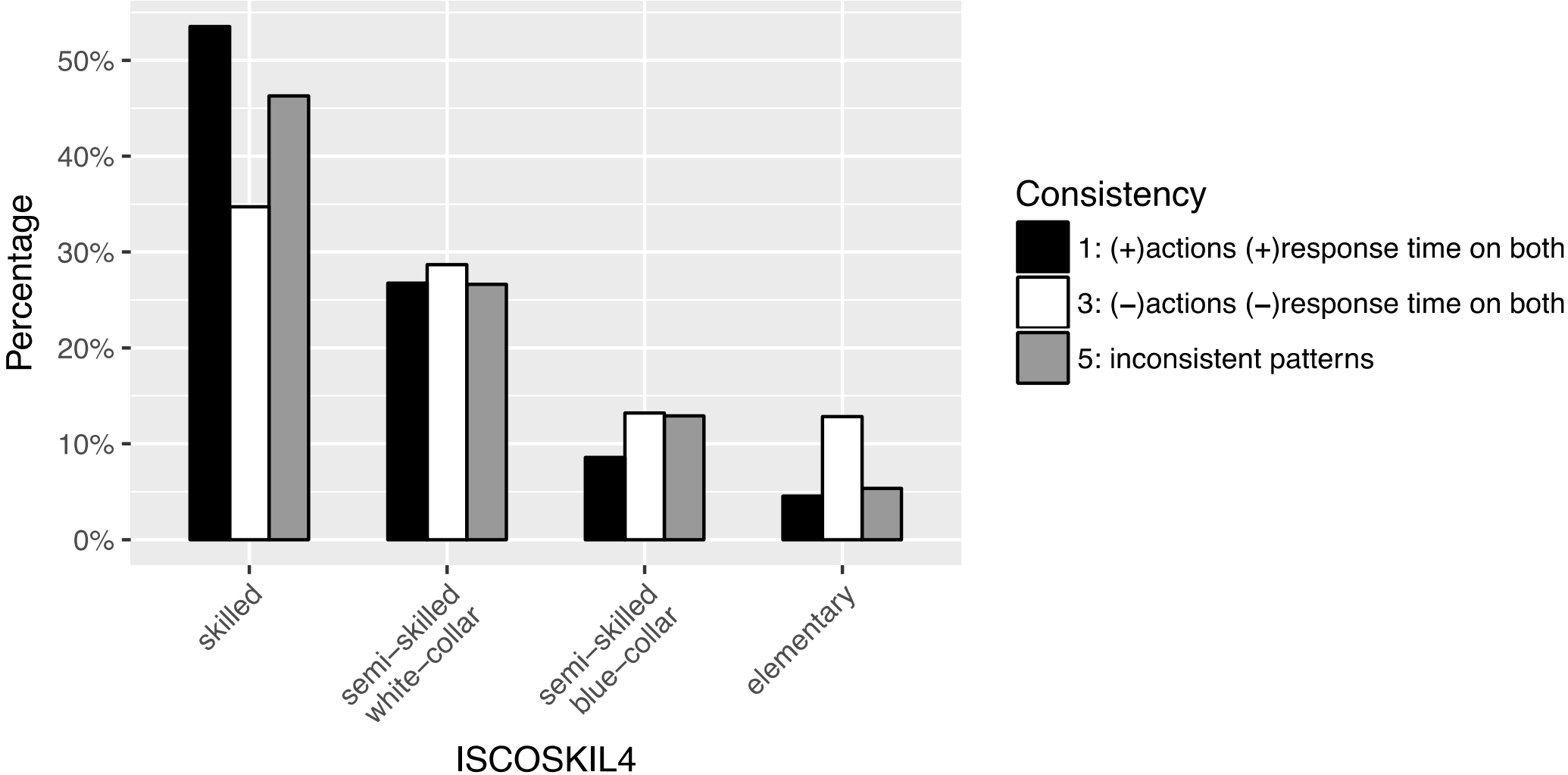- Group test takers into five consistency groups based on the quadrants.
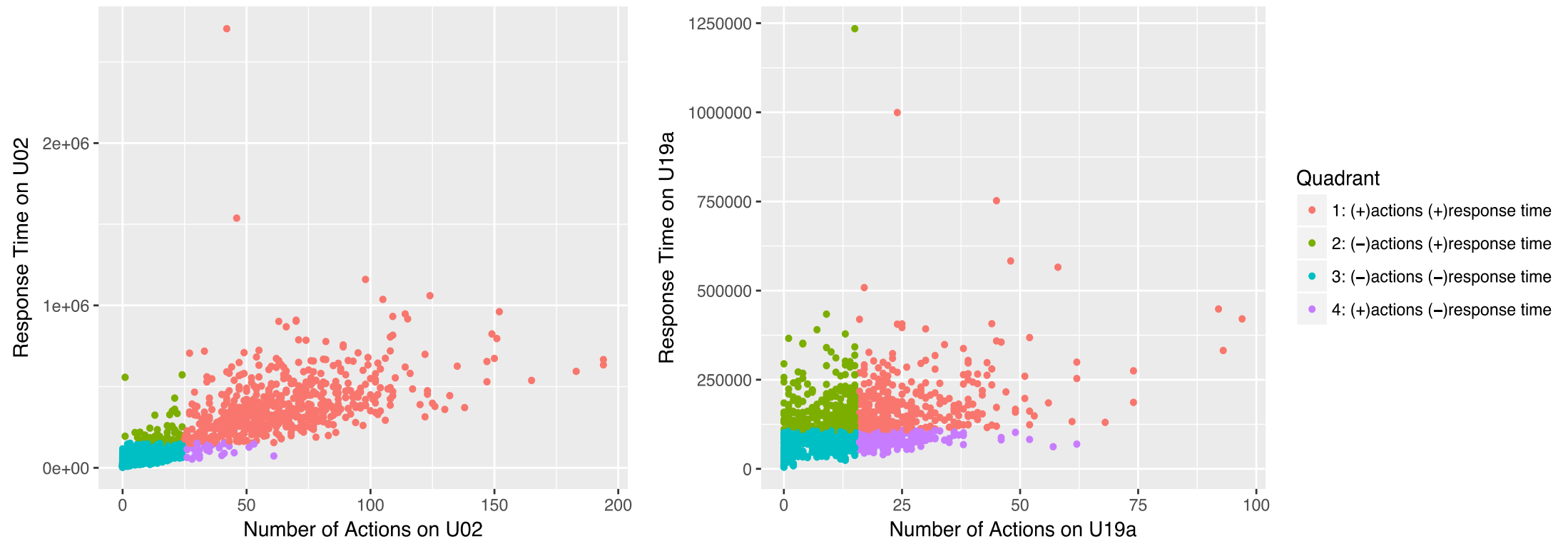
RQ3 – Consistency Analyses

Consistency	Sample Size
1	198
2	11
3	265
4	6
5	860

RQ3 – Consistency Analyses

Findings

- Young and well-educated test takers with more work experience and higher work-related skills have higher chance to succeed in solving digital tasks.

- The higher-performing group is more likely to use actions with clear sub-goals, whereas the lower-performing group shows more frequent uses of aimless actions.

- Test takers with the most effort have the highest proficiency level, but do not necessarily possess the highest income, work-related skill use, or education level.

- Special attention needs to be paid to subgroups of elder test takers who possess non-skilled occupations with lower income, work-related skill use and education, for their consistent patterns in low-effort and lower proficiency levels in PSTRE.

Implications

- This project not only yields advances in methodology for others to use in the future but also provides insights about the strategies that differentiate high and low PSTRE proficiency and how it relates to adults' employment status.

- This would be of importance for policymakers to better understand the strategies that different subgroups use to solve digital problems, hence finding better solutions to improve U.S. adults' problem solving skills.

- Future study could develop an approach to generalize problem solving patterns by multiple items to get more reliable results.

FURTHER INQUIRES:

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THANK YOU

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