



Integrative **A**nalysis of **L**ongitudinal **S**tudies on **A**ging

www.ialsa.org

Big Data, Big Analysis:

A Collaborative Modeling Framework for Multi-study Replication

Andriy V. Koval

University of Victoria

William H. Beasley

University of Oklahoma

Andrea Piccinin

University of Victoria

Graciela Muniz-Terrera

University of Edinburgh

Scott Hofer

University of Victoria



Integrative Analysis of Longitudinal Studies on Aging

www.ialsa.org

- The IALSA network ([NIH/NIA 1P01AG043362](https://www.nih.gov/NIH/NIA/1P01AG043362)) is comprised of over **100 longitudinal studies** on aging, health and dementia.
 - Mix of samples aged from **birth to 100 years**
 - Assessed from **1921 to the present**.
 - Monitoring each individual for **4 to 48 years**
 - Time between assessments **6 months to 17 years**
- Focus on the **reproducibility of results** (i.e., direction and pattern of effects) across **populations**, historical **periods**, **measurements**, **designs**, and statistical **models**.
- **Research aim**: *To maintain and enhance cognitive and physical health and well-being throughout the lifespan*



IALSA Approach: **Coordinated Analysis with Replication** (CAR)

- Finds common/similar measures among studies (maelstrom-research.org)
- Fits same models to many longitudinal studies
- Meta-analyzes model solutions
- **Aim:** *Maximize value from each study while providing comparable results*
- Expect similar conclusions regardless of the exact variables used.
- Evaluation of sensitivity to statistical model
- Meta-Analysis / Meta-Regression

Hofer, S. M., & Piccinin, A. M. (2009). Integrative data analysis through coordination of measurement and analysis protocol across independent longitudinal studies. *Psychological Methods, 14*(2), 150.



IALSA **Portland** Workshop *Feb 23-25, 2015* (github.com/IALSA/IALSA-2015-Portland)

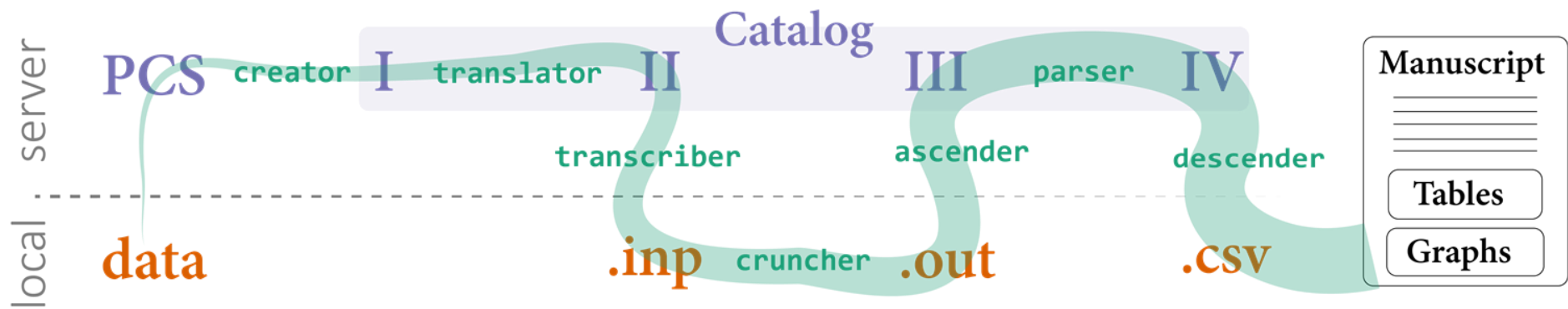
- **Primary aim:** To examine the associations between changes in
 - **physical functioning** (e.g., grip strength, pulmonary function) and
 - **cognitive functioning** (e.g., memory, reasoning)
 - in multiple-study comparative framework.
- **Research foci:** To examine concurrent decline between
 - Pulmonary function – Cognition
 - Grip Strength – Cognition
 - Gait – Cognition
 - Cognition: Within and across cognitive domains
 - Physical functioning: Across pulmonary, grip, gait
- **Bivariate linear growth curve** models
- Adjustment for age, sex, education, height, health behaviors and outcomes

IALSA **Portland** Workshop *Feb 23-25, 2015* (github.com/IALSA/IALSA-2015-Portland)

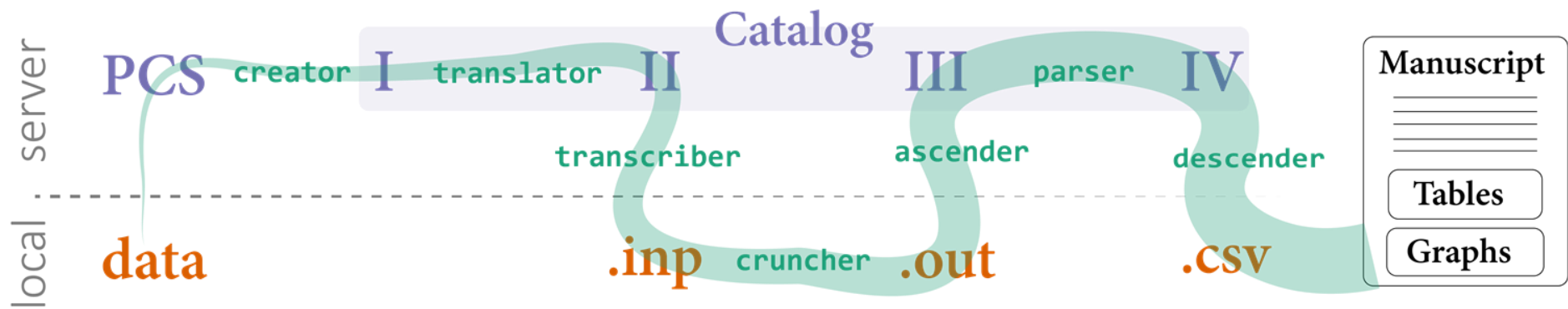
Study		Driver
Einstein Aging Study	EAS	Andrea Zammit
English Longitudinal Study of Aging	ELSA	Annie Robitaille
Health and Retirement Study	HRS	Chenkai Wu
Interdisciplinary Longitudinal Study of Aging	ILSE	Philipp Handschuh
Normative Aging Study	NAS	Lewina Lee
Quebec Longitudinal Study on Nutrition and Aging	NuAge	Valerie Jarry
Octogenarian Twins	OCTO	Marcus Praetorius
Rush Memory and Aging Project	MAP	Cassandra Brown
Swedish Adoption Twin Study of Aging	SATSA	Deborah Finkel

Portland, OR
Feb 23-25, 2015

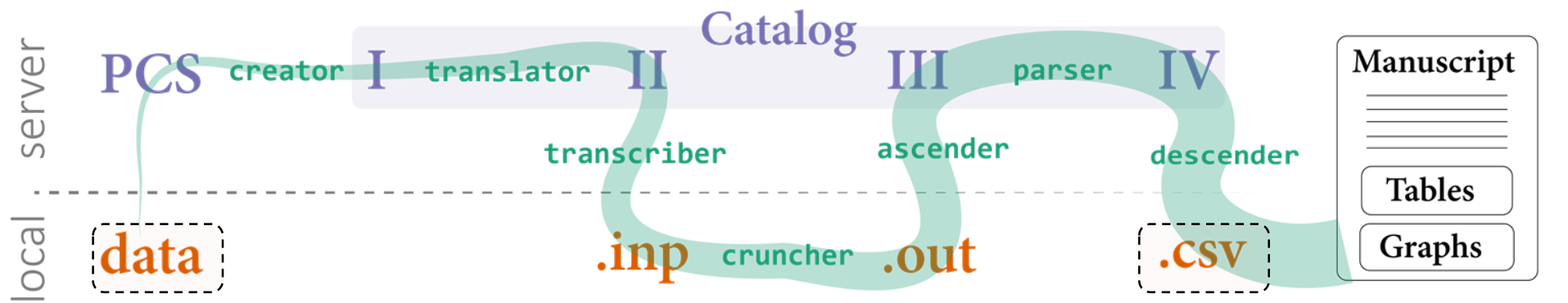




This is the
 WORKFLOW MAP
 of the coordinated analysis.



Next,
we will show you
what each element and process
IS and DOES.

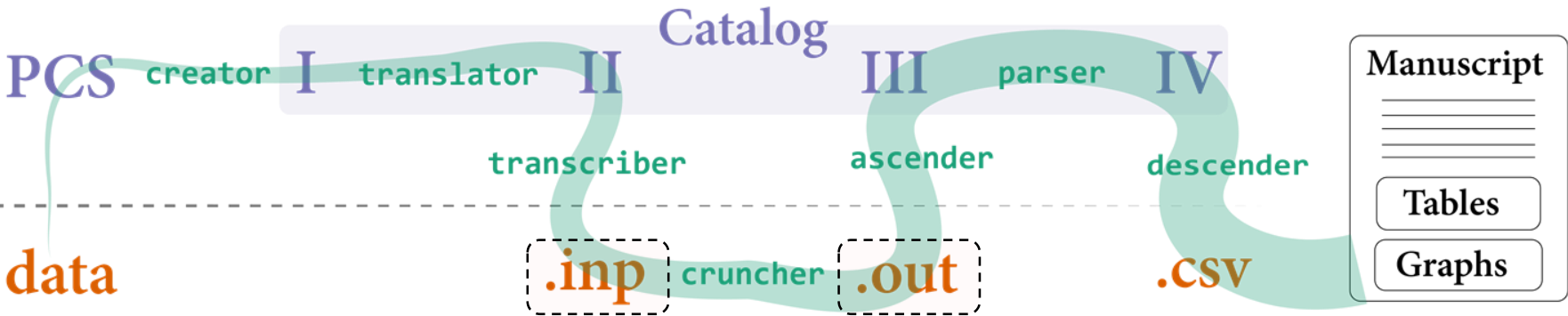


These are
language-agnostic, tabulated DATA FILES.
They can be used by any software (R, SAS, STATA, Mplus, etc)



	A	B	C	D	E	F	H	I	J	Q	R	S	T	U
1	study_name	model_number	subgroup	model_type	subject_count	wave_count	LL	aic	bic	ab_TAU_00_est	ab_TAU_00_se	ab_TAU_00_wald	ab_TAU_00_pval	ab_TAU_00_
2	eas	b1	female	ae	580	8	-12370.4	24790.79	24899.86	-214.803	119.207	-1.802	0.072	-1.4
3	eas	b1	female	ae	593	8	-8766.76	17583.53	17693.16	24.846	13.797	1.801	0.072	0.6
4	eas	b1	female	ae	572	8	-8975.66	18001.32	18110.05	69.278	19.852	3.49	0	1.0
5	eas	b1	female	ae	524	7	-7043.93	14137.86	14244.4	5.151	9.445	0.545	0.586	-0.2
6	eas	b1	female	ae	594	8	-9357.93	18765.87	18875.54	55.35	19.105	2.897	0.004	0.8
7	eas	b1	female	ae	594	8	-6681.55	13413.11	13522.78	5.336	4.51	1.183	0.237	0.1
8	eas	b1	female	ae	595	8	-7094.86	14239.72	14349.44	17.044	5.765	2.956	0.003	0.3
9	eas	b1	female	ae	554	8	-8065.42	16180.84	16288.77	8.647	9.337	0.926	0.354	0.1
10	eas	b1	female	ae	383	8	-3871.71	7793.415	7892.116	10.378	5.741	1.808	0.071	-0.0
11	eas	b1	female	ae	563	8	-8499.24	17048.48	17156.81	31.673	13.058	2.426	0.015	0.4
12	eas	b1	female	ae	592	8	-9307.2	18664.39	18773.98	69.62	20.65	3.371	0.001	1.4
13	eas	b1	female	ae	150	8	-4939.77	9937.539	10024.85	-219.554	185.685	-1.182	0.237	-1.1
14	eas	b1	female	ae	150	8	-3582.45	7222.909	7310.217	16.88	20.942	0.806	0.42	0.8
15	eas	b1	female	ae	150	8	-3709.14	7476.282	7563.591	81.433	32.4	2.513	0.012	0.8
16	eas	b1	female	ae	130	7	-2632.36	5322.718	5405.877	15.274	13.399	1.14	0.254	-0.4
17	eas	b1	female	ae	150	8	-3714.27	7486.538	7573.847	60.856	26.394	2.306	0.021	1.
18	eas	b1	female	ae	150	8	-2825.3	5708.606	5795.914	9.225	7.158	1.289	0.197	0.2
19	eas	b1	female	ae	150	8	-2910.72	5879.44	5966.749	14.142	7.545	1.874	0.061	0.3
20	eas	b1	female	ae	150	8	-3450.76	6959.528	7046.837	10.8	13.947	0.774	0.439	0.2

	id	year_bl	age_bl	year_born	male_bl	edu_bl	height_cm_bl	diabetes_bl	cardio_bl	smoke_bl	age_t1	age_t2	age_t3	age_t4	age_t5	age_t6	animals_t1	animals_t2	animals_t3	animals_t4	animals_t5	animals_t6
1	103712	2002	55	1947	0	4	172.20	1	0	0	55	57	59	61	63	65	18	24	15	16	23	NA
2	103713	2002	71	1931	1	3	NA	0	0	0	71	73	75	NA	NA	NA	10	9	8	NA	NA	NA
3	103714	2002	51	1950	0	4	169.50	0	0	0	51	53	55	57	59	61	33	27	19	28	31	NA



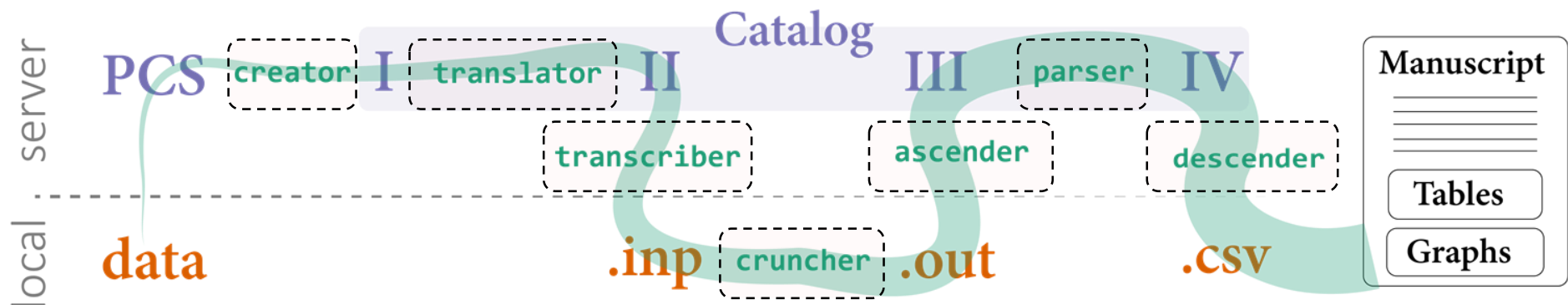
```
Mplus (M20000701) -win-64-categori-female-walsh
M> file edit view status Plot Diagram Window Help
M> FILE EDIT VIEW STATUS PLOT DIAGRAM WINDOW HELP
MODELS: FIT INFORMATION
Number of free parameters      27
Loglikelihood
  MD Value                    -26716.001
  MD Scaling Correction Factor  1.0313
Information Criteria
  Akaike (AIC)                  53416.002
  Bayesian (BIC)                 53558.917
  Sample-size Adjusted DIC       53572.522
  (df = (m - 2) / J)
MODLS RESULTS
  Estimate   S.E.   Std./S.E.   Two-Tailed
  A1  ASE_SL    -0.023    0.001   -20.819    0.000
  A2  EOU_SL    -0.024    0.004   - 3.732    0.000
  A3  KEGTOM_CM  0.025    0.002    15.963    0.000
  DA  ASE_SL    -0.001    0.000   - 0.235    0.820
  DA  EOU_SL    -0.001    0.001   - 0.210    0.830
  DA  KEGTOM_CM  0.000    0.000    0.639    0.523
  ID  ASE_SL    -0.123    0.014   - 8.820    0.000
  ID  EOU_SL    -0.410    0.064   - 6.374    0.000
  ID  KEGTOM_CM  0.102    0.020    5.213    0.000
  ID  ASE_SL    -0.037    0.003   - 9.787    0.000
  ID  EOU_SL    -0.010    0.012   - 0.776    0.430
  ID  KEGTOM_CM  -0.004    0.004   - 0.942    0.346
  IA  ASE_SL    0.000    0.000    0.000    1.000
  IA  EOU_SL    0.000    0.000    0.000    1.000
  IA  KEGTOM_CM  0.000    0.000    0.000    1.000
  IB  ASE_SL    0.143    0.065    2.189    0.029
  IB  EOU_SL    0.000    0.009    0.039    0.968
  IA  WITH     0.000    0.009    0.039    0.968
  IB  WITH     -0.009    0.017   - 0.498    0.619
  IB  WITH     0.000    0.003    0.008    0.993
  IB  WITH     0.000    0.009    0.039    0.968
  A2  WITH     -0.005    0.031   - 0.177    0.860
  A4  WITH     -0.005    0.031   - 0.177    0.860
```

Mplus

These are input and output files consumed and produced by Mplus.

Mplus

Mplus - [M20000701]-win-64-categori-female-walsh				
Variable	Mean	SD	SE	CI
A1	-0.023	0.001	0.001	-0.025 -0.021
A2	-0.024	0.004	0.004	-0.032 -0.016
A3	0.025	0.002	0.002	0.021 0.029
DA	-0.001	0.000	0.000	-0.001 0.000
DA	-0.001	0.001	0.001	-0.002 0.000
DA	0.000	0.000	0.000	-0.000 0.000
ID	-0.123	0.014	0.014	-0.147 -0.099
ID	-0.410	0.064	0.064	-0.534 -0.286
ID	0.102	0.020	0.020	0.062 0.142
ID	-0.037	0.003	0.003	-0.043 -0.031
ID	-0.010	0.012	0.012	-0.024 0.004
ID	-0.004	0.004	0.004	-0.013 0.005
IA	0.000	0.000	0.000	0.000 0.000
IA	0.000	0.000	0.000	0.000 0.000
IA	0.000	0.000	0.000	0.000 0.000
IB	0.143	0.065	0.065	0.009 0.277
IB	0.000	0.009	0.009	-0.029 0.029
IA	0.000	0.009	0.009	-0.029 0.029
IB	-0.009	0.017	0.017	-0.036 0.017
IB	0.000	0.003	0.003	-0.003 0.003
IB	0.000	0.009	0.009	-0.029 0.029
A2	-0.005	0.031	0.031	-0.071 0.061
A4	-0.005	0.031	0.031	-0.071 0.061



These are R SCRIPTS
Run in RStudio and coordinated in GitHub



```

1 # Read the file to 'Projecthaus'
2 # For a brief description of this file see the presentation at
3 # https://www.cpa.ca/2016-06-09-cpa/README.html
4 # Under: https://www.cpa.ca/2016-06-09-cpa/README.html#presentation
5 # Clear the variables from previous runs.
6
7 # Load packages
8 # Call require() on any R packages that define functions needed below. Ideally, use eval()
9 # to load packages
10 # Load packages
11 # Attach these packages so their functions don't need to be qualified: https://rstats.had.co.nz/man/
12 library(MASS)
13 library(RShiny)
14 library(reshape2)
15
16 # Verify these packages are available on the machine, but their functions need to be qualified by
17 requireNamespace("RShiny")
18 requireNamespace("Rcpp")
19 requireNamespace("RcppEigen")
20 requireNamespace("RcppEigen")
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100 requireNamespace("RcppEigen")
  
```

master

Filter repositories

ALSAS-2015-Portland

Update README.md 25 hours ago by Andriy V. Kovak

init readme and abstract 1 day ago by Andriy V. Kovak

Reverse study order. Another attempt to coord... 2 days ago by Will Beasley

Merge branch 'master' of github.com:ALSAS-2015-Portland into master 3 days ago by Will Beasley

Random & Fixed Effects cosmetics 5 days ago by Will Beasley

Forests with plotmah. More conventional sub... 4 days ago by Will Beasley

Forest for fixed effects 4 days ago by Will Beasley

widen forest & rotate facet labels 5 days ago by Will Beasley

Start of forest plot loop 3 days ago by Will Beasley

Starting to pull CUs for graphs 8 days ago by Will Beasley

Initial forest plot 20 days ago by Will Beasley

rename datasets to help graphing 10 days ago by Will Beasley

Replace missing estimates with dashes 25 days ago by Will Beasley

Final fixes in random forests

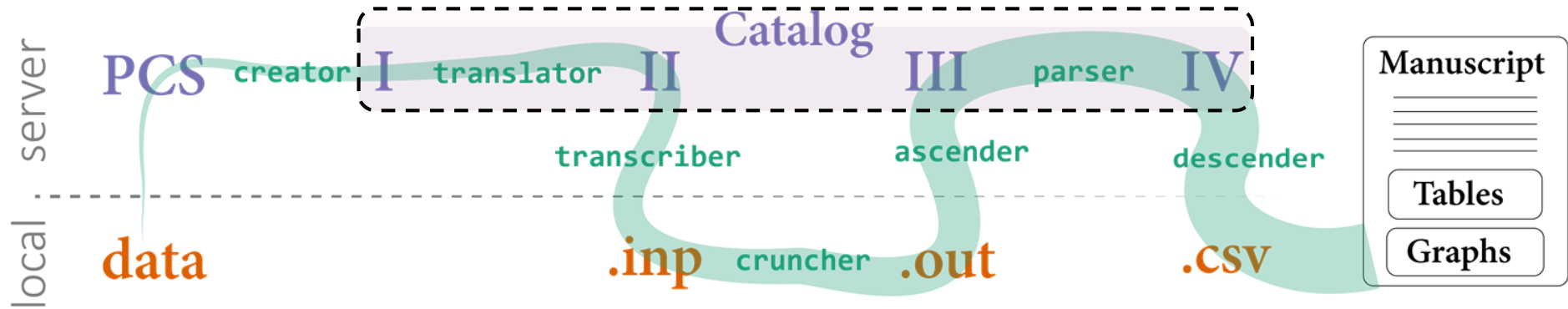
init readme and abstract

Andriy V. Kovak · 1 day ago · info

pub/2016-tables/2016-06-09-cpa/README.md

```

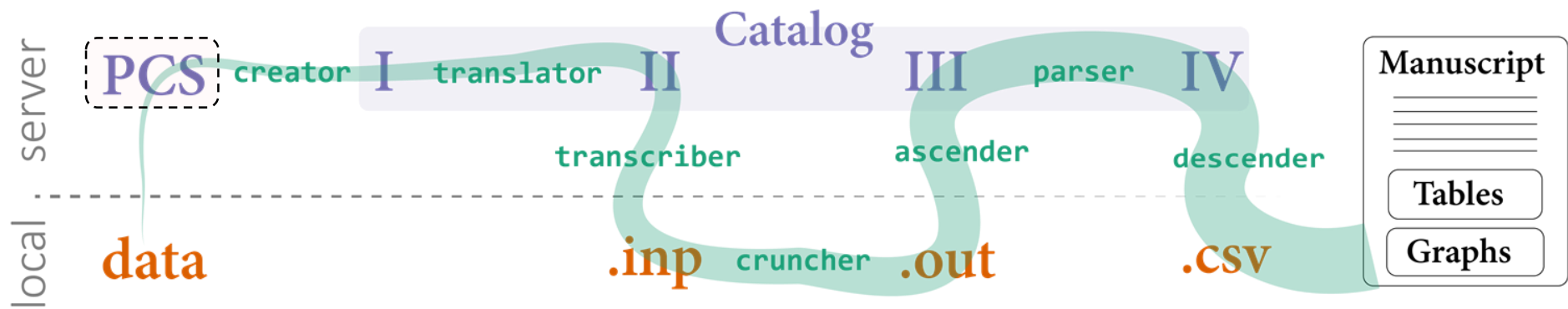
1 # Digital poster presented at the Canadian Psychological Association on June 9, 2016 at Victoria,
2 # Canada.
3 # ## abstract
4 #
5 # The Integrative Analysis of Longitudinal Studies of Aging and Dementia (IALSA) network is
6 # comprised of nearly 100 longitudinal studies of aging, health, and dementia. While harmonization and
7 # coordinated analysis (Moffe & Picot, 2009; Moffe & Picot, 2009) enable replication and
8 # extension of research findings across independent studies, the challenges of organizing and
9 # efficiently carrying out such analyses and cross-study synthesis remain pressing. A single multi-
10 # study project may require to estimate... (line truncated)...
11 #
12 # ## Team
13 # 1. Andriy Kovak (University of Victoria)
14 # 2. Will Beasley (University of Oklahoma)
15 # 3. Andrea Picot (University of Victoria)
16 # 4. Graciela Muniz-Ibarra (University of Edinburgh)
17 # 5. Scott Meier (University of Victoria)
18 #
19 # ## Useful links
20 # 1. [Description of the presentation format](http://www.cpa.ca/convention/presentationformat/)
  
```



This is a
DATASET
each row = one model per study
It is stored on a REDCap server.



Harris, PA, Taylor, R, Thielke, R, Payne, R, Gonzalez, N, Conde, JG (2009). Research electronic data capture (REDCap) - A metadata-driven methodology and workflow process for providing translational research informatics support, *J Biomed Inform*, 42(2), 377-81.



Drivers enter their study's
METADATA
into this REDCap survey.



Pre-conference Survey

Temporal Design

For this particular wide data specification, please refer to the data specification document

7) How many waves does [your study] contain? (include the baseline, enter as an integer.)
(e.g. "3", "7", etc., without the quotes)

8) What is the sample size at each wave? Enter as integers (starting with baseline) separated by spaces.
(e.g. "609 500 424", "1120 1058 998 840 724 667 301", etc.)

9) Enter the [calendar year] of the baseline measure.
(e.g. "2018", without the quotes)

10) In your dataset, what is the exact name (case sensitive) of the variable measuring the respondents' [year of birth]?

11) In your dataset, what is the exact name (case sensitive) of the variable measuring the respondents' [age at death]?

12) In your dataset, what is the exact name (case sensitive) of the variable measuring the [age] of respondents at baseline?

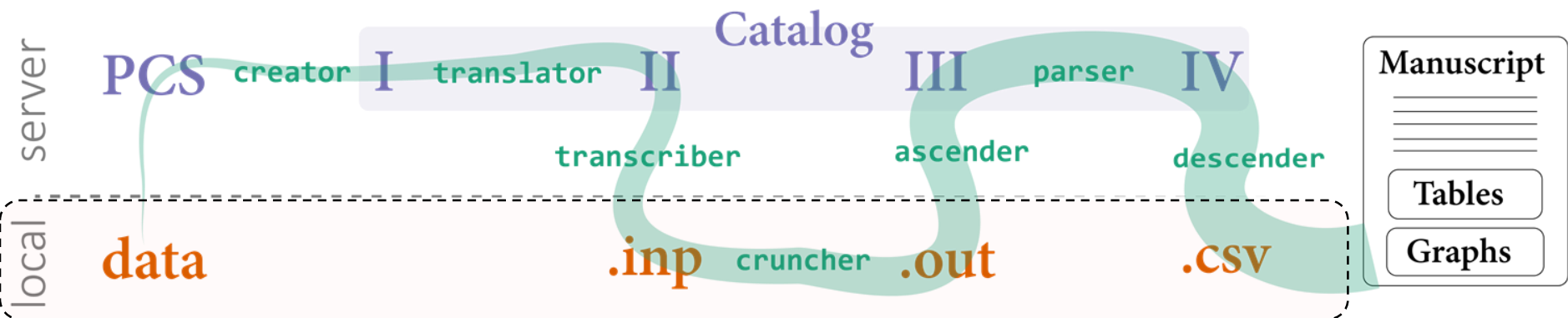
13) In your dataset, what is the exact name (case sensitive) of the variable measuring respondents' [age at wave]? Enter only the stem, without the wave indicator and the separator character.
For example, if your variable names are "Age_at_wave_1", "Age_at_wave_2", and "Age_at_wave_3" then enter "Age_at_wave" into the text box (without the quotes)

14) Enter each wave for which [age at wave] is available in your dataset using numbers separated by spaces.
For example: "1 2 3 4 5", "2 4 6", "1 3 7", etc. (without the quotes).

<< Previous Page Next Page >>

Save & Return Later

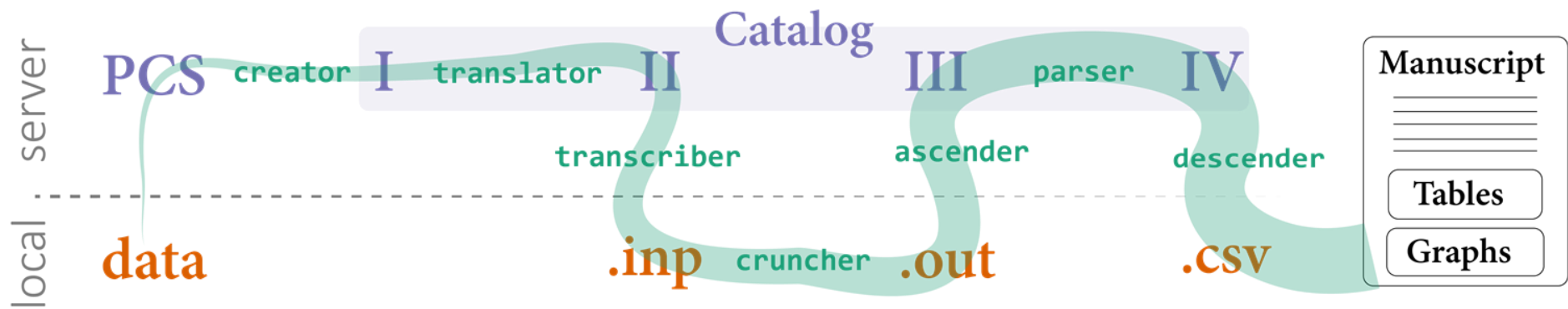
Harris, PA, Taylor, R, Thielke, R, Payne, R, Gonzalez, N, Conde, JG (2009). Research electronic data capture (REDCap) - A metadata-driven methodology and workflow process for providing translational research informatics support, *J Biomed Inform*, 42(2), 377-81.



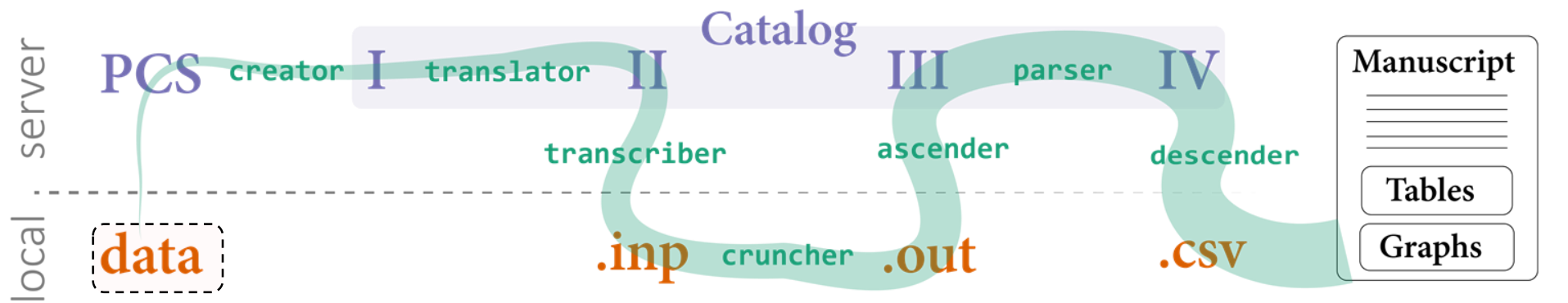
This is PRIVATE space on local machines.
 Sensitive information ALWAYS under control of the driver.
 Raw data is not shared with anyone at any point.

-> greater security

-> less IRB paperwork



Now we will walk you through
 Coordinated Analysis with Replication
 from raw data files to tables and graphs in manuscripts.



DRIVERS

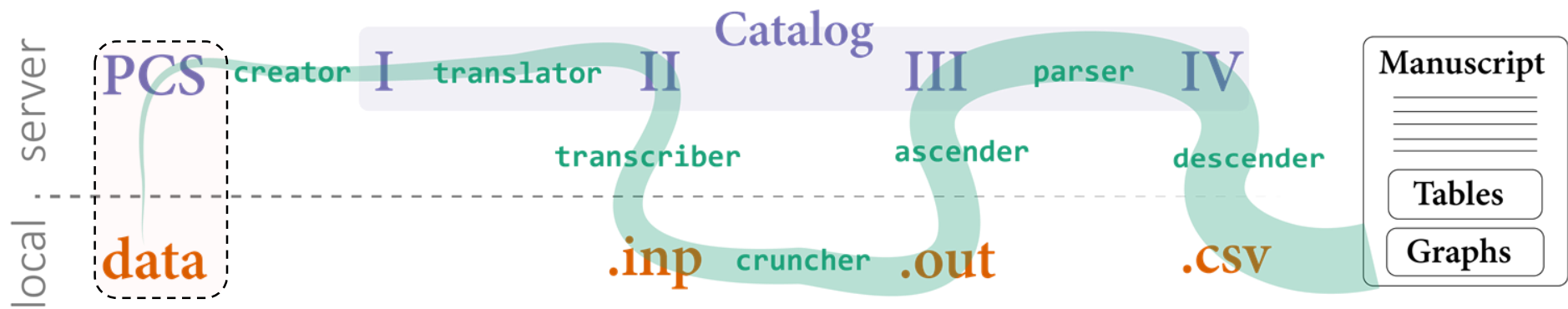
provide expertise on their longitudinal studies,
bring groomed dataset to CAR, and
need only basic knowledge of R

Wide

	id	year_bl	age_bl	year_born	male_bl	edu_bl	height_cm_bl	diabetes_bl	cardio_bl	smoke_bl	age_t1	age_t2	age_t3	age_t4	age_t5	age_t6	animals_t1	animals_t2	animals_t3	animals_t4	animals_t5	animals
1	103712	2002	55	1947	0	4	172.20	1	0	0	55	57	59	61	63	65	18	24	15	16	23	NA
2	103713	2002	71	1931	1	3	NA	0	0	0	71	73	75	NA	NA	NA	10	9	8	NA	NA	NA
3	103714	2002	51	1950	0	4	169.50	0	0	0	51	53	55	57	59	61	33	27	19	28	31	NA

Long

	id	wave	year_born	years_since_bl	year_bl	year	age_bl	age	male_bl	edu_bl	height_cm_bl	diabetes_bl	cardio_bl	smoke_bl	fev	fvc	pef	grip	gait	word_recall_im	word_recall_de	animals
1	103712	1	1947	0	2002	2002	55	55	0	4	172.20	1	0	0	NA	NA	NA	NA	NA	6	6	18
2	103712	2	1947	2	2002	2004	55	57	0	4	172.20	1	0	0	2.99	2.99	4.99	26.833333	NA	6	6	24
3	103712	3	1947	4	2002	2006	55	59	0	4	172.20	1	0	0	NA	NA	NA	NA	NA	10	8	15
4	103712	4	1947	6	2002	2008	55	61	0	4	172.20	1	0	0	2.58	2.58	3.78	21.333333	0.687679112	7	7	16
5	103712	5	1947	8	2002	2010	55	63	0	4	172.20	1	0	0	NA	NA	NA	NA	1.105990767	7	6	23
6	103712	6	1947	10	2002	2012	55	65	0	4	172.20	1	0	0	NA	NA	NA	25.500000	1.019108295	6	6	NA
7	103713	1	1931	0	2002	2002	71	71	1	3	NA	0	0	0	NA	NA	NA	NA	0.108572721	5	1	10
8	103713	2	1931	2	2002	2004	71	73	1	3	NA	0	0	0	NA	NA	3.62	17.166667	0.096793711	3	4	9
9	103713	3	1931	4	2002	2006	71	75	1	3	NA	0	0	0	NA	NA	NA	NA	NA	4	16	8
10	103714	1	1950	0	2002	2002	51	51	0	4	169.50	0	0	0	NA	NA	NA	NA	NA	8	7	33



REDCap interacts with the DRIVER to obtain relevant description of the study 's DATASET and characteristics.



Image credit: <https://support.novell.com/techcenter/articles/ana19920502.html>

Pre-conference Survey

Temporal Design

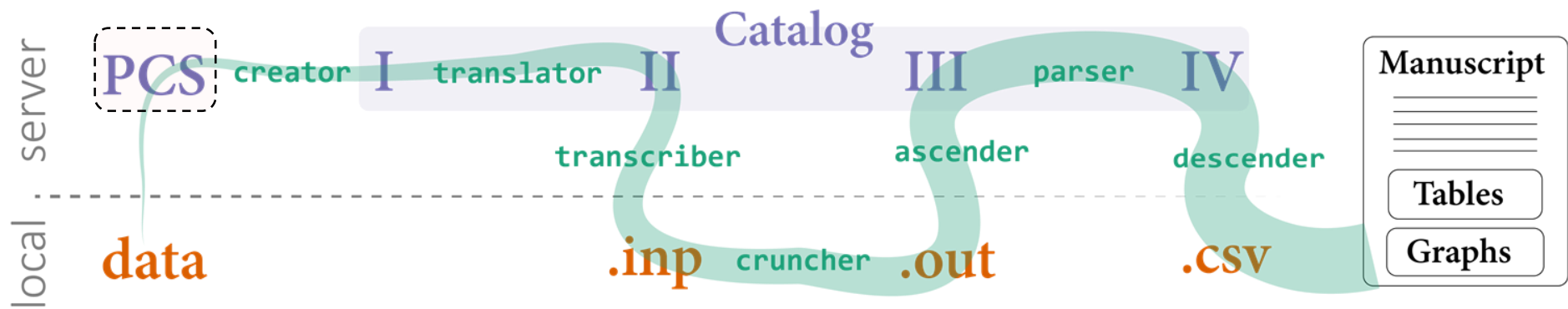
For this particular wide data specification, please refer to the data specification document

- How many waves does [your study] contain? (include the baseline, enter as an integer.
(e.g. "3", "7", etc., without the quotes)
- What is the sample size at each wave? Enter as integers (starting with baseline) separated by spaces.
(e.g. "609 500 424", "1120 1050 990 840 724 607 301", etc.)
- Enter the [calendar year] of the baseline measure.
(e.g. "1976", without the quotes)
- In your dataset, what is the exact name (case sensitive) of the variable measuring the respondents' [year of birth]?
- In your dataset, what is the exact name (case sensitive) of the variable measuring the respondents' [age at death]?
- In your dataset, what is the exact name (case sensitive) of the variable measuring the [age] of respondents at baseline?
- In your dataset, what is the exact name (case sensitive) of the variable measuring respondents' [age at wave]?
Enter only the stem, without the wave indicator and the separator character.
For example, if your variable names are "Age_at_wave_1", "Age_at_wave_2", and "Age_at_wave_3" then enter "Age_at_wave" into the text box (without the quotes)
- Enter each wave for which [age at wave] is available in your dataset using numbers separated by spaces.
For example: "1 2 3 4 5", "2 4 6", "1 3 7", etc. (without the quotes).

<< Previous Page Next Page >>

Save & Return Later

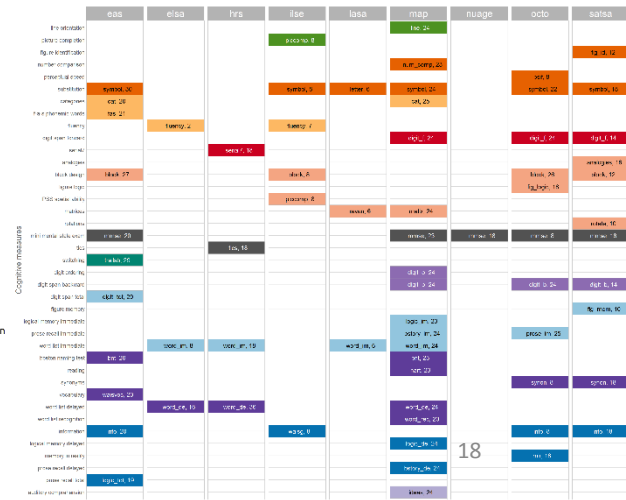
	id	year_bl	age_bl	year_born	male_bl	edu_bl	height_cm_bl	diabetes_bl	cardio_bl	smoke_bl	age_t1	age_t2	age_t3	age_t4	age_t5	age_t6	animals_t1	animals_t2	animals_t3	animals_t4	animals_t5	anima
1	103712	2002	55	1947	0	4	172.20	1	0	0	55	57	59	61	63	65	18	24	15	16	23	NA
2	103713	2002	71	1931	1	3	NA	0	0	0	71	73	75	NA	NA	NA	10	9	8	17	NA	NA
3	103714	2002	51	1950	0	4	169.50	0	0	0	51	53	55	57	59	61	33	27	19	28	31	NA



When all drivers fill in the Pre-Conference Survey
we can see which studies have similar
COGNITIVE MEASURES

- EAS
- ELSA
- HRS
- ILSE
- LASA
- MAP
- NuAge
- OCTO
- SATSA

- Domains
- visual discrimination
- perceptual speed
- fluency
- attention
- fluid reasoning
- mental status
- executive function
- working memory
- short-term memory
- semantic memory
- episodic memory
- verbal comprehension



server



local

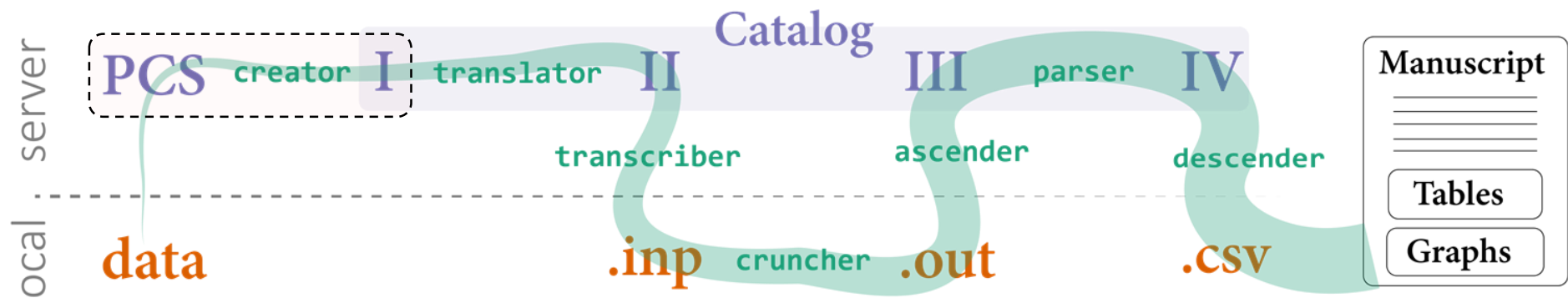
data



Domains

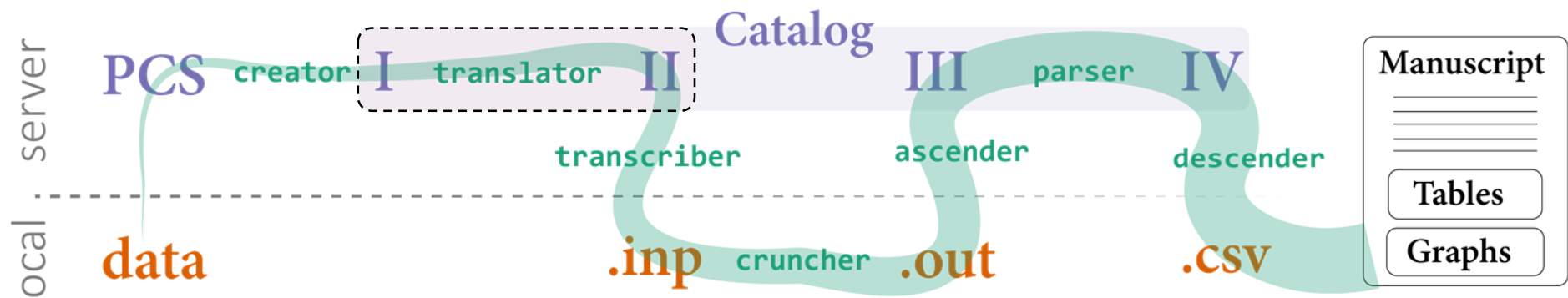
- visual discrimination
- perceptual speed
- fluency
- attention
- fluid reasoning
- mental status
- executive function
- working memory
- short-term memory
- semantic memory
- episodic memory
- verbal comprehension

	eas	elsa	hrs	ilse	lasa	map	nuage	octo	satsa
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Script run on server.
 After drivers enter responses into PCS,
 the CREATOR populates/writes
 PART I of the Catalog.

1	eas	gait	block	female	a
2	eas	gait	block	female	ae
3	eas	gait	block	female	aeH
4	eas	gait	block	female	aeHplus
5	eas	gait	block	female	full
6	eas	gait	block	male	a
7	eas	gait	block	male	ae
8	eas	gait	block	male	aeH
9	eas	gait	block	male	aeHplus
10	eas	gait	block	male	full
11	eas	gait	bnt	female	a
12	eas	gait	bnt	female	ae
13	eas	gait	bnt	female	aeH
14	eas	gait	bnt	female	aeHplus
15	eas	gait	bnt	female	full



Script run on server.

Using dataset descriptions, the TRANSLATOR encodes STATISTICAL MODELS Into Mplus estimation language

1	eas	gait	block	female	a
2	eas	gait	block	female	ae
3	eas	gait	block	female	aeh
4	eas	gait	block	female	aehplus
5	eas	gait	block	female	full
6	eas	gait	block	male	a
7	eas	gait	block	male	ae
8	eas	gait	block	male	aeh
9	eas	gait	block	male	aehplus
10	eas	gait	block	male	full
11	eas	gait	bnt	female	a
12	eas	gait	bnt	female	ae
13	eas	gait	bnt	female	aeh
14	eas	gait	bnt	female	aehplus
15	eas	gait	bnt	female	full

$$o=\text{Physical } \beta_{0i} = {}_p\gamma_{00} + {}_p\Gamma_{0k}(\text{CovSet}) + {}_p u_{0i}$$

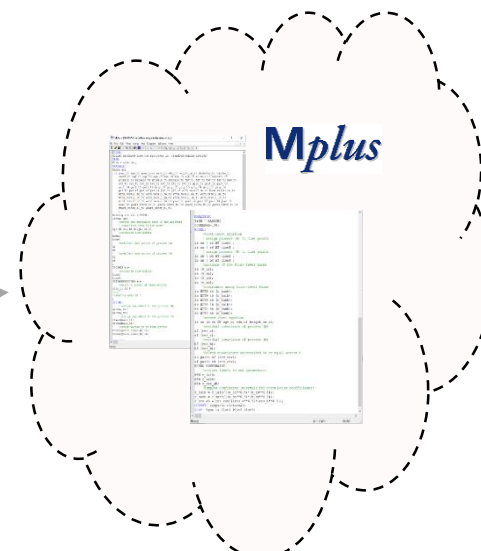
$$o=\text{Physical } \beta_{1i} = {}_p\gamma_{10} + {}_p\Gamma_{1k}(\text{CovSet}) + {}_p u_{1i}$$

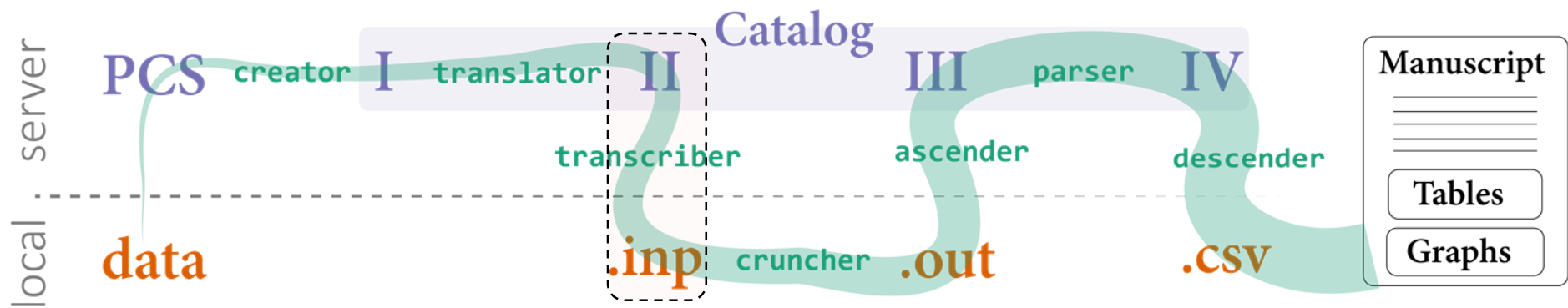
$$o y_{ti} = o\beta_{0i} + o\beta_{1i}(\text{Time}_{ti}) + o\mathcal{E}_{ti}$$

$$o=\text{Cognitive } \beta_{1i} = {}_c\gamma_{10} + {}_c\Gamma_{1k}(\text{CovSet}) + {}_c u_{1i}$$

$$o=\text{Cognitive } \beta_{0i} = {}_c\gamma_{00} + {}_c\Gamma_{0k}(\text{CovSet}) + {}_c u_{0i}$$

	Fixed Effects	Random Effects	Residuals
Physical Intercept	${}_p\gamma_{00}$	${}_p\gamma_{01}$	${}_p\gamma_{02} \dots {}_p\gamma_{0k}$
Physical Slope	${}_p\gamma_{10}$	${}_p\gamma_{11}$	${}_p\gamma_{12} \dots {}_p\gamma_{1k}$
Cognitive Slope	${}_c\gamma_{10}$	${}_c\gamma_{11}$	${}_c\gamma_{12} \dots {}_c\gamma_{1k}$
Cognitive Intercept	${}_c\gamma_{00}$	${}_c\gamma_{01}$	${}_c\gamma_{02} \dots {}_c\gamma_{0k}$
		${}_{pp}\tau_{00}$	${}_{pp}\tau_{01}$
		${}_{pp}\tau_{11}$	${}_{pp}\tau_{11}$
		${}_{pc}\tau_{01}$	${}_{pc}\tau_{10}$
		${}_{cc}\tau_{11}$	${}_{cc}\tau_{10}$
		${}_{cc}\tau_{00}$	
		${}_p\sigma^2$	${}_{pc}\sigma^2$
			${}_c\sigma^2$





Script run on driver's local machine.

TRANSCRIBER takes model syntax from Part II, and saves it as an **.inp** file on the driver's local machine

book	female	a
book	female	ae
book	female	aeH
book	female	aeHplus
book	female	full
book	male	a
book	male	ae
book	male	aeH
book	male	aeHplus
book	male	full
t	female	a
t	female	ae
t	female	aeH
t	female	aeHplus
t	female	full

$$o=\text{Physical } \beta_{0i} = p\gamma_{00} + p\Gamma_{0k}(\text{CovSet}) + p u_{0i}$$

$$o=\text{Physical } \beta_{1i} = p\gamma_{10} + p\Gamma_{1k}(\text{CovSet}) + p u_{1i}$$

$$o y_{ti} = o\beta_{0i} + o\beta_{1i}(\text{Time}_{ti}) + o\epsilon_{ti}$$

$$o=\text{Cognitive } \beta_{1i} = c\gamma_{10} + c\Gamma_{1k}(\text{CovSet}) + c u_{1i}$$

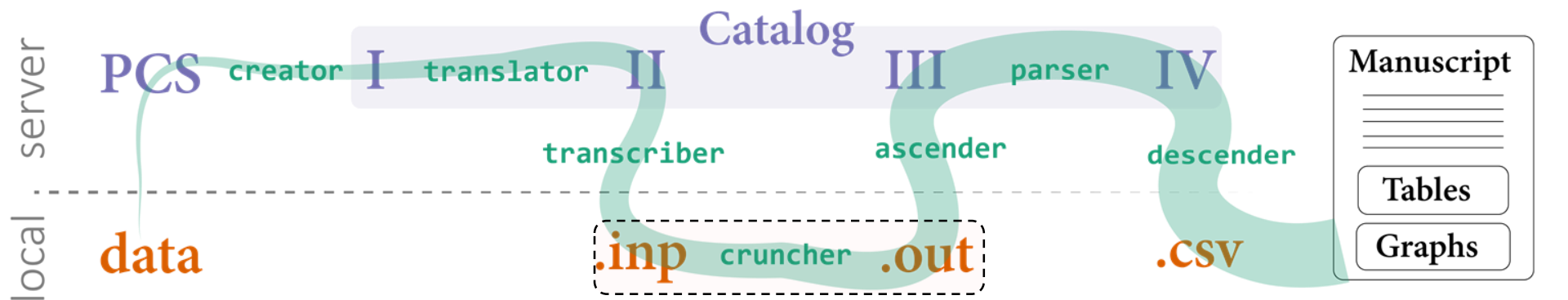
$$o=\text{Cognitive } \beta_{0i} = c\gamma_{00} + c\Gamma_{0k}(\text{CovSet}) + c u_{0i}$$

	Fixed Effects	Random Effects	Residuals
Physical Intercept	$p\gamma_{00}$	$pp\epsilon_{00}$	$p\sigma^2$
Physical Slope	$p\gamma_{10}$	$pp\epsilon_{11}$	$pc\sigma^2$
Cognitive Slope	$c\gamma_{10}$	$cc\epsilon_{11}$	$c\sigma^2$
Cognitive Intercept	$c\gamma_{00}$	$cc\epsilon_{00}$	

The screenshot shows the Mplus software interface with a model syntax file open. The syntax includes:

- DATA:** filename, nfiles, usev;
- MODEL:** DEFINE NAMES; DEFINE VARIABLE; DEFINE METRIC; DEFINE MODEL; DEFINE MODEL CONSTRAINTS; DEFINE OUTPUT;
- ANALYSIS:** TYPE = RANDOM; COVARIANCE = 00;
- MODEL:** First-level equation (assign process (A) to time points); Second-level equation (assign process (B) to time points); Residual covariance of process (A); Residual covariance of process (B); Residual covariance of process (B); Fixed covariances constrained to be equal across t; Assigns labels to new parameters; Compute correlation intervals for correlation coefficients; OUTPUT: sampstat; cinterstat; save: type is plot plot2 plot3;

The **Mplus** logo is prominently displayed on the right side of the screenshot.



Script run on driver's local machine.

Calls a local installation of Mplus, which uses the local .dat and .inp files.

Returns an .out file containing the MODEL SOLUTION



Mplus - (000007) bi-able-fee-categories

MODEL FIT INFORMATION

Number of Free Parameters: 1921

Loglikelihood: -26716.001

Information Criteria

Akaike (AIC): 53486.002

Bayesian (BIC): 53659.317

Sample-Size Adjusted BIC: 53572.522

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
IA AGE_B1 ON	-0.923	0.001	-20.819	0.000
EDU_B1	-0.016	0.004	-3.732	0.000
HEIGHT_CM	0.025	0.002	15.963	0.000
SA AGE_B1 ON	-0.001	0.000	-2.325	0.020
EDU_B1	-0.001	0.001	-1.310	0.190
HEIGHT_CM	0.000	0.000	0.639	0.523
ID AGE_B1 ON	-0.123	0.014	-8.820	0.000
EDU_B1	-0.102	0.064	-12.740	0.000
HEIGHT_CM	0.010	0.020	0.513	0.600
SB AGE_B1 ON	-0.019	0.003	-5.787	0.000
EDU_B1	-0.010	0.013	-0.776	0.438
HEIGHT_CM	-0.004	0.004	-0.942	0.346
IA SA WITH	0.000	0.009	0.039	0.968
EDU	0.143	0.065	2.189	0.029
SB	0.000	0.009	0.039	0.968
IA SA WITH	-0.009	0.017	-0.498	0.618
ID	0.000	0.003	0.000	0.993
IA SB WITH	0.000	0.009	0.039	0.968
A2	-0.005	0.031	-0.177	0.860
B4 WITH	-0.005	0.031	-0.177	0.860

RESIDUAL VARIANCES

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
AGE	0.100	0.000	200.000	0.000
EDU	0.100	0.000	200.000	0.000
HEIGHT	0.100	0.000	200.000	0.000
RESIDUAL VARIANCES	0.100	0.000	200.000	0.000
AGE	0.100	0.000	200.000	0.000
EDU	0.100	0.000	200.000	0.000
HEIGHT	0.100	0.000	200.000	0.000

QUALITY OF MODEL FIT

CONFIDENCE INTERVALS FOR MODEL PARAMETERS

CONFIDENCE INTERVALS FOR MODEL PARAMETERS

```

Mplus
DATA IS READ FROM (
  'data.dat'
);
MODEL IS (
  ! Physical
  AGE_B1 ON
  EDU_B1
  HEIGHT_CM
  ! Cognitive
  AGE_B1 ON
  EDU_B1
  HEIGHT_CM
  ! Residuals
  AGE
  EDU
  HEIGHT
);

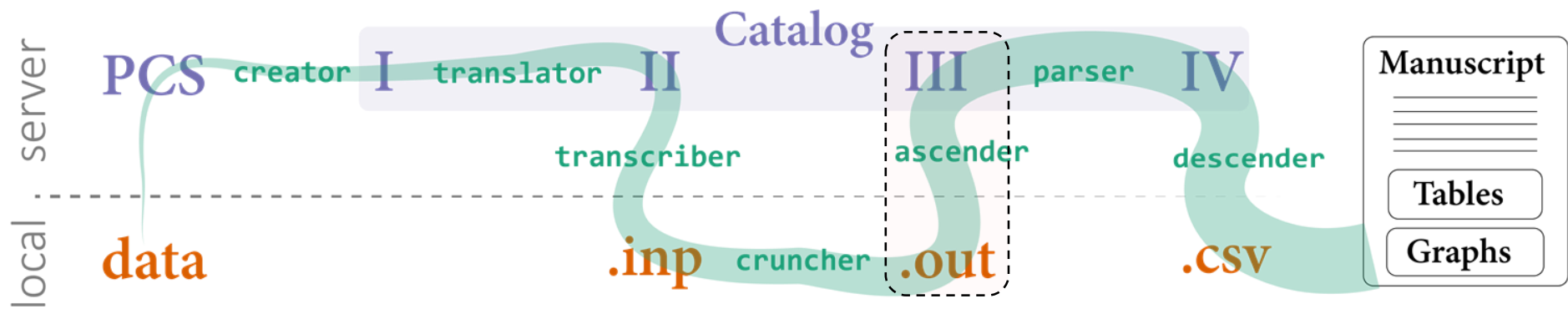
```

$$\begin{aligned} \beta_{0i} &= \text{Physical } \beta_{0i} = \gamma_{00} + \gamma_{0k}(\text{CovSet}) + u_{0i} \\ \beta_{1i} &= \text{Physical } \beta_{1i} = \gamma_{10} + \gamma_{1k}(\text{CovSet}) + u_{1i} \\ \beta_{2i} &= \text{Cognitive } \beta_{2i} = \gamma_{20} + \gamma_{2k}(\text{CovSet}) + u_{2i} \\ \beta_{0i} &= \text{Cognitive } \beta_{0i} = \gamma_{00} + \gamma_{0k}(\text{CovSet}) + u_{0i} \end{aligned}$$

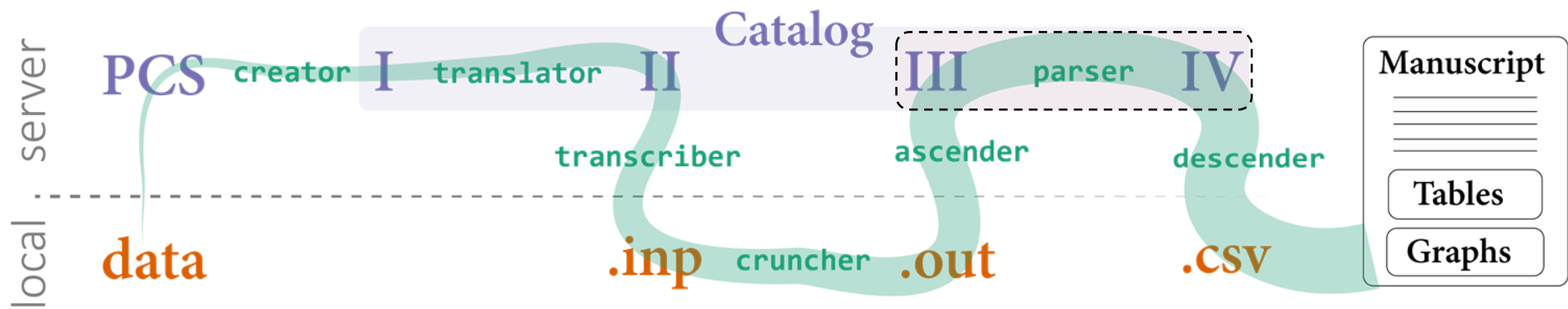
	Fixed Effects	Random Effects	Residuals
Physical Intercept	γ_{00}	γ_{0k}	u_{0i}
Physical Slope	γ_{10}	γ_{1k}	u_{1i}
Cognitive Slope	γ_{20}	γ_{2k}	u_{2i}
Cognitive Intercept	γ_{00}	γ_{0k}	u_{0i}

$$p \sigma^2$$

$$pc \sigma^2$$



Script run on driver's local machine.
 Uploads the contents of the **.out** files
 to Part III of the Catalog.

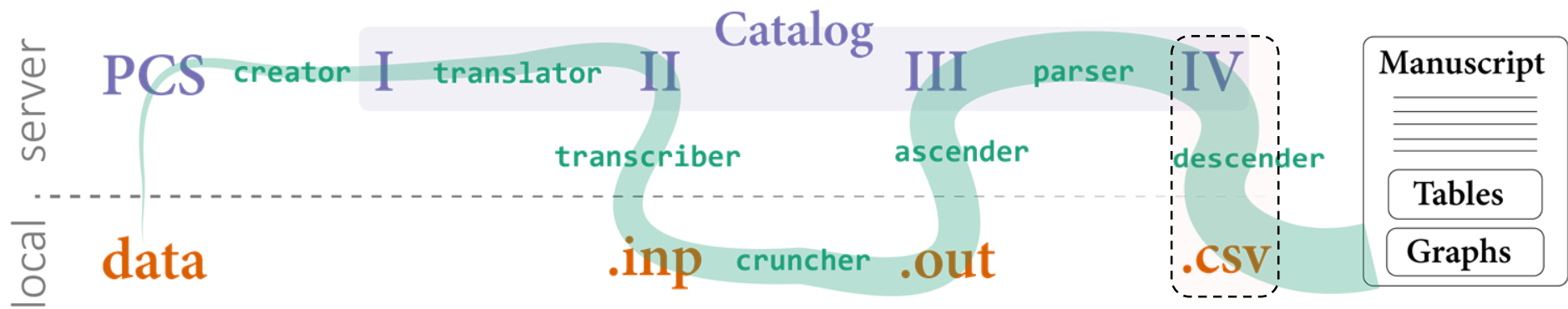


Script run on server.

PARSER extracts elements of model solution from the *Mplus* output (e.g. parameter estimates, fit indices, and the convergence status).

For each model, these values are saved as separate columns in a single row of Part IV.

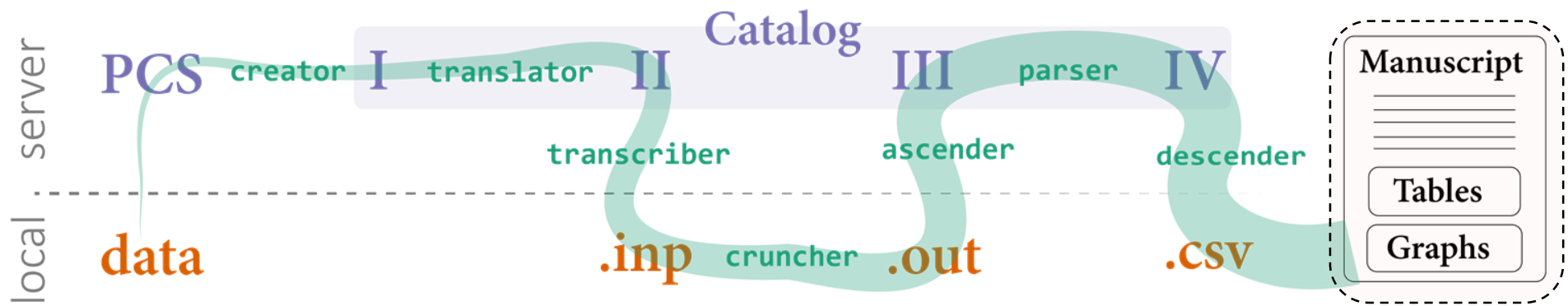
	A	B	C	D	E	F	H	I	J	Q	R	S	T	U	V	W	X	Y	Z	AA
1	study_name	model_number	subgroup	model_type	subject_count	wave_count	LL	aic	bic	ab_TAU_00_est	ab_TAU_00_se	ab_TAU_00_wald	ab_TAU_00_pval	ab_TAU_11_est	ab_TAU_11_se	ab_TAU_11_wald	ab_TAU_11_pval	ab_TAU_01_est	ab_TAU_01_se	ab_TAU_01_wald
2	eas	b1	female	ae	580	8	-12370.4	24790.79	24899.86	-214.803	119.207	-1.802	0.072	-1.426	2.859	-0.499	0.618	-22.556	18.624	-1.2
3	eas	b1	female	ae	593	8	-8766.76	17583.53	17693.16	24.846	13.797	1.801	0.072	0.642	0.347	1.848	0.065	3.495	2.177	1.6
4	eas	b1	female	ae	572	8	-8975.66	18001.32	18110.05	69.278	19.852	3.49	0	1.023	0.37	2.766	0.006	-1.254	2.055	-0.
5	eas	b1	female	ae	524	7	-7043.93	14137.86	14244.4	5.151	9.445	0.545	0.586	-0.282	0.357	-0.79	0.43	2.919	1.916	1.5
6	eas	b1	female	ae	594	8	-9357.93	18765.87	18875.54	55.35	19.105	2.897	0.004	0.815	0.456	1.786	0.074	0.303	2.457	0.1
7	eas	b1	female	ae	594	8	-6681.55	13413.11	13522.78	5.336	4.51	1.183	0.237	0.112	0.109	1.026	0.305	-0.201	0.628	-0.3
8	eas	b1	female	ae	595	8	-7094.86	14239.72	14349.44	17.044	5.765	2.956	0.003	0.322	0.185	1.742	0.081	-1.337	1.027	-1.3
9	eas	b1	female	ae	554	8	-8065.42	16180.84	16288.77	8.647	9.337	0.926	0.354	0.157	0.283	0.553	0.58	2.549	1.865	1.3
10	eas	b1	female	ae	383	8	-3871.71	7793.415	7892.116	10.378	5.741	1.808	0.071	-0.002	0.119	-0.017	0.987	0.215	0.657	0.3
11	eas	b1	female	ae	563	8	-8499.24	17048.48	17156.81	31.673	13.058	2.426	0.015	0.446	0.305	1.462	0.144	-2.218	1.767	-1.2
12	eas	b1	female	ae	592	8	-9307.2	18664.39	18773.98	69.62	20.65	3.371	0.001	1.426	0.639	2.231	0.026	0.118	3.455	0.0
13	eas	b1	female	aeh	150	8	-4939.77	9937.539	10024.85	-219.554	185.685	-1.182	0.237	-1.111	4.85	-0.229	0.819	-10.409	35.697	-0.2
14	eas	b1	female	aeh	150	8	-3582.45	7222.909	7310.217	16.88	20.942	0.806	0.42	0.837	0.945	0.886	0.376	5.52	4.478	1.2
15	eas	b1	female	aeh	150	8	-3709.14	7476.282	7563.591	81.433	32.4	2.513	0.012	0.817	0.561	1.456	-0.832	3.422	3.422	-0.2
16	eas	b1	female	aeh	130	7	-2632.36	5322.718	5405.877	15.274	13.399	1.14	0.254	-0.483	0.706	-0.684	0.494	4.214	3.568	1.1
17	eas	b1	female	aeh	150	8	-3714.27	7486.538	7573.847	60.856	26.394	2.306	0.021	1.19	0.811	1.467	0.142	-3.555	3.466	-1.0
18	eas	b1	female	aeh	150	8	-2825.3	5708.606	5795.914	9.225	7.158	1.289	0.197	0.286	0.231	1.237	0.216	-0.949	1.443	-0.6
19	eas	b1	female	aeh	150	8	-2910.72	5879.44	5966.749	14.142	7.545	1.874	0.061	0.362	0.232	1.56	0.119	-1.206	1.531	-0.7
20	eas	b1	female	aeh	150	8	-3450.76	6959.528	7046.837	10.8	13.947	0.774	0.439	0.247	0.583	0.423	0.672	1.455	3.278	0.6
21	eas	b1	female	aeh	72	8	-1316.58	2691.156	2757.179	2.34	3.898	0.6	0.548	0.012	0.179	0.068	0.946	0.26	0.828	0.3
22	eas	b1	female	aeh	72	8	-1316.58	2691.156	2757.179	2.34	3.898	0.6	0.548	0.012	0.179	0.068	0.946	0.26	0.828	0.3



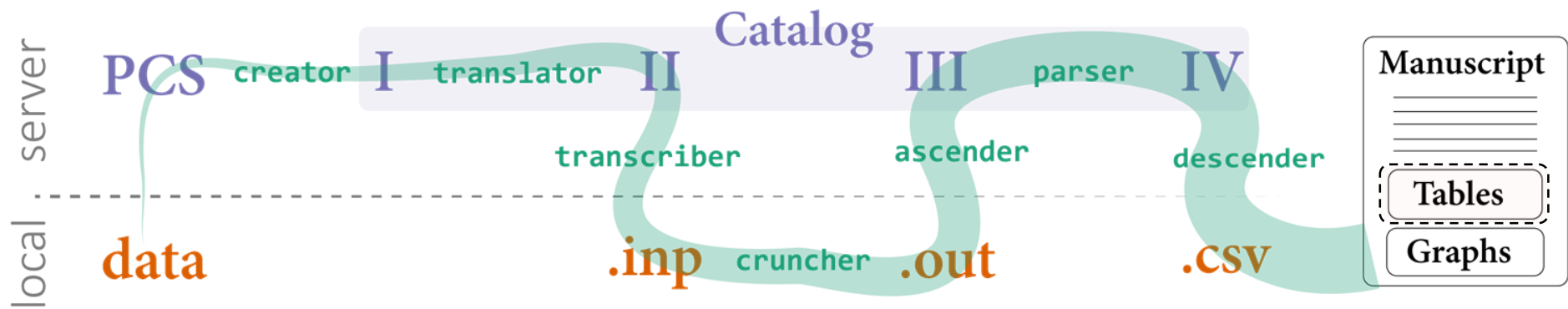
Script run on driver's local machine.

Copies the entire catalog as a **.csv** on the driver's local machine.

This disconnected CSV allows the drivers to pursue their own analyses after the workshop.



The catalog forms the dataset for META-ANALYSIS,
 in which models are the new units.
 MANUSCRIPTS reports and interprets the results of meta-analysis.



DYNAMIC tables store all extracted model estimates.
 These are useful for EXPLORATION.
 You can filter and sort to guide your search for patterns.

Dynamic Table

Show 10 entries

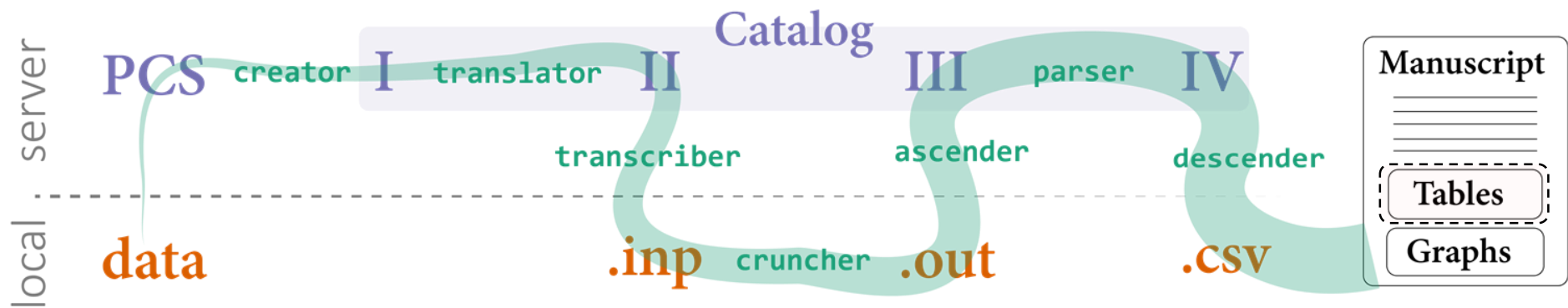
Search:

Random Effects Growth Curve Model Solution

	study name	process a	process b	subgroup	model type	n	r intercept	r slope	r residual
	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
1	eas	gait	block	female	a	563	0.25 (0.06), p<.01	0.30 (0.27), p=.26	-0.02 (0.05), p=.72
2	eas	gait	block	female	ae	563	0.22 (0.08), p=.01	0.46 (0.31), p=.14	-0.02 (0.05), p=.73
3	eas	gait	block	female	aeh	150	0.26 (0.14), p=.06	0.03 (0.63), p=.96	-0.06 (0.08), p=.41
4	eas	gait	block	female	aehplus	150	0.17 (0.16), p=.28	0.02 (0.67), p=.98	-0.07 (0.08), p=.36
5	eas	gait	block	female	full	150	0.14 (0.17), p=.41	0.01 (0.69), p=.99	-0.07 (0.08), p=.38
6	eas	gait	block	male	a	350	0.40 (0.11), p<.01	0.39 (0.70), p=.58	-0.05 (0.07), p=.50
7	eas	gait	block	male	ae	350	0.40 (0.12), p<.01	0.40 (0.78), p=.61	-0.05 (0.07), p=.50
8	eas	gait	block	male	aeh	72	0.28 (0.30), p=.34	0.22 (3.38), p=.95	0.01 (0.13), p=.91
9	eas	gait	block	male	aehplus	72	0.29 (0.37), p=.43	0.15 (7.19), p=.98	0.01 (0.15), p=.95
10	eas	gait	block	male	full	72	0.25 (0.43), p=.56	0.17 (4.41), p=.97	0.00 (0.16), p=.98

Showing 1 to 10 of 987 entries

Previous 2 3 4 5 ... 99 Next



STATIC tables print targeted results.
 These are useful to have for
 DEMONSTRATION and MANUSCRIPT CONSTRUCTION.

Dynamic Table

Show 10 entries

Random Effects Growth Curve Model Solution

study name	process a	process b	subgroup	model type	n	r intercept	r slope	r residual
1 eas	gait	block	female	a	563	0.25 (0.06), p<.01	0.30 (0.27), p=.26	-0.02 (0.05), p=.72
2 eas	gait	block	female	ae	563	0.22 (0.08), p=.01	0.46 (0.31), p=.14	-0.02 (0.05), p=.73
3 eas	gait	block	female	aeh	150	0.26 (0.14), p=.06	0.03 (0.63), p=.96	-0.06 (0.08), p=.41
4 eas	gait	block	female	aehplus	150	0.17 (0.16), p=.28	0.02 (0.67), p=.98	-0.07 (0.08), p=.36
5 eas	gait	block	female	full	150	0.14 (0.17), p=.41	0.01 (0.69), p=.99	-0.07 (0.08), p=.38
6 eas	gait	block	male	a	350	0.40 (0.11), p<.01	0.39 (0.70), p=.58	-0.05 (0.07), p=.50
7 eas	gait	block	male	ae	350	0.40 (0.12), p<.01	0.40 (0.78), p=.61	-0.05 (0.07), p=.50
8 eas	gait	block	male	aeh	72	0.28 (0.30), p=.34	0.22 (3.38), p=.95	0.01 (0.13), p=.91
9 eas	gait	block	male	aehplus	72	0.29 (0.37), p=.43	0.15 (7.19), p=.98	0.01 (0.15), p=.95
10 eas	gait	block	male	full	72	0.25 (0.43), p=.56	0.17 (4.41), p=.97	0.00 (0.16), p=.98

Show 1 to 10 of 987 entries

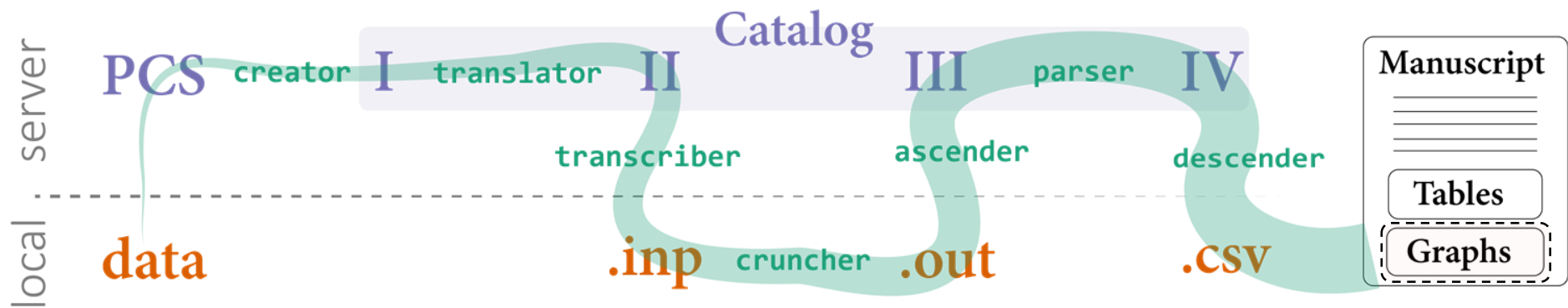
Static Tables

The 'aehplus' model (with covariates age, education, health, and others) is shown for each combination of

- study,
- process, and
- gender.

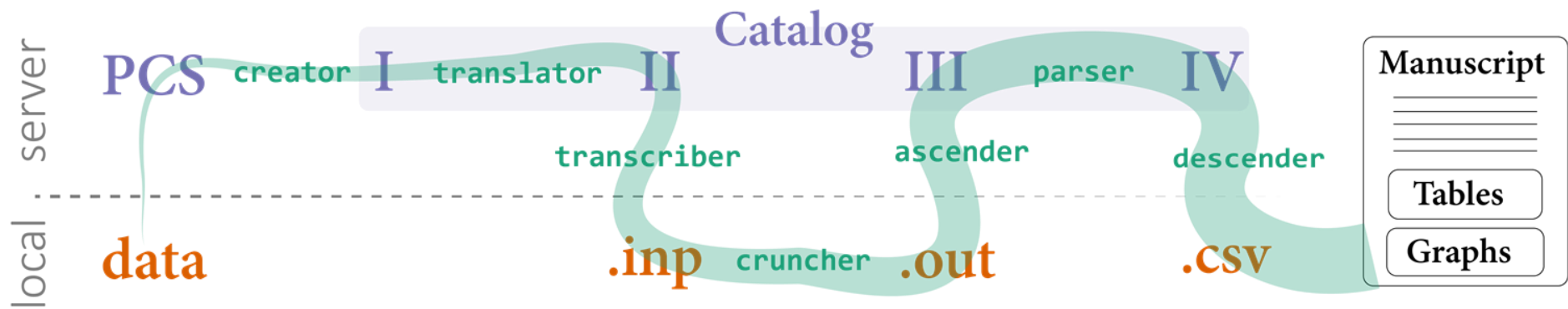
eas

Processes	Gender	n	r intercepts	r slopes	r residuals
gait vs block	female	150	0.17 (0.16), p=.28	0.02 (0.67), p=.98	-0.07 (0.08), p=.36
gait vs block	male	72	0.29 (0.37), p=.43	0.15 (7.19), p=.98	0.01 (0.15), p=.95
gait vs bnt	female	150	0.09 (0.18), p=.63	0.67 (0.49), p=.18	-0.01 (0.12), p=.97
gait vs bnt	male	72	0.17 (0.38), p=.64	0.27 (2.80), p=.92	-0.02 (0.20), p=.91
gait vs categories	female	150	0.01 (0.13), p=.93	0.38 (0.44), p=.39	0.05 (0.11), p=.67
gait vs categories	male	72	0.24 (0.38), p=.52	0.92 (1.14), p=.42	-0.02 (0.17), p=.90
gait vs digit_tot	female	150	0.18 (0.17), p=.29	0.65 (0.40), p=.10	0.07 (0.08), p=.40
gait vs digit_tot	male	72	0.06 (0.37), p=.87	0.71 (1.50), p=.63	-0.01 (0.18), p=.96
gait vs fas	female	150	0.26 (0.14), p=.06	0.49 (0.61), p=.42	-0.07 (0.08), p=.40
gait vs fas	male	72	-0.05 (0.29), p=.86	0.68 (2.69), p=.80	-0.02 (0.22), p=.93
gait vs information	female	130	0.12 (0.22), p=.48	-0.54 (1.41), p=.70	-0.02 (0.11), p=.87
gait vs information	male	70	0.44 (0.44), p=.32	-0.21 (8.37), p=.98	0.02 (0.19), p=.91
gait vs logic_tot	female	150	0.08 (0.15), p=.60	0.31 (0.76), p=.69	0.02 (0.10), p=.83
gait vs logic_tot	male	72	0.17 (0.36), p=.62	0.62 (2.40), p=.80	-0.03 (0.19), p=.90
gait vs mmms	female	72	0.27 (0.63), p=.67	0.14 (3.05), p=.96	0.03 (0.17), p=.85
gait vs mmms	male	72	0.27 (0.63), p=.67	0.14 (3.05), p=.96	0.03 (0.17), p=.85
gait vs symbol	female	150	0.18 (0.15), p=.24	0.79 (0.61), p=.19	-0.08 (0.10), p=.44
gait vs symbol	male	72	0.01 (0.29), p=.97	0.82 (1.15), p=.47	-0.05 (0.22), p=.83



FOREST plots display the values from the tables
To optimize for useful comparisons.





Big Data, Big Analysis:

A Collaborative Modeling Framework for Multi-study Replication

Andriy V. Koval
University of Victoria

William H. Beasley
University of Oklahoma

Andrea Piccinin
University of Victoria

Graciela Muniz-Terrera
University of Edinburgh

Scott Hofer
University of Victoria



Integrative **A**nalysis of **L**ongitudinal **S**tudies on **A**ging

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**University
of Victoria**

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Study		Driver
Einstein Aging Study	EAS	<u>Andrea Zammit</u>
English Longitudinal Study of Aging	ELSA	<u>Annie Robitaille</u>
Health and Retirement Study	HRS	<u>Chenkai Wu</u>
Interdisciplinary Longitudinal Study of Aging	ILSE	<u>Philipp Handschuh</u>
Normative Aging Study	NAS	<u>Lewina Lee</u>
Quebec Longitudinal Study on Nutrition and Aging	NuAge	<u>Valerie Jarry</u>
Octogenarian Twins	OCTO	<u>Marcus Praetorius</u>
Rush Memory and Aging Project	MAP	<u>Cassandra Brown</u>
Swedish Adoption Twin Study of Aging	SATSA	<u>Deborah Finkel</u>