On the Relationship of Complexity Metrics With Cognitive Load and Visual Behavior: A Multi-Granular Eye-Tracking Analysis

Appendix

Basic patterns

Table 1 lists five basic patterns. All the models used in this study are generated by combining these models.

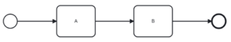
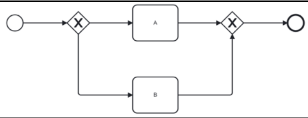
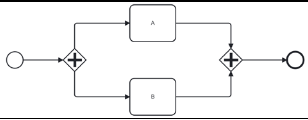
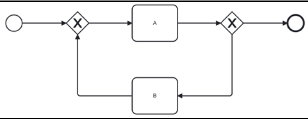
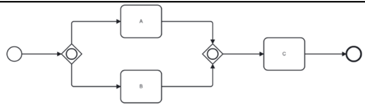
Simple pattern	Exclusive conditional pattern	Parallel pattern
		
	Loop pattern	Inclusive conditional pattern
		

Table 1 - Basic patterns

Complexity metrics

Essential complexity

Table 2 presents a subset of the metrics that have been associated to model-related characteristics in [Mendling2008] and [Mendling2012].

Category [Mendling2008]	**Description**	**Name/symbol**	**References**
Size	The number of nodes in the model (e.g., tasks, gateways, events).	Size, diameter (Diam)	Mendling2008, Sanchez-Gonzalez2010, Mendling2012
Density ('Connection' in [Mendling2012])	Relates the number of edges (possible flows) to the size of the model.	Coeff. of connectivity (Conn. Coeff.), average degree of a connector (Avg d_c), maximum degree of a connector (Max d_c)	Mendling2008, Mendling2012
Partitionability ('Modularity' in [Mendling2012])	Considers the relationship of subcomponents to the overall model	Separability (Π), Sequentiality (Ξ), depth (Λ), Structuredness (Φ)	Mendling2008, Figl2011, Mendling2012
Connector interplay	Considers the interactions and effects of the different connector types	Connector Heterogeneity (CH), Control Flow Complexity (CFC)	Cardoso2006, Mendling2008, Mendling2012
Cyclicity (merged in 'Complex behavior' in [Mendling2012])	Counts the number of nodes for which a cycle exists then provide the ratio of this number to the total number of nodes of the model.	Cyclicity (CYC)	Mendling2008, Mendling2012
Concurrency (merged in 'Complex behavior' in [Mendling2012])	Explores the possible concurrent paths of a model. The Token split metrics counts the control tokens associated with the control (e.g. AND or OR) designed in the model	Token split (TS)	Mendling2008, Mendling2012

Table 2 - List of metrics addressing essential complexity.

Examples

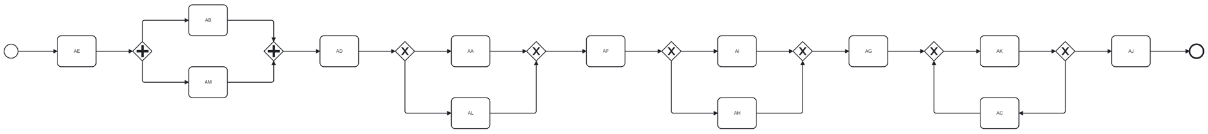


*Figure 1 - Process model (model_g3.png) with low **essential** complexity, labeled as 'Simple'*

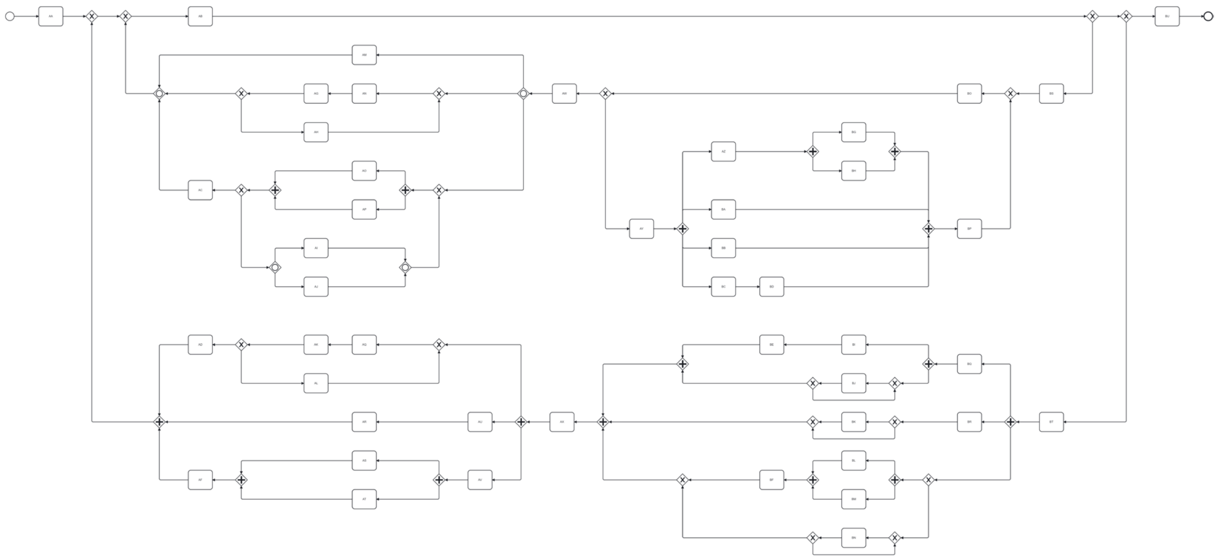


*Figure 2 - Process model (model_g2.png) with high **essential** complexity, labeled as 'Complex'*

Table 3 and Table 4 show the results of the metrics applied to 'Simple' and 'Complex' models, in Figure 1 and Figure 2, respectively. Next to each symbol in the column headings, an arrow indicates the interpretation of the metrics, i.e. whether a low (↘) or high (↗) value tends towards greater understandability and less possibility of error.

Scores

Model	Size (↘)	Diam (↘)	Avg d_c(↘)	Max d_c **(↘)**	Coeff. Conn. **(↘)**
Fig. 1, Simple	23	23	3	3	1.1304
Fig. 2, Complex	88	68	3.2500	5	1.2727

Table 3 – Essential complexity metrics. Categories Size and Density

Model	Π (↗)	Ξ **(↗)**	Λ **(↘)**	Φ (↗)	**CH (↘)**	CFC (↘)	**CYC (↘)**	**TS (↘)**
Fig. 1, Simple	0.5714	0.0769	1	1	0.8113	7	0.1739	1
Fig. 2, Complex	0.0698	0.0625	5	0.8523	0.8587	38	0.9545	15

Table 4 - Essential complexity metrics. Categories Partionability, Connector interplay, Cyclicity and Token split.

Accidental complexity

Table 5 summarizes a list of metrics provided by [Bernstein2015] and [Burattin2017] (detailed formulas can be found in the cited studies) with name and the description of each feature category:

From [Bernstein2015]	**Description**	**Name / Symbol**	**Reference (support the features)**
Edges style	A measure of the style of the edges as the ratio of simple (default) or 'broken' (with breaking points) edges to the total number of edges.	%brokenEdges (%bE), %simpleEdges (%sE)	[Purchase1997], [Schrepfer2009], [Effinger2010]
Crossing edges	Ratio of the number of crossing edges to the total number of edges	%totalCross (%tC)	[Purchase1997], [Schrepfer2009], [Effinger2010]
Angles	Ratio of the number of orthogonal segments to the total number of segments. *Orthogonal segments are parts of edges which are aligned with a grid layout of the model.*	%orthogonalSegments (%oS)	[Purchase1997], [Effinger2010]
Symmetry in blocks*	Symmetry of the elements' arrangement inside a block of the model.	%symmetricalPatterns (%sP)	*(See note on symmetry in blocks afterwards)*
From [Burattin2017]			
Consistency flow	Measure how the flow (the general direction) in the model can change or not its general direction.	Metric based on behavioral profiles (M-BP)	[Effinger2010]

Table 5 - List of metrics addressing accidental complexity proposed by [Bernstein2015] and [Burattin2017]. (*) Authors in [Bernsetin2015] propose the concept of symmetry in blocks as a category of visual features that affect positively the reading/understanding of models, but did not provide any quantification.

Example

Figure 3 shows an example of process model that is designed to avoid accidental complexity as much as possible. Figure 4 presents the same model, but with different kinds of accidental complexity applied on it.

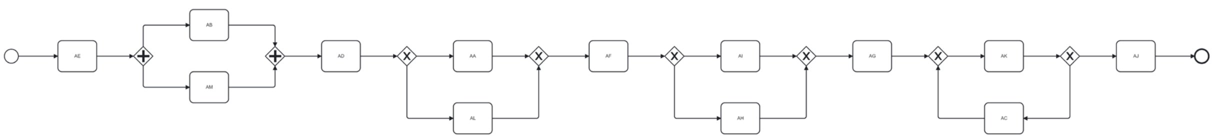


*Figure 3 - Process model (model_g3.png) with low **accidental** complexity, labeled as 'Simple'*

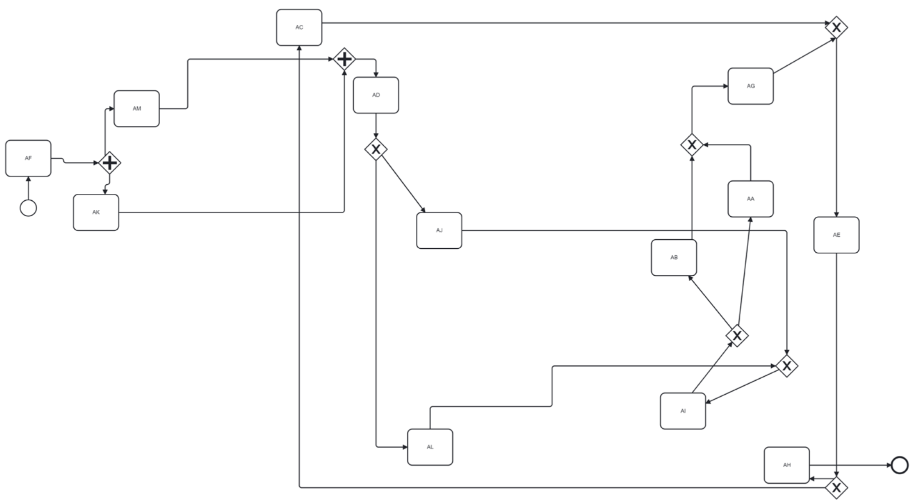


*Figure 4 - Process model (model_g5.png) with high **accidental** complexity, labeled as 'Complex'*

Scores

Model	*%sE (↗)*	**%bE (↘)**	*%tC (↘)*	*%oS (↗)*	%sP (↗)	M-BP ***(↗)***
Figure 3 - Simple	0.6154	0.3846	0.0000	1.0000	1.0000	0.8235
Figure 4 - Complex	0.5385	0.4615	0.0698	0.8605	0.0000	0.7059

Table 6 - Accidental complexity metrics

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