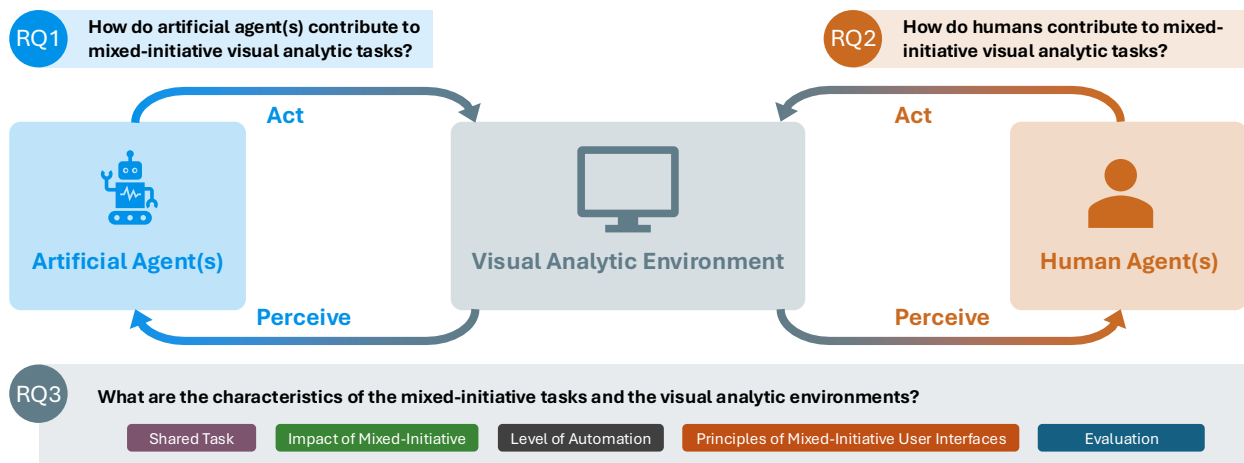


# Supplemental Material: A Scoping Review of Mixed Initiative Visual Analytics in the Automation Renaissance

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**Figure 1:** The overview of the research questions in our scoping review, where we aim to characterize mixed-initiative visual analytic settings. Throughout this work, we adopt an agent-based framework where human and artificial agents perceive their visual analytic environment and act upon it.

## 1. Paper Selection

### 1.1. Venues

The full list of venues considered is as follows:

- IEEE Transactions on Visualization and Computer Graphics (TVCG)
- Computer Graphics Forum (CGF)
- IEEE Conference on Visual Analytics Science and Technology (VIS)
- ACM International Conference on Human Factors in Computing Systems (CHI)
- ACM International Conference on Intelligent User Interfaces (IUI)
- ACM International Conference on Knowledge Discovery and Data Mining (KDD)
- IEEE Pacific Visualization Symposium (PacificVis)
- Information Visualization Journal (IVJ)

### 1.2. List of Papers

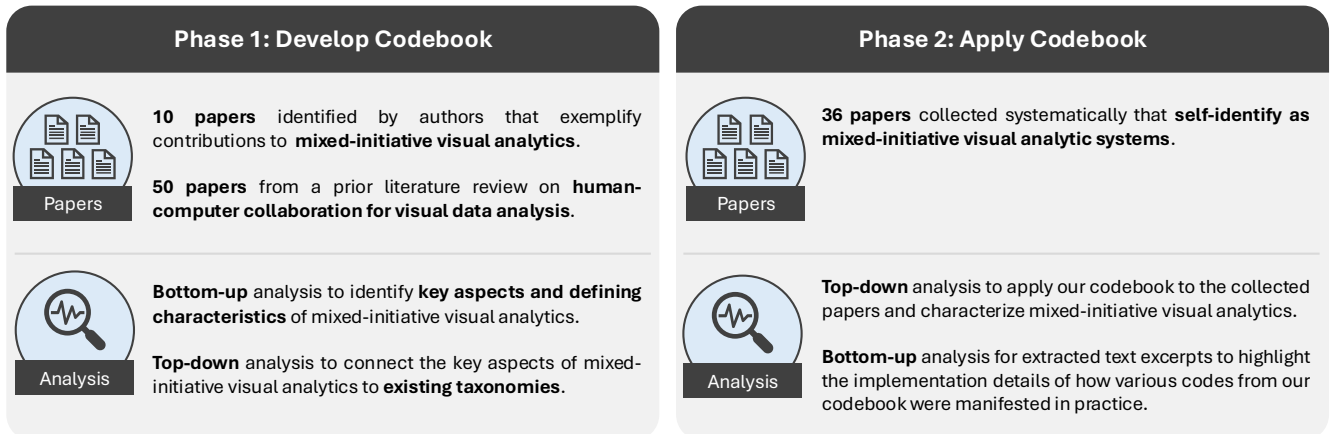


Figure 2: Overview of our two-phase methods: (1) develop the codebook, and (2) apply the codebook.

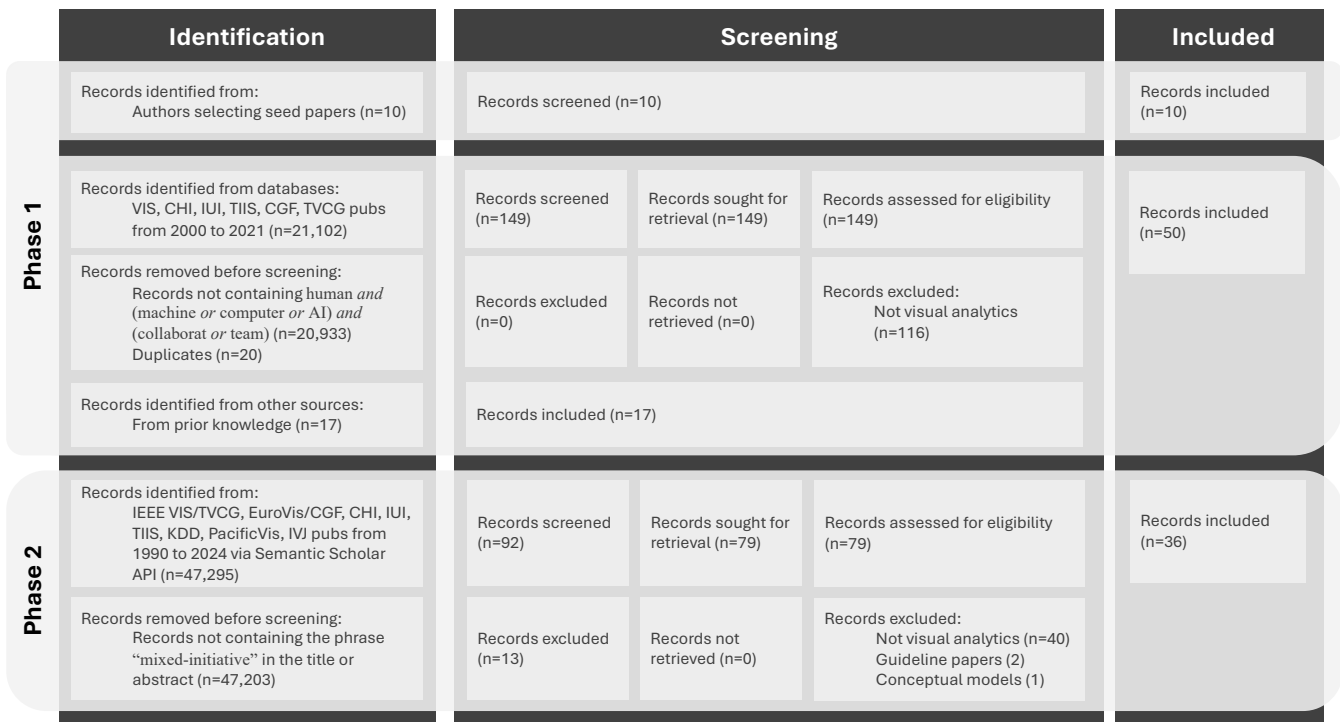


Figure 3: The PRISMA diagrams of the paper selection process for the two phases.

Table 1: List of all papers reviewed across the two phases of analysis, sorted by publication year.

Title	Reference	Year	Venue	Phase 1	Phase 2
Interactive problem solving vi...	[PL00]	2000	IEEE VIS	✓	
Design visual thinking tools f...	[PL02]	2002	ACM IUI		✓
A collaborative intelligent tu...	[SH04]	2004	ACM IUI	✓	
Conversing with the user based...	[QZ05]	2005	ACM CHI	✓	
Analysis Guided Visual Explora...	[DRW07]	2007	IEEE VIS	✓	
Visual Perception and Mixed-In...	[HKR*08]	2008	IEEE TVCG	✓	
Behavior-driven visualization ...	[GW09]	2009	ACM CHI	✓	
Apolo: interactive large graph...	[CKHF11a]	2011	ACM KDD		✓
Apolo: making sense of large n...	[CKHF11b]	2011	ACM CHI		✓
VisualWikiCurator: human and m...	[KHW*11]	2011	ACM IUI		✓

Title	Reference	Year	Venue	Phase 1	Phase 2
Wrangler: interactive visual s...	[KPHH11]	2011	ACM CHI	✓	
Human computation tasks with g...	[ZLM*12]	2012	ACM CHI	✓	
Semantic interaction for visua...	[EFN12]	2012	ACM CHI	✓	
Say Anything: Using Textual Ca...	[SG12]	2012	ACM TIIS	✓	
Interest Driven Navigation in ...	[HD12]	2012	IEEE VIS	✓	
MotionExplorer: Exploratory Se...	[BWK*13]	2013	IEEE VIS	✓	
Directing Exploratory Search: ...	[GRK*13]	2013	ACM IUI	✓	
Finding Waldo: Learning about ...	[BOZ*14]	2014	IEEE VIS	✓	✓
TimeFork: Mixed-initiative tim...	[BZEE14]	2014	IEEE VIS		✓
Trend-Centric Motion Visualiza...	[SKK*14]	2014	IEEE VIS	✓	
Predictive Translation Memory:...	[GCHM14]	2014	ACM UIST	✓	
Visual Analysis of Spatio-Temp...	[DPD*15]	2015	CGF/EuroVis	✓	
Voyager: Exploratory Analysis ...	[WMA*16]	2015	IEEE TVCG	✓	✓
Mixed-initiative visual analyt...	[CCI*15]	2015	IEEE VIS		✓
Mixed-Initiative Real-Time Top...	[DCL*15]	2015	ACM IUI		✓
Eye tracking evaluation of vis...	[KFBW16]	2016	IUI		✓
Visualization by Demonstration...	[SKBE17]	2016	IEEE TVCG	✓	✓
Empirically Studying Participa...	[DHY*16]	2016	ACM IUI	✓	
Adaptive Contextualization: Co...	[GSC16]	2016	ACM IUI	✓	
Dynamic prefetching of data ti...	[BCS16]	2016	SIGMOD	✓	
Interface Design Optimization ...	[LFP*16]	2016	ACM CHI	✓	
Quantifying Collaboration with...	[DHS*17]	2017	ACM TIIS	✓	
Annotation Graphs: A Graph-Bas...	[ZGB*17]	2017	IEEE VIS		✓
Familiarity Vs Trust: A Compar...	[DLW*17]	2017	IEEE VIS	✓	✓
TopoAngler: Interactive Topolo...	[BDSS18]	2017	IEEE VIS	✓	
Voyager 2: Augmenting Visual A...	[WQM*17]	2017	ACM CHI	✓	✓
Using Machine Learning to Supp...	[CDK*18]	2018	ACM TIIS	✓	
Detecting Negative Emotion for...	[PC18]	2018	ACM CHI		✓
TreePOD: Sensitivity-Aware Sel...	[MLMP18]	2018	IEEE TVCG	✓	
ConceptVector: Text Visual Ana...	[PKL*18]	2018	IEEE TVCG	✓	
Podium: Ranking Data Using Mix...	[WDC*18]	2018	IEEE VIS	✓	✓
Avoiding drill-down fallacies ...	[LDH*19]	2019	ACM IUI	✓	
FAIRVIS: Visual Analytics for ...	[ESD*19]	2019	IEEE VIS		✓
Follow The Clicks: Learning an...	[OGW19]	2019	CGF/EuroVis	✓	✓
Visual Analytics for Topic Mod...	[ESD*19]	2019	IEEE VIS		✓
TopicSifter: Interactive searc...	[KCD*19]	2019	IEEE VIS	✓	
Visual Interaction with Deep L...	[GSK*19]	2019	IEEE VIS	✓	
VisiBlends: A Flexible Workflo...	[CPA19]	2019	ACM CHI	✓	
What can AI do for me?: evalua...	[FB19]	2019	ACM IUI	✓	
Human-Centered Tools for Copin...	[CRH*19]	2019	ACM CHI	✓	
Supporting the Problem-Solving...	[LDT*21]	2020	IEEE VIS	✓	
PlotThread: Creating Expressiv...	[TLW*21]	2020	IEEE VIS		✓
IsoTrotter: Visually Guided Em...	[PSH21]	2020	IEEE VIS		✓
Urban Mosaic: Visual Explorati...	[MHL*20]	2020	ACM CHI	✓	
Draw with me: human-in-the-loo...	[WHH*20]	2020	ACM IUI	✓	
CcNav: Understanding Compiler ...	[DAK*21]	2020	IEEE VIS	✓	
Integrating Prior Knowledge in...	[PBF*21]	2020	IEEE VIS		✓
ChartSeer: Interactive Steerin...	[ZFF22]	2020	IEEE TVCG	✓	
Foveated Encoding for Large Hi...	[FBB*21]	2021	IEEE TVCG	✓	
Learning Contextualized User P...	[SSKE21]	2021	CGF/EuroVis	✓	✓
Lumos: Increasing awareness of...	[NCWE22]	2021	IEEE VIS	✓	
A Mixed-Initiative Visual Anal...	[HPC*21]	2021	IEEE VIS		✓
Mixed-Initiative Approach to E...	[JCP*21]	2021	IEEE PacificVIS		✓
GenNI: Human-AI Collaboration ...	[SKK*22]	2021	IEEE VIS	✓	
THALIS: Human-Machine Analysis...	[FNB*22]	2021	IEEE VIS	✓	
Towards Visual Explainable Act...	[JLCL22]	2021	IEEE VIS	✓	
Rapid Assisted Visual Search: ...	[LLL21]	2021	ACM IUI	✓	
A Mixed-Initiative Approach to...	[CWH*22]	2021	IEEE VIS		✓
Kori: Interactive Synthesis of...	[LZK*22]	2021	IEEE VIS		✓
Sibyl: Understanding and Addre...	[ZLVV22]	2021	IEEE VIS	✓	
MultiVision: Designing Analyt...	[WWZ*22]	2021	IEEE VIS		✓
Modeling and Leveraging Analyt...	[ZWWG21]	2021	ACM CHI	✓	
Intentable: A Mixed-Initiative...	[CJ22]	2022	IEEE VIS		✓
Guided Data Discovery in Inter...	[MHN*22]	2022	IEEE VIS	✓	
A Typology of Guidance Tasks i...	[PCE*22]	2022	CGF/EuroVis	✓	
MEDLEY: Intent-based Recommend...	[PSS23]	2022	IEEE VIS		✓
Interpreting High-Dimensional ...	[ZLL*24]	2023	IEEE VIS		✓
Mystique: Deconstructing SVG C...	[CLW*24]	2023	IEEE VIS		✓
Dupo: A Mixed-Initiative Autho...	[KRHH23]	2023	IEEE VIS	✓	✓
How Do Data Analysts Respond L...	[GGM*24]	2023	ACM CHI	✓	
ConceptEVA: Concept-Based Inte...	[ZLC*23]	2023	ACM CHI		✓
InkSight: Leveraging Sketch In...	[LLY*23]	2023	IEEE VIS		✓
LEVA: Using Large Language Mod...	[ZZZ*25]	2024	IEEE VIS		✓
<b>Total</b>	—	—	—	<b>56 unique (60 w/ dups.)</b>	<b>36</b>

## 2. Detailed Codes for Phase 2

The table below shows three rows of codes for each reviewed paper in Phase 3: the first coder's selection, the second coder's selection, and the consensus after discussion.

Table 2: List of all papers reviewed across the two phases of analysis, sorted by publication year.

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[CWH*22]	Coder 2	Technique	[Faster than human alone, More accurate than human alone]	[Visualization generation]	[(5) the computer executes its suggestion if the human approves]	[Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative), Other - algorithmic evaluation (quantitative)]
[CWH*22]	Coder 3	Technique	[Faster than human alone, More accurate than human alone, Other - more creative than AI alone]	[Visualization generation]	[(5) the computer executes its suggestion if the human approves]	[Manipulation of recommendations, Other - Select seed examples, Other - approve results]	[Other - extract structure from chart images]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Case study (qualitative), Interview (qualitative)]
[CWH*22]	Consensus	Technique	[Faster than human alone, More accurate than human alone, Other - more creative than AI alone]	[Visualization generation]	[(5) the computer executes its suggestion if the human approves]	[Manipulation of recommendations, Constraint specification, Other - Select seed examples, Other - approve results]	[Other - extract structure from chart images, Recommend alternatives/options]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative), Other - algorithmic evaluation (quantitative)]
[HPC*21]	Coder 1	Technique	[More accurate than AI alone, Faster than human alone, More accurate than human alone]	[Model refinement]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative)]
[HPC*21]	Coder 3	Technique	[More accurate than AI alone, Faster than human alone, More accurate than human alone]	[Model refinement]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative)]
[HPC*21]	Consensus	Technique	[More accurate than AI alone, Faster than human alone, More accurate than human alone]	[Model refinement]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative)]
[ZGB*17]	Coder 4	System	[Faster than human alone, "better suit humans' mental model"]	[graph layout]	[(7) the computer executes the action and necessarily informs the human]	[Constraint specification]	[Optimise layout]	[Developing significant value-added automation]	[Interview (qualitative)]
[ZGB*17]	Coder 5	Technique	[More accurate than AI alone]	[Visualization generation]	[(4) the computer suggests one alternative action or decision]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Interview (qualitative)]
[ZGB*17]	Consensus	Technique	[More accurate than AI alone, "better suit humans' mental model"]	[Visualization generation, graph layout]	[(7) the computer executes the action and necessarily informs the human]	[Manipulation of recommendations, Constraint specification]	[Other - Layout]	[Developing significant value-added automation]	[Interview (qualitative)]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[CKHF11a]	Coder 4	System	[Faster than human alone]	[Sensemaking]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Developing significant value-added automation]	[None]
[CKHF11a]	Coder 5	System	[Faster than human alone, More accurate than human alone]	[Domain specific (specify)]	[(3) the computer narrows the selection down to a few]	[Constraint specification]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Case study (qualitative)]
[CKHF11a]	Consensus	System	[Faster than human alone]	[Domain specific (specify), Sensemaking]	[(3) the computer narrows the selection down to a few]	[Constraint specification]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results, Developing significant value-added automation]	[Case study (qualitative)]
[CKHF11b]	Coder 1	System	[Faster than human alone]	[Guidance, Knowledge Externalization]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Experiment (quantitative)]
[CKHF11b]	Coder 2	System	[Faster than human alone]	[Guidance, Knowledge Externalization]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Experiment (quantitative)]
[CKHF11b]	Consensus	System	[Faster than human alone]	[Guidance, Knowledge Externalization]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Experiment (quantitative)]
[ZLC*23]	Coder 1	System	[More accurate than AI alone]	[Data generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations]	[Other - summarize text]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Likert survey (quantitative)]
[ZLC*23]	Coder 3	System	[More accurate than AI alone]	[Data generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations]	[Other - summarize text]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Likert survey (quantitative)]
[ZLC*23]	Consensus	System	[More accurate than AI alone]	[Data generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations]	[Other - summarize text]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Likert survey (quantitative)]
[PL02]	Coder 1	Guidelines (theory)	["better suit humans' mental model", Faster than human alone]	[Other - goal agnostic]	[(4) the computer suggests one alternative action or decision]	[Manipulation of recommendations, Constraint specification]	[Optimise layout]	[Developing significant value-added automation]	[Case study (qualitative)]
[PL02]	Coder 5	Technique	[More accurate than AI alone]	[Domain specific (specify)]	[(2) the computer offers a complete set of decision or action alternatives]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Allowing efficient direct invocation and termination]	[Interview (qualitative)]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[PL02]	Consensus	Technique	[More accurate than AI alone]	[Domain specific (specify)]	[(2) the computer offers a complete set of decision or action alternatives]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Allowing efficient direct invocation and termination]	[Interview (qualitative)]
[PC18]	Coder 3	Technique	[More accurate than human alone]	[Other - goal agnostic]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	["Considering the status of a user's attention in the timing of service"]	[Experiment (quantitative)]
[PC18]	Coder 4	Technique	[More accurate than human alone, More active (analytic process) than human alone]	[na_goals]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	["Considering the status of a user's attention in the timing of service"]	[Experiment (quantitative)]
[PC18]	Consensus	Technique	[Faster than human alone, Lower cognitive load than human alone., More engagement than human alone.]	[Other - goal agnostic]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	["Considering the status of a user's attention in the timing of service"]	[Experiment (quantitative)]
[KRHH23]	Coder 2	System	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations]	[Recommend alternatives/options]	[Minimizing the cost of poor guesses about action and timing, Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative)]
[KRHH23]	Coder 5	Technique	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few, (4) the computer suggests one alternative action or decision]	[Constraint specification, Manipulation of recommendations]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative)]
[KRHH23]	Consensus	Technique	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few, (4) the computer suggests one alternative action or decision]	[Constraint specification, Manipulation of recommendations]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative)]
[KFBW16]	Coder 3	na_primary_contribution	[na_motivation_for_mi]	[na_goals]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	[na_mi_ui_principles]	[na_evaluation]
[KFBW16]	Coder 4	na_primary_contribution	[na_motivation_for_mi]	[na_goals]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	[na_mi_ui_principles]	[na_evaluation]
[KFBW16]	Consensus	na_primary_contribution	[na_motivation_for_mi]	[na_goals]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	[na_mi_ui_principles]	[na_evaluation]
[ESD*19]	Coder 1	System	[Other - human has access to domain knowledge]	[Model inspection]	[(3) the computer narrows the selection down to a few]	[Visual inspection of user-defined and AI-suggested alternatives]	[Generate search space]	[na_mi_ui_principles]	[na_evaluation]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[ESD*19]	Coder 3	System	[Other - human has access to domain knowledge]	[Model inspection]	[(3) the computer narrows the selection down to a few]	[Visual inspection of user-defined and AI-suggested alternatives]	[Generate search space]	[na_mi_ui_principles]	[None]
[ESD*19]	Consensus	System	[Other - human has access to domain knowledge]	[Model inspection]	[(3) the computer narrows the selection down to a few]	[Visual inspection of user-defined and AI-suggested alternatives]	[Generate search space]	[na_mi_ui_principles]	[None]
[DLW*17]	Coder 3	Empirical study (quantitative)	[Other - more familiar to users than AI alone, Faster than human alone]	[Sensemaking]	[(3) the computer narrows the selection down to a few, (7) the computer executes the action and necessarily informs the human]	[Other - approve results, Other - determine importance of hypothesis]	[Other - sort items on the visualization, Generate search space, Recommend alternatives/options]	[Maintaining working memory of recent interactions, Allowing efficient direct invocation and termination, Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative), Likert survey (quantitative)]
[DLW*17]	Coder 5	System	[More accurate than human alone, Faster than human alone]	[Domain specific (specify)]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	[na_mi_ui_principles]	[Experiment (quantitative)]
[DLW*17]	Consensus	Empirical study (quantitative)	[Other - more familiar to users than AI alone, Faster than human alone, More accurate than human alone]	[Sensemaking, Domain specific (specify), Domain specific - biology data cluster analysis, Domain specific - biology literature discovery]	[(3) the computer narrows the selection down to a few, (7) the computer executes the action and necessarily informs the human]	[Other - approve results, Other - determine importance of hypothesis]	[Generate search space, Recommend alternatives/options, Other - cluster items on the visualization]	[Allowing efficient direct invocation and termination, Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative), Likert survey (quantitative)]
[BOZ*14]	Coder 1	Empirical study (quantitative)	[na_motivation_for_mi]	[na_goals]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	[na_mi_ui_principles]	[Experiment (quantitative)]
[BOZ*14]	Coder 4	Empirical study (quantitative)	[na_motivation_for_mi]	[na_goals]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	[na_mi_ui_principles]	[Experiment (quantitative)]
[BOZ*14]	Consensus	Empirical study (quantitative)	[na_motivation_for_mi]	[na_goals]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	[na_mi_ui_principles]	[Experiment (quantitative)]
[OGW19]	Coder 4	Conceptual model (theory)	[na_motivation_for_mi]	[na_goals]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	[na_mi_ui_principles]	[Experiment (quantitative)]
[OGW19]	Coder 5	Technique	[Faster than human alone]	[Domain specific (specify)]	[(3) the computer narrows the selection down to a few]	[Other (specify)]	[Predict outcomes]	[Continuing to learn by observing]	[Experiment (quantitative)]
[OGW19]	Consensus	Technique	[na_motivation_for_mi]	[na_goals]	[na_level_of_automation]	[na_human_mean_of_contribution]	[na_ai_mean_of_contribution]	[Continuing to learn by observing]	[Experiment (quantitative)]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[LLY*23]	Coder 2	System	[Other - human has access to domain knowledge]	[Insight Generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification]	[Recommend alternatives/options]	["Considering the status of a user's attention in the timing of service", Developing significant value-added automation]	[Interview (qualitative)]
[LLY*23]	Coder 5	System	[Faster than human alone]	[Domain specific (specify)]	[(4) the computer suggests one alternative action or decision]	[Manipulation of recommendations, Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Case study (qualitative), Experiment (quantitative)]
[LLY*23]	Consensus	System	[Other - human has access to domain knowledge]	[Insight Generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification]	[Recommend alternatives/options]	["Considering the status of a user's attention in the timing of service", Developing significant value-added automation]	[Interview (qualitative)]
[PBF*21]	Coder 2	Technique	[Faster than human alone]	[Sensemaking]	[(7) the computer executes the action and necessarily informs the human]	[Constraint specification]	[Generate search space]	[Developing significant value-added automation]	[Case study (qualitative), Interview (qualitative)]
[PBF*21]	Coder 5	Technique	[More accurate than AI alone]	[Domain specific (specify)]	[(3) the computer narrows the selection down to a few]	[Constraint specification]	[Explore search space]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Case study (qualitative)]
[PBF*21]	Consensus	Technique	[More accurate than AI alone]	[Domain specific (specify)]	[(3) the computer narrows the selection down to a few]	[Constraint specification]	[Explore search space]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Case study (qualitative)]
[CJ22]	Coder 1	System	[Faster than human alone, Other - human has access to domain knowledge]	[Data generation]	[(4) the computer suggests one alternative action or decision]	[Constraint specification]	[Recommend alternatives/options]	[na_mi_ui_principles]	[Other - algorithmic evaluation (quantitative), Other - algorithmic evaluation (qualitative)]
[CJ22]	Coder 3	System	[Faster than human alone, Other - human has access to domain knowledge]	[Data generation]	[(4) the computer suggests one alternative action or decision]	[Constraint specification]	[Recommend alternatives/options]	[na_mi_ui_principles]	[Other - algorithmic evaluation (quantitative), Other - algorithmic evaluation (qualitative)]
[CJ22]	Consensus	System	[Faster than human alone, Other - human has access to domain knowledge]	[Data generation]	[(4) the computer suggests one alternative action or decision]	[Constraint specification]	[Recommend alternatives/options]	[na_mi_ui_principles]	[Other - algorithmic evaluation (quantitative), Other - algorithmic evaluation (qualitative)]
[ZLL*24]	Coder 1	Technique	[Easier for human to understand]	[Algorithm interpretation]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[na_mi_ui_principles]	[Experiment (quantitative), Interview (qualitative), Case study (qualitative)]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[ZLL*24]	Coder 4	Technique	[Easier for human to understand]	[Algorithm interpretation]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[None]	[Experiment (quantitative), Interview (qualitative), Case study (qualitative)]
[ZLL*24]	Consensus	Technique	[Easier for human to understand]	[Algorithm interpretation]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[na_mi_ui_principles]	[Experiment (quantitative), Interview (qualitative), Case study (qualitative)]
[PSH21]	Coder 2	Technique	[Faster than human alone]	[Other - search space exploration]	[(7) the computer executes the action and necessarily informs the human]	[Visual inspection of user-defined and AI-suggested alternatives]	[Generate search space]	[Minimizing the cost of poor guesses about action and timing]	[Field Study (qualitative)]
[PSH21]	Coder 4	System	[Faster than human alone]	[Scientific modeling]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Generate search space]	[Developing significant value-added automation]	[Case study (qualitative)]
[PSH21]	Consensus	Technique	[Faster than human alone]	[Other - search space exploration]	[(7) the computer executes the action and necessarily informs the human]	[Visual inspection of user-defined and AI-suggested alternatives]	[Generate search space]	[Minimizing the cost of poor guesses about action and timing, Developing significant value-added automation]	[Field Study (qualitative), Case study (qualitative)]
[LZK*22]	Coder 3	System	[Faster than human alone, Other - More flexible than AI alone]	[Data annotation]	[(3) the computer narrows the selection down to a few]	[Other - approve results]	[Recommend alternatives/options]	[Minimizing the cost of poor guesses about action and timing, "Considering uncertainty about a user's goals", Providing mechanisms for efficient agent-user collaboration to refine results]	[Likert survey (quantitative), Interview (qualitative), Other - algorithmic evaluation (quantitative)]
[LZK*22]	Coder 4	System	[Faster than human alone, Easier for (non-expert) human users]	[Text-chart synthesis (authoring)]	[(3) the computer narrows the selection down to a few]	[Asking the artificial agent to provide suggestions, Accepting suggestions]	[Recommend alternatives/options]	[Allowing efficient direct invocation and termination, Minimizing the cost of poor guesses about action and timing, "Considering the status of a user's attention in the timing of service", Allowing user creation?, Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative), Likert survey (quantitative), Interview (qualitative)]
[LZK*22]	Consensus	System	[Faster than human alone, Easier for humans without technical expertise, Other - More flexible than AI alone]	[Text-chart synthesis (authoring)]	[(3) the computer narrows the selection down to a few]	[Accepting suggestions, Asking the artificial agent to provide suggestions]	[Recommend alternatives/options]	[Minimizing the cost of poor guesses about action and timing, Providing mechanisms for efficient agent-user collaboration to refine results, Allowing efficient direct invocation and termination, "Considering uncertainty about a user's goals", "Other - Considering the user's attention in the presentation of suggestions"]	[Likert survey (quantitative), Interview (qualitative), Other - algorithmic evaluation (quantitative)]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[ZZZ*25]	Coder 2	System	[Faster than human alone]	[Other - Guidance]	[(9) the computer executes actions and informs the human if the computer wants to]	[Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Case study (qualitative), Likert survey (quantitative)]
[ZZZ*25]	Coder 4	System	[More accurate than human alone, Faster than human alone]	[Visual data exploration]	[(3) the computer narrows the selection down to a few]	[Prompting the artificial agent]	[Recommend alternatives/options]	[Maintaining working memory of recent interactions, Considering the latency of the artificial agent, Providing mechanisms for efficient agent-user collaboration to refine results, Developing significant value-added automation]	[Experiment (quantitative), Case study (qualitative), Interview (qualitative), Likert survey (quantitative)]
[ZZZ*25]	Consensus	System	[Faster than human alone, More accurate than human alone]	[Other - Guidance, Visual data exploration]	[(3) the computer narrows the selection down to a few]	[Prompting the artificial agent, Constraint specification]	[Recommend alternatives/options]	[Maintaining working memory of recent interactions, Considering the latency of the artificial agent, Providing mechanisms for efficient agent-user collaboration to refine results, Developing significant value-added automation]	[Experiment (quantitative), Likert survey (quantitative), Case study (qualitative), Interview (qualitative)]
[SSKE21]	Coder 3	Technique	["Other - capture users perceived notion of quality in AI models"]	[Model refinement]	[(5) the computer executes its suggestion if the human approves]	[Constraint specification]	[Recommend alternatives/options]	[Continuing to learn by observing, "Considering the status of a user's attention in the timing of service", Employing dialog to resolve key uncertainties, Maintaining working memory of recent interactions, Allowing efficient direct invocation and termination]	[Interview (qualitative), Experiment (quantitative)]
[SSKE21]	Coder 5	Technique	[More accurate than human alone]	[Model refinement]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative), Experiment (quantitative)]
[SSKE21]	Consensus	Technique	[More accurate than human alone, "Other - capture users perceived notion of quality in AI models"]	[Model refinement]	[(3) the computer narrows the selection down to a few, (5) the computer executes its suggestion if the human approves]	[Constraint specification, Accepting suggestions]	[Recommend alternatives/options]	[Continuing to learn by observing, "Considering the status of a user's attention in the timing of service", Employing dialog to resolve key uncertainties, Maintaining working memory of recent interactions, Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative), Experiment (quantitative)]
[PSS23]	Coder 4	System	[Faster than human alone, More active (analytic process) than human alone]	[Visualisation generation (dashboard composition)]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Asking the artificial agent to provide suggestions, Manipulation of recommendations]	[Recommend alternatives/options]	[Enhancing interpretability of recommendations]	[Likert survey (quantitative), Interview (qualitative)]
[PSS23]	Coder 5	System	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative)]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[PSS23]	Consensus	System	[Faster than human alone, Lower cognitive load than human alone.]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations, Asking the artificial agent to provide suggestions]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Likert survey (quantitative)]
[JCP*21]	Coder 1	System	[More accurate than AI alone]	[Other - Medical Form Readability]	[(7) the computer executes the action and necessarily informs the human]	[Other - approve results]	[Other (specify), Other - Data Extraction]	[Developing significant value-added automation]	[Interview (qualitative)]
[JCP*21]	Coder 2	System	[More accurate than AI alone]	[Other - Medical Form Readability]	[(7) the computer executes the action and necessarily informs the human]	[Other - approve results]	[Other (specify), Other - Data Extraction]	[Developing significant value-added automation]	[Interview (qualitative)]
[JCP*21]	Consensus	System	[More accurate than AI alone]	[Other - Medical Form Readability]	[(7) the computer executes the action and necessarily informs the human]	[Other - approve results]	[Other (specify), Other - Data Extraction]	[Developing significant value-added automation]	[Interview (qualitative)]
[DCL*15]	Coder 2	System	[Faster than human alone, Other - human has access to domain knowledge]	[Model refinement]	[(2) the computer offers a complete set of decision or action alternatives]	[Constraint specification]	[Other - Topic Classification]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative)]
[DCL*15]	Coder 3	System	[Faster than human alone, More accurate than AI alone, "Other - capture users perceived notion of quality in AI models"]	[Data annotation]	[(5) the computer executes its suggestion if the human approves]	[Other - provide meaningful examples of sentences]	[Other - summarize text conversations]	[Developing significant value-added automation]	[Interview (qualitative)]
[DCL*15]	Consensus	System	[Faster than human alone, Other - human has access to domain knowledge, More accurate than AI alone, "Other - capture users perceived notion of quality in AI models"]	[Model refinement, Data annotation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Other - provide meaningful examples of sentences]	[Other - Topic Classification, Other - summarize text conversations]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Interview (qualitative)]
[CCI*15]	Coder 1	System	[Faster than human alone, "better suit humans' mental model"]	[Guidance, Knowledge Externalization]	[(7) the computer executes the action and necessarily informs the human]	[Manipulation of recommendations, Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Case study (qualitative)]
[CCI*15]	Coder 5	Guidelines (theory)	[More accurate than human alone]	[Domain specific (specify)]	[(7) the computer executes the action and necessarily informs the human]	[Constraint specification]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Case study (qualitative)]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[CCI*15]	Consensus	System	[Faster than human alone, "better suit humans' mental model"]	[Guidance, Knowledge Externalization]	[(7) the computer executes the action and necessarily informs the human]	[Manipulation of recommendations, Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Case study (qualitative)]
[WWZ*22]	Coder 2	System	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation, Maintaining working memory of recent interactions]	[Likert survey (quantitative)]
[WWZ*22]	Coder 3	System	[Faster than human alone, Other - human control is nice to have as optional]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations]	[Generate search space]	[Maintaining working memory of recent interactions, Continuing to learn by observing, Providing mechanisms for efficient agent-user collaboration to refine results, Developing significant value-added automation]	[Likert survey (quantitative), Interview (qualitative), Experiment (quantitative)]
[WWZ*22]	Consensus	System	[Faster than human alone, Other - human control is nice to have as optional]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations]	[Generate search space]	[Maintaining working memory of recent interactions, Continuing to learn by observing, Providing mechanisms for efficient agent-user collaboration to refine results, Developing significant value-added automation]	[Likert survey (quantitative), Interview (qualitative), Experiment (quantitative)]
[CLW*24]	Coder 1	System	[More accurate than AI alone]	[Chart deconstruction]	[(4) the computer suggests one alternative action or decision]	[Manipulation of recommendations]	[Predict outcomes]	[Providing mechanisms for efficient agent-user collaboration to refine results, Developing significant value-added automation]	[Experiment (quantitative), Likert survey (quantitative), Interview (qualitative)]
[CLW*24]	Coder 4	System	[More accurate than AI alone]	[Chart deconstruction]	[(4) the computer suggests one alternative action or decision]	[Manipulation of recommendations]	[Predict outcomes]	[Providing mechanisms for efficient agent-user collaboration to refine results, Developing significant value-added automation]	[Experiment (quantitative), Likert survey (quantitative), Interview (qualitative)]
[CLW*24]	Consensus	System	[More accurate than AI alone]	[Chart deconstruction]	[(4) the computer suggests one alternative action or decision]	[Manipulation of recommendations]	[Predict outcomes]	[Providing mechanisms for efficient agent-user collaboration to refine results, Developing significant value-added automation]	[Experiment (quantitative), Likert survey (quantitative), Interview (qualitative)]
[TLW*21]	Coder 1	Technique	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Asking the artificial agent to provide suggestions]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative), Interview (qualitative)]
[TLW*21]	Coder 4	Technique	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Asking the artificial agent to provide suggestions]	[Recommend alternatives/options]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative), Interview (qualitative)]
[TLW*21]	Consensus	Technique	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Asking the artificial agent to provide suggestions]	[Recommend alternatives/options]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative), Interview (qualitative)]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[WDC*18]	Coder 3	Technique	[Other - human has access to domain knowledge]	[Model refinement]	[(4) the computer suggests one alternative action or decision]	[Other - direct parameter assignment, Manipulation of recommendations]	[Recommend alternatives/options]	[Allowing efficient direct invocation and termination, Maintaining working memory of recent interactions, Providing mechanisms for efficient agent-user collaboration to refine results, Continuing to learn by observing]	[Case study (qualitative)]
[WDC*18]	Coder 5	System	[More accurate than human alone]	[Domain specific (specify)]	[(5) the computer executes its suggestion if the human approves]	[Constraint specification]	[Predict outcomes]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Case study (qualitative), Interview (qualitative)]
[WDC*18]	Consensus	System	[Faster than human alone, "Other - capture users preferences"]	[Domain specific (specify), Other - data ranking]	[(5) the computer executes its suggestion if the human approves]	[Constraint specification, Other - direct parameter assignment]	[Predict outcomes]	[Providing mechanisms for efficient agent-user collaboration to refine results, Allowing efficient direct invocation and termination, Continuing to learn by observing]	[Case study (qualitative), Interview (qualitative)]
[BZEE14]	Coder 3	Technique	[Other - AI knowledge can be outdated (offline), Other - Human has real-time knowledge, Other - human has access to domain knowledge]	[Other - Forecasting]	[(3) the computer narrows the selection down to a few]	[Other - model selection, Manipulation of recommendations]	[Predict outcomes]	[Minimizing the cost of poor guesses about action and timing]	[None]
[BZEE14]	Coder 5	Technique	[More accurate than AI alone]	[Domain specific (specify)]	[(4) the computer suggests one alternative action or decision]	[Manipulation of recommendations]	[Predict outcomes]	[Providing mechanisms for efficient agent-user collaboration to refine results]	[Case study (qualitative)]
[BZEE14]	Consensus	Technique	[More accurate than AI alone, Other - AI knowledge can be outdated (offline), Other - Human has real-time knowledge, Other - human has access to domain knowledge]	[Other - Forecasting]	[(4) the computer suggests one alternative action or decision]	[Manipulation of recommendations]	[Predict outcomes]	[Providing mechanisms for efficient agent-user collaboration to refine results, Minimizing the cost of poor guesses about action and timing]	[Case study (qualitative)]
[ESD*19]	Coder 1	System	[More accurate than AI alone, Faster than AI alone]	[Model refinement]	[(7) the computer executes the action and necessarily informs the human]	[Constraint specification, Manipulation of recommendations]	[Predict outcomes, Generate search space]	[Developing significant value-added automation]	[Interview (qualitative), Other - algorithmic evaluation (quantitative)]
[ESD*19]	Coder 5	Technique	[Other (specify), Explainable AI]	[Model refinement]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Predict outcomes]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative), Interview (qualitative)]
[ESD*19]	Consensus	Technique	[Other (specify), Explainable AI]	[Model refinement]	[(3) the computer narrows the selection down to a few]	[Manipulation of recommendations]	[Predict outcomes]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative), Interview (qualitative)]

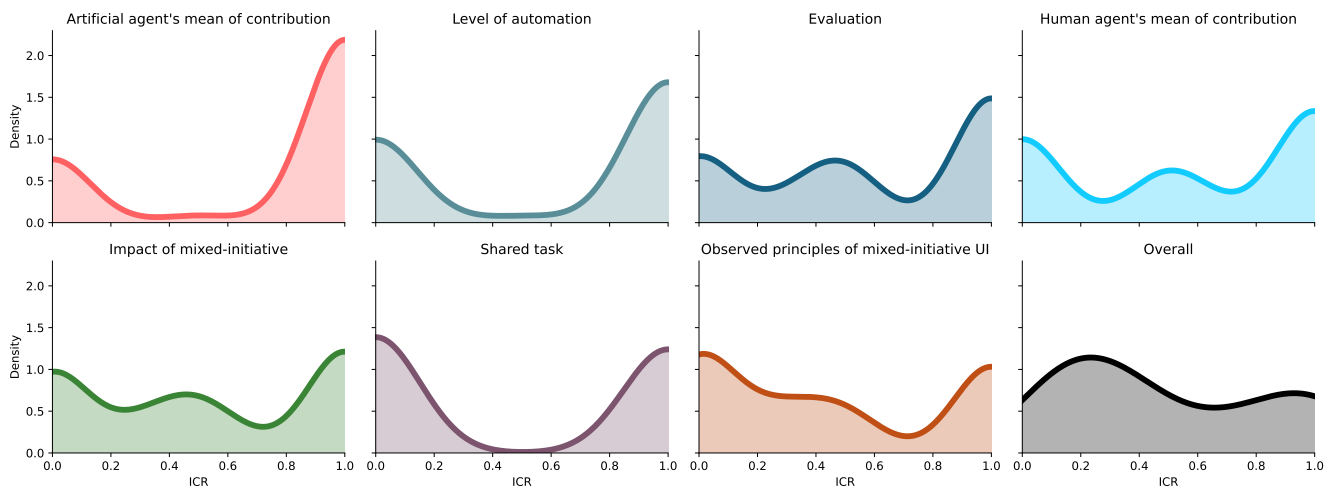
Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[KHW*11]	Coder 3	System	[More accurate than AI alone]	[Data annotation]	[(5) the computer executes its suggestion if the human approves]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Experiment (quantitative), Likert survey (quantitative)]
[KHW*11]	Coder 4	System	[More accurate than AI alone]	[Data curation (organise data)]	[(5) the computer executes its suggestion if the human approves]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Providing mechanisms for efficient agent-user collaboration to refine results, Continuing to learn by observing, Developing significant value-added automation]	[None]
[KHW*11]	Consensus	System	[More accurate than AI alone]	[Data annotation]	[(5) the computer executes its suggestion if the human approves]	[Manipulation of recommendations]	[Recommend alternatives/options]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results]	[Experiment (quantitative), Likert survey (quantitative)]
[SKBE17]	Coder 2	System	[Other - human has access to domain knowledge]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Other - Select seed examples, Constraint specification]	[Recommend alternatives/options]	["Considering the status of a user's attention in the timing of service"]	[Case study (qualitative)]
[SKBE17]	Coder 4	Conceptual model (theory)	[Faster than human alone, Easier for (non-expert) human users]	[Visual data exploration]	[(3) the computer narrows the selection down to a few]	[Visual demonstration]	[Recommend alternatives/options]	[Enhancing interpretability of recommendations]	[None]
[SKBE17]	Consensus	Technique	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Other - Select seed examples]	[Recommend alternatives/options]	[Inferring ideal action in light of costs, benefits, and uncertainties, Continuing to learn by observing]	[Case study (qualitative)]
[WQM*17]	Coder 2	System	[Faster than human alone]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Experiment (quantitative)]
[WQM*17]	Coder 4	System	[Faster than human alone, More accurate than AI alone, Other - Easier for (non-expert) human users]	[Visual data exploration]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations]	[Recommend alternatives/options]	[Developing significant value-added automation, Providing mechanisms for efficient agent-user collaboration to refine results, Enhancing interpretability of recommendations, Maintaining working memory of recent interactions, "Considering the status of a user's attention in the timing of service"]	[Experiment (quantitative), Likert survey (quantitative)]
[WQM*17]	Consensus	System	[Faster than human alone, Other - Easier for (non-expert) human users, Other - More relevant recommendations]	[Visualization generation]	[(3) the computer narrows the selection down to a few]	[Constraint specification, Manipulation of recommendations]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Experiment (quantitative), Likert survey (quantitative)]
[WMA*16]	Coder 1	System	[Faster than human alone, Other - More breadth during analysis]	[Visualization generation]	[(7) the computer executes the action and necessarily informs the human]	[Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation, Enhancing interpretability of recommendations, Providing mechanisms for efficient agent-user collaboration to refine results]	[Likert survey (quantitative), Experiment (quantitative)]

Paper	Coder	Primary Contribution	Impact of mixed-initiative	Shared Task	Level of Automation	Human Contribution	AI Contribution	Principles of Mixed-Initiative UI	Evaluation
[WMA*16]	Coder 2	System	[Faster than human alone]	[Visualization generation]	[(7) the computer executes the action and necessarily informs the human]	[Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Likert survey (quantitative)]
[WMA*16]	Consensus	System	[Faster than AI alone, Other - More breadth during analysis]	[Visualization generation]	[(7) the computer executes the action and necessarily informs the human]	[Constraint specification]	[Recommend alternatives/options]	[Developing significant value-added automation]	[Likert survey (quantitative)]

### 3. Inter-Coder Reliability

**Table 3:** The ICR values for the papers coded in Phase 2. The rows are sorted based on the Overall ICR value (paper with highest overall agreement first). The columns are sorted based on the mean ICR across all papers (attribute with highest mean consensus shown first).

Title	AI Contribution	Automation Level	Evaluation	Human Contribution	Impact of MI	Shared Task	MI Principles	Overall
[HPC*21] A Mixed-Init...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
[JCP*21] Mixed-Init...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
[CKHF11a] Apollo: mak...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
[ZLC*23] ConceptEVA...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
[CJ22] Intentable...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
[KFBW16] Eye tracki...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
[CLW*24] Mystique: ...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
[BOZ*14] Finding Wa...	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
[TLW*21] PlotThread...	1.0	1.0	1.0	1.0	1.0	1.0	0.5	0.89
[KRHH23] Dupo: A Mi...	1.0	0.5	1.0	1.0	1.0	1.0	0.5	0.8
[ZLL*24] Interpreti...	1.0	1.0	1.0	1.0	1.0	1.0	0.0	0.8
[ESD*19] FAIRVIS: V...	1.0	1.0	0.0	1.0	1.0	1.0	1.0	0.75
[PC18] Detecting ...	1.0	1.0	1.0	1.0	0.5	0.0	1.0	0.67
[WMA*16] Voyager: E...	1.0	1.0	0.5	1.0	0.5	1.0	0.33	0.64
[WWZ*22] MultiVisio...	0.0	1.0	0.33	0.5	0.5	1.0	0.5	0.47
[CWH*22] A Mixed-Init...	0.0	1.0	0.33	0.0	0.67	1.0	1.0	0.44
[KHW*11] VisualWiki...	1.0	1.0	0.0	1.0	1.0	0.0	0.33	0.42
[WQM*17] Voyager 2:...	1.0	1.0	0.5	0.5	0.33	0.0	0.2	0.38
[PSS23] MEDLEY: In...	1.0	1.0	0.0	0.67	0.5	0.0	0.0	0.36
[LZK*22] Kori: Inte...	1.0	1.0	0.5	0.0	0.33	0.0	0.33	0.35
[CCI*15] Mixed-init...	1.0	1.0	1.0	0.5	0.0	0.0	0.0	0.33
[ESD*19] Visual Ana...	0.5	0.0	0.33	0.5	0.0	1.0	0.5	0.31
[ZZZ*25] LEVA: Usin...	1.0	0.0	0.5	0.0	0.5	0.0	0.25	0.29
[SSKE21] Learning C...	1.0	0.0	1.0	0.0	0.0	1.0	0.0	0.25
[CKHF11a] Apollo: int...	1.0	1.0	0.0	0.0	0.5	0.0	0.0	0.25
[LLY*23] InkSight: ...	1.0	0.0	0.0	0.5	0.0	0.0	0.5	0.21
[PSH21] IsoTrotter...	1.0	0.0	0.0	0.0	1.0	0.0	0.0	0.17
[ZGB*17] Annotation...	0.0	0.0	1.0	0.0	0.0	0.0	1.0	0.15
[PBF*21] Integratin...	0.0	0.0	0.5	1.0	0.0	0.0	0.0	0.15
[SKBE17] Visualizat...	1.0	1.0	0.0	0.0	0.0	0.0	0.0	0.14
[BZEE14] TimeFork: ...	1.0	0.0	0.0	0.5	0.0	0.0	0.0	0.13
[DCL*15] Mixed-Init...	0.0	0.0	1.0	0.0	0.25	0.0	0.0	0.13
[WDC*18] Podium: Ra...	0.0	0.0	0.5	0.0	0.0	0.0	0.25	0.12
[DLW*17] Familiarit...	0.0	0.0	0.5	0.0	0.33	0.0	0.0	0.1
[OGW19] Follow The...	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.08
[PL02] Design vis...	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.07
<b>Mean</b>	0.74	0.62	0.6	0.56	0.53	0.47	0.45	0.57



**Figure 4:** The distribution density (KDE) of ICR values per coded attribute. We observe a multi-modal distribution for most attributes, indicating the existence of differences between coders' interpretations before resolving the codes.

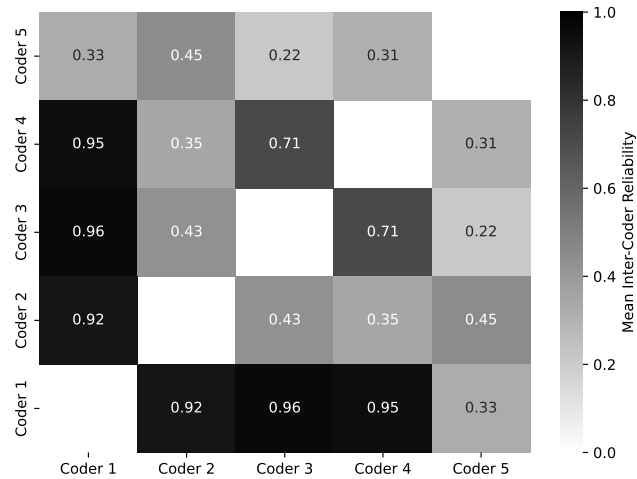


Figure 5: Pairwise average ICR values between coders.

#### 4. The Integrated Taxonomy

We have created a web application (<https://smonadjemi.github.io/miva>) for exploring our integrated taxonomy and the reviewed literature. In this section, we provide an alternative view of the taxonomy in a tabular format.

Table 4: Characterizing *human agents'* contribution to mixed-initiative visual analytic tasks.

What do they contribute?	How do they contribute?	Examples
Goal augmentation	specify constraints	[CKHF11a; CJ22; CCI*15; CWH*22; DCL*15; KRHH23; LLY*23; PSS23; PBF*21; SKBE17; SSKE21; WDC*18; WMA*16; WQM*17; WWZ*22; ZLC*23; ZGB*17; ZZZ*25]
	select seed examples	[CWH*22; DCL*15; SKBE17]
Action augmentation	prompt the artificial agent	[LZK*22; PSS23; TLW*21; ZZZ*25]
	manipulate recommendations	[BZEE14; CKHF11a; CLW*24; CCI*15; CWH*22; ESD*19; HPC*21; KHW*11; PSS23; PL02; WQM*17; WWZ*22; ZLL*24; ZGB*17]
Decision augmentation	approve results	[DLW*17; JCP*21]
	accept suggestions	[LZK*22; SSKE21]
	assign values to parameters	[WDC*18]
Cognitive augmentation	inspect alternatives	[ESD*19; PSH21]
	determine importance	[DLW*17]

Table 5: Characterizing *artificial agents'* contribution to mixed-initiative visual analytic tasks.

What do they contribute?	How do they contribute?	Examples
Goal augmentation	—	—
Action augmentation	recommend alternatives	[CKHF11a; CJ22; CCI*15; CWH*22; DLW*17; HPC*21; KRHH23; KHW*11; LZK*22; LLY*23; PSS23; PL02; SKBE17; SSKE21; TLW*21; WMA*16; WQM*17; ZLL*24; ZZZ*25]
	generate search space	[DLW*17; ESD*19; PSH21; WWZ*22; PBF*21]
Decision augmentation	update the visual layout	[DLW*17; ZGB*17]
	classify topics	[DCL*15]
Cognitive augmentation	summarize text	[DCL*15; ZLC*23]
	predict outcomes	[BZEE14; CLW*24; ESD*19; WDC*18]
	extract structure from charts	[CWH*22]
	extract data	[JCP*21]

**Table 6:** Characterizing *the shared tasks* in mixed-initiative visual analytics.

Which visual analytic step?	What task is shared?	Examples
Data	annotate data	[DCL*15; KHW*11]
	discover relevant data	[DLW*17]
	extract data from images	[JCP*21]
	rank data	[WDC*18]
	summarize text	[ZLC*23]
Models	analyze clusters	[DLW*17]
	inspect models	[ESD*19]
	refine models	[DCL*15; ESD*19; HPC*21; PSH21; PBF*21; SSKE21]
	understand models	[ZLL*24]
Visualizations	extract visualization layout	[CLW*24; CWH*22]
	generate captions for visualization	[CJ22]
	make visualizations	[KRHH23; PSS23; SKBE17; TLW*21; WMA*16; WQM*17; WWZ*22]
	refer to visualizations in text	[LZK*22]
	refine visualization layout	[ZLL*24; ZGB*17]
Knowledge and Decisions	discover evidence	[CKHF11a]
	externalize knowledge	[CCI*15]
	forecast outcomes	[BZEE14]
	generate insight	[LLY*23; ZZZ*25]
	navigate design space	[PL02]

**Table 7:** Characterizing *the impact of mixed-initiative interaction* in visual analytics.

What is impacted?	How is it impacted?	Examples
Speed	mixed-initiative is faster than human alone	[CKHF11a; CJ22; CCI*15; CWH*22; DLW*17; DCL*15; HPC*21; KRHH23; LZK*22; PSH21; PSS23; PC18; SKBE17; TLW*21; WDC*18; WWZ*22; ZZZ*25]
Accuracy	mixed-initiative is more accurate than automation alone	[BZEE14; CLW*24; HPC*21; JCP*21; KHW*11; PBF*21; PL02; SSKE21; ZLC*23; ZGB*17]
	mixed-initiative is more accurate than human alone	[CWH*22; DLW*17; HPC*21; ZZZ*25]
Accessibility and Convenience	easier model understanding than automation alone	[ESD*19]
	lower cognitive load than human alone	[PSS23; PC18; ZLL*24]
	more accessible to non-technical users	[LZK*22; WQM*17]
	more familiar to users than automation alone	[DLW*17]
	nicer to have human control	[WWZ*22]
Alignment with Human	more aligned with human's preferences	[WDC*18]
	more creative than automation alone	[CWH*22]
	more flexible than automation alone	[LZK*22]
	more in tune with human mental model	[CCI*15; ZGB*17]
	more in tune with human notion of quality	[SSKE21]
Knowledge	more domain knowledge than automation alone	[BZEE14; CJ22; ESD*19; LLY*23; CEH*19]
	more real-time knowledge than human or automation alone	[BZEE14]

**Table 8: Characterizing the level of automation in mixed-initiative visual analytic tasks, according to the taxonomy by [PSW00].**

How is agency divided between human and artificial agents?	Examples
(1) the computer offers no assistance; human must take all decisions and actions	–
(2) the computer offers a complete set of alternatives; human chooses from the set	[PL02]
(3) the computer narrows the selection down to a few; human chooses from the set	[CKHF11a; DLW*17; DCL*15; ESD*19; HPC*21; KRHH23; LZK*22; LLY*23; PSS23; PBF*21; SKBE17; SSKE21; TLW*21; WQM*17; WWZ*22; ZLC*23; ZLL*24; ZZZ*25]
(4) the computer suggests one alternative to the human	[BZEE14; CLW*24; CJ22; KRHH23]
(5) the computer executes the suggestion if human approves	[CWH*22; KHW*11; SSKE21; WDC*18]
(6) the computer allows the human a limited time to veto before automatic execution	–
(7) the computer executes an action automatically, then necessarily informs the human	[CCI*15; DLW*17; JCP*21; PSH21; WMA*16; ZGB*17]
(8) the computer executes an action autonomously, then informs the human only if requested	–
(9) the computer executes an action autonomously, then informs the human if the computer decides to	–
(10) the computer decides everything and acts autonomously, ignoring the human	–

**Table 9: The observed principles of mixed-initiative user interfaces [Hor99] in reviewed mixed-initiative visual analytic systems.**

What principle?	Examples
aware of user attention	[LZK*22; LLY*23; PC18; SSKE21]
aware of user goal uncertainty	[LZK*22]
consider costs, benefits, and uncertainties	[SKBE17]
continuous learning by observing	[OGW19; SKBE17; SSKE21; WDC*18; WWZ*22]
dialog for uncertainty resolution	[SSKE21]
direct invocation/termination	[DLW*17; LZK*22; PL02; WDC*18]
efficient result refinement	[BZEE14; CKHF11a; CLW*24; CWH*22; DLW*17; DCL*15; ESD*19; HPC*21; KRHH23; KHW*11; LZK*22; PSS23; PBF*21; SSKE21; TLW*21; WDC*18; WWZ*22; ZLC*23; ZZZ*25]
minimize poor actions and timing	[BZEE14; LZK*22; PSH21]
significant value added	[CKHF11a; CLW*24; CCI*15; CWH*22; DCL*15; ESD*19; JCP*21; KHW*11; LLY*23; TLW*21; WMA*16; WQM*17; WWZ*22; ZLC*23; ZGB*17; ZZZ*25]
working memory of interactions	[SSKE21; WWZ*22; ZZZ*25]
socially appropriate behavior	–
adaptive service to match uncertainty	–

**Table 10: The approaches used for evaluating mixed-initiative visual analytic systems.**

Type	Method	Examples
Qualitative	interview study	[CLW*24; CWH*22; DCL*15; ESD*19; HPC*21; JCP*21; KRHH23; LZK*22; LLY*23; PL02; SSKE21; TLW*21; WDC*18; WWZ*22; ZLL*24; ZGB*17; ZZZ*25]
	case study	[BZEE14; CKHF11a; CCI*15; PSH21; PBF*21; SKBE17; WDC*18; ZLL*24; ZZZ*25]
	field study	[PSH21]
	qualitative algorithm evaluation	[CJ22]
Quantitative	experiment	[BOZ*14; CKHF11a; CLW*24; DLW*17; ESD*19; KHW*11; OGW19; PC18; SSKE21; TLW*21; WQM*17; WWZ*22; ZLL*24; ZZZ*25]
	likert survey	[CLW*24; DLW*17; KHW*11; LZK*22; PSS23; WMA*16; WQM*17; WWZ*22; ZLC*23; ZZZ*25]
	quantitative algorithm evaluation	[CWH*22; LZK*22; CJ22]

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