Hierarchical, multi-feature visual grouping processes for ACT-R

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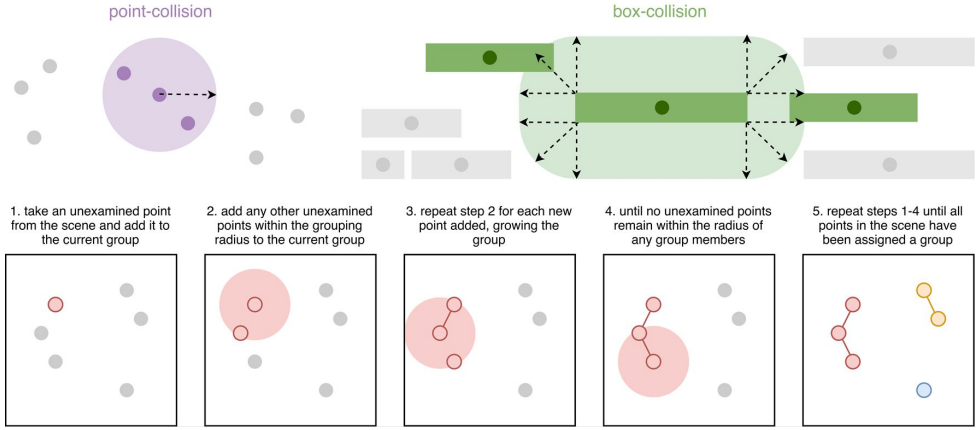
chil
THE COMPUTER-HUMAN INTERACTION LABORATORY AT RICE UNIVERSITY

VEGA - Visicon Entry Grouping Algorithm

- Presented at 2018 ACT-R workshop by John Lindstedt, now at SUNY Oswego
- Motivated by observation of behavioral error associated with certain ballot designs
- Two core concepts:
  - Collision methods
    - Parameterized by a radius value
  - Agglomeration



VEGA - 2023 edition

- How does it work?
  - Code that handles grouping is implemented in python rather than lisp
  - Relies on a set of command monitors which track changes to the visicon and the (proc-display) call
    - :force-visual-commands is necessary

ACT-R		Python
1. Device code modifies visicon	→	VEGA maintains a record of the visicon
2. Visicon modification results in (proc-display) call	→	VEGA groups visicon entries before (proc-display) call executes

Name	Att	Loc	KIND	WIDTH	VALUE	HEIGHT	SIZE	SCREEN-BOTTOM	SCREEN-TOP	SCREEN-RIGHT	SCREEN-LEFT	COLOR	GROUP	TEXT	OVAL	IMAGE
VISUAL-LOCATION57	NIL	(18 234 1080)	TEXT	14	"To"	10	0.39	238	228	24	10	BLACK	G86696	T		
VISUAL-LOCATION69	NIL	(18 258 1080)	TEXT	14	"to"	10	0.39	262	252	24	10	BLACK	G86696	T		
VISUAL-LOCATION116	NIL	(18 370 1080)	TEXT	14	"If"	10	0.39	374	364	24	10	BLACK	G86697	T		
VISUAL-LOCATION175	NIL	(18 520 1080)	TEXT	14	"of"	10	0.39	524	514	24	10	BLACK	G86698	T		
VISUAL-LOCATION197	NIL	(18 568 1080)	TEXT	14	"on"	10	0.39	572	562	24	10	BLACK	G86698	T		
VISUAL-LOCATION202	NIL	(20 641 1080)	OVAL	20	OVAL	10	0.56	646	636	30	10	WHITE	G86700		T	
VISUAL-LOCATION203	NIL	(20 659 1080)	OVAL	20	OVAL	10	0.56	664	654	30	10	BLACK	G86700		T	
VISUAL-LOCATION205	NIL	(20 742 1080)	OVAL	20	OVAL	10	0.56	746	736	30	10	BLACK	G86702		T	
VISUAL-LOCATION15	NIL	(21 98 1080)	TEXT	21	"FOR"	10	0.59	102	92	30	10	BLACK	G86695	T		
VISUAL-LOCATION50	NIL	(21 194 1080)	TEXT	21	"the"	10	0.59	198	188	30	10	BLACK	G86695	T		
VISUAL-LOCATION90	NIL	(21 294 1080)	TEXT	21	"the"	10	0.59	298	288	30	10	BLACK	G86696	T		
VISUAL-LOCATION111	NIL	(21 330 1080)	TEXT	21	"the"	10	0.59	334	324	30	10	BLACK	G86696	T		
VISUAL-LOCATION24	NIL	(25 134 1080)	TEXT	28	"This"	10	0.78999996	138	128	38	10	BLACK	G86695	T		
VISUAL-LOCATION45	NIL	(25 182 1080)	TEXT	28	"must"	10	0.78999996	186	176	38	10	BLACK	G86695	T		
VISUAL-LOCATION63	NIL	(25 246 1080)	TEXT	28	"your"	10	0.78999996	250	240	38	10	BLACK	G86696	T		
VISUAL-LOCATION77	NIL	(25 270 1080)	TEXT	28	"name"	10	0.78999996	274	264	38	10	BLACK	G86696	T		
VISUAL-LOCATION98	NIL	(25 306 1080)	TEXT	28	"name"	10	0.78999996	310	300	38	10	BLACK	G86696	T		
VISUAL-LOCATION138	NIL	(25 418 1080)	TEXT	28	"ices"	10	0.78999996	422	412	38	10	BLACK	G86697	T		
VISUAL-LOCATION145	NIL	(25 430 1080)	TEXT	28	"LEFT"	10	0.78999996	434	424	38	10	BLACK	G86697	T		
VISUAL-LOCATION182	NIL	(25 532 1080)	TEXT	28	"When"	10	0.78999996	536	526	38	10	BLACK	G86698	T		
VISUAL-LOCATION192	NIL	(25 556 1080)	TEXT	28	"vote"	10	0.78999996	560	550	38	10	BLACK	G86698	T		
VISUAL-LOCATION55	NIL	(29 206 1080)	TEXT	35	"clerk"	10	0.97999996	210	200	46	10	BLACK	G86695	T		
VISUAL-LOCATION84	NIL	(29 282 1080)	TEXT	35	"whose"	10	0.97999996	286	276	46	10	BLACK	G86696	T		
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VISUAL-LOCATION157	NIL	(32 454 1080)	TEXT	42	"cannot"	10	1.18	458	448	52	10	BLACK	G86697	T		
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VISUAL-LOCATION70	NIL	(42 258 1080)	TEXT	21	"the"	10	0.59	262	252	52	30	BLACK	G86696	T		
VISUAL-LOCATION117	NIL	(42 370 1080)	TEXT	21	"you"	10	0.59	374	364	52	30	BLACK	G86697	T		
VISUAL-LOCATION176	NIL	(42 520 1080)	TEXT	21	"the"	10	0.59	524	514	52	30	BLACK	G86698	T		
VISUAL-LOCATION78	NIL	(43 270 1080)	TEXT	7	"."	10	0.19999999	274	264	46	38	BLACK	G86696	T		
VISUAL-LOCATION139	NIL	(43 418 1080)	TEXT	7	","	10	0.19999999	422	412	46	38	BLACK	G86697	T		
VISUAL-LOCATION167	NIL	(43 496 1080)	TEXT	63	"IMPORTANT"	10	1.77	500	490	74	10	BLACK	G86698	T		
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VISUAL-LOCATION129	NIL	(50 394 1080)	TEXT	7	","	10	0.19999999	398	388	52	46	BLACK	G86697	T		
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VISUAL-LOCATION46	NIL	(60 182 1080)	TEXT	28	"bear"	10	0.78999996	186	176	74	46	BLACK	G86695	T		
VISUAL-LOCATION79	NIL	(60 270 1080)	TEXT	14	"To"	10	0.39	274	264	66	52	BLACK	G86696	T		
VISUAL-LOCATION91	NIL	(60 294 1080)	TEXT	42	"ballot"	10	1.18	298	288	80	38	BLACK	G86696	T		
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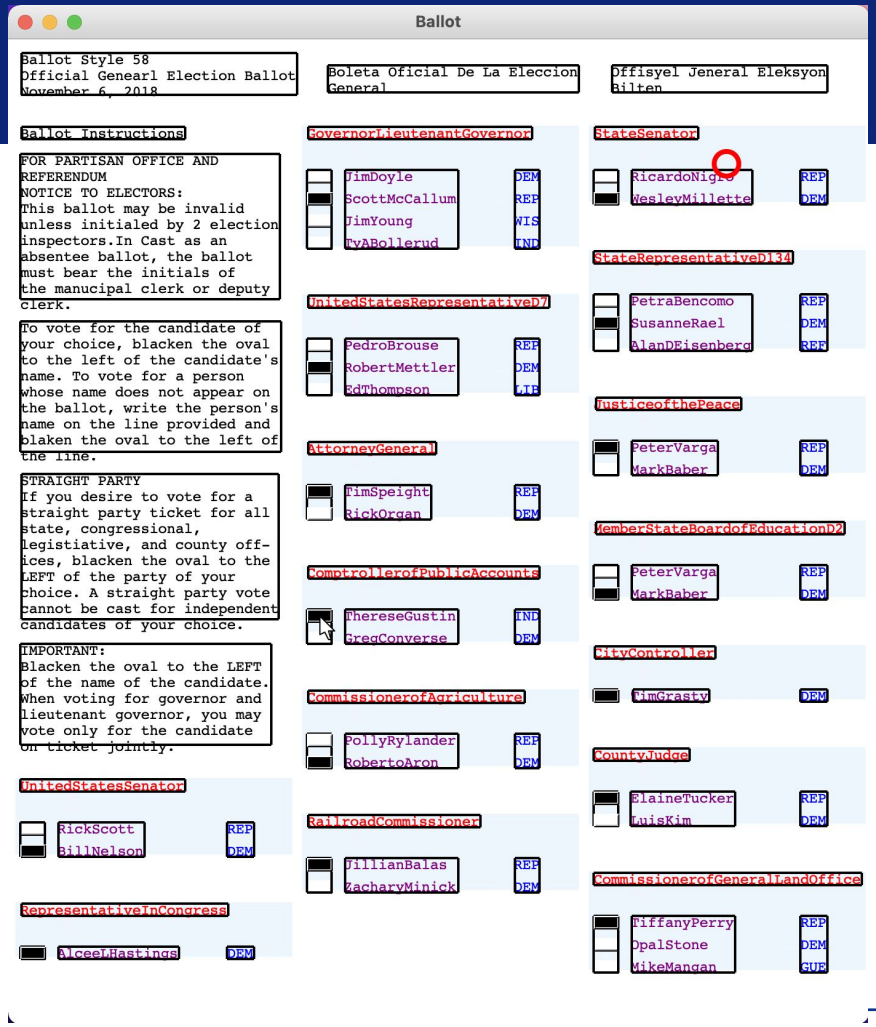
VISUAL-LOCATION21	NIL	(67 122 1080)	TEXT	14	"TO"	10	0.39	126	116	74	60	BLACK	G86695	T		
VISUAL-LOCATION25	NIL	(67 134 1080)	TEXT	42	"ballot"	10	1.18	138	128	88	46	BLACK	G86695	T		


Ballot
Ballot Style 58
Official Genearl Election Ballot
November 6, 2018
Boleta Oficial De La Eleccion General
Offisyel Jeneral Eleksyon Bilten
Ballot Instructions
FOR PARTISAN OFFICE AND REFERENDUM
NOTICE TO ELECTORS:
This ballot may be invalid unless initialed by 2 election inspectors.In Cast as an absentee ballot, the ballot must bear the initials of the manucipal clerk or deputy clerk.
To vote for the candidate of your choice, blacken the oval to the left of the candidate's name. To vote for a person whose name does not appear on the ballot, write the person's name on the line provided and blaken the oval to the left of the line.
STRAIGHT PARTY
If you desire to vote for a straight party ticket for all state, congressional, legistiative, and county offices, blacken the oval to the LEFT of the party of your choice. A straight party vote cannot be cast for independent candidates of your choice.
IMPORTANT:
Blacken the oval to the LEFT of the name of the candidate. When voting for governor and lieutenant governor, you may vote only for the candidate on ticket jointly.
UnitedStatesSenator
RickScott REP
BillNelson DEM
RepresentativeInCongress
AlceeLHastings DEM
GovernorLieutenantGovernor
JimDoyle DEM
ScottMcCallum REP
JimYoung WIS
TyABollerud IND
UnitedStatesRepresentativeD7
PedroBrouse REP
RobertMettler DEM
EdThompson LIB
AttorneyGeneral
TimSpeight REP
RickOrgan DEM
ComptrollerofPublicAccounts
ThereseGustin IND
GregConverse DEM
CommissionerofAgriculture
PollyRylander REP
RobertoAron DEM
RailroadCommissioner
JillianBalas REP
ZacharyMinick DEM
StateSenator
RicardoNigro REP
WesleyMillette DEM
StateRepresentativeD134
PetraBencomo REP
SusanneRael DEM
AlanDEisenberg REF
JusticeofthePeace
PeterVarga REP
MarkBaber DEM
MemberStateBoardofEducationD2
PeterVarga REP
MarkBaber DEM
CityController
TimGrasty DEM
CountyJudge
ElaineTucker REP
LuisKim DEM
CommissionerofGeneralLandOffice
TiffanyPerry REP
OpalStone DEM
MikeMangan GUE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RickOrgan DEM
ComptrollerofPublicAccounts
ThereseGustin IND
GregConverse DEM
CommissionerofAgriculture
PollyRylander REP
RobertoAron DEM
RailroadCommissioner
JillianBalas REP
ZacharyMinick DEM
StateSenator
RicardoNigro REP
WesleyMillette DEM
StateRepresentativeDl34
PetraBencomo REP
SusanneRael DEM
AlanDEisenberg REP
JusticeofthePeace
PeterVarga REP
MarkBaber DEM
MemberStateBoardofEducationD2
PeterVarga REP
MarkBaber DEM
CityController
TimGrasty DEM
CountyJudge
ElaineTucker REP
LuisKim DEM
CommissionerofGeneralLandOffice
TiffanyPerry REP
OpalStone DEM
MikeMangan GUF

VEGA - 2023 edition

- VEGA 2023 does everything that the 2018 version did
    - Plus bug fixes!
- How has it been extended?
    - Hierarchical grouping
        - Iterative Radii

Radius value	# Groups
1	10
2	10
3	7
4	7
5	3
6	1



VEGA - 2023 edition

- What does it do?
  - Everything that the 2018 version did
  - Hierarchical grouping
    - Iterative Radii
      - “Top-down”/“bottom-up”
      - Naturally identify number of levels of hierarchy
      - Difficult to tell what belongs to what
      - Manual setting of radius values
      - Relatively computationally intensive

Radius value	# Groups
1	10
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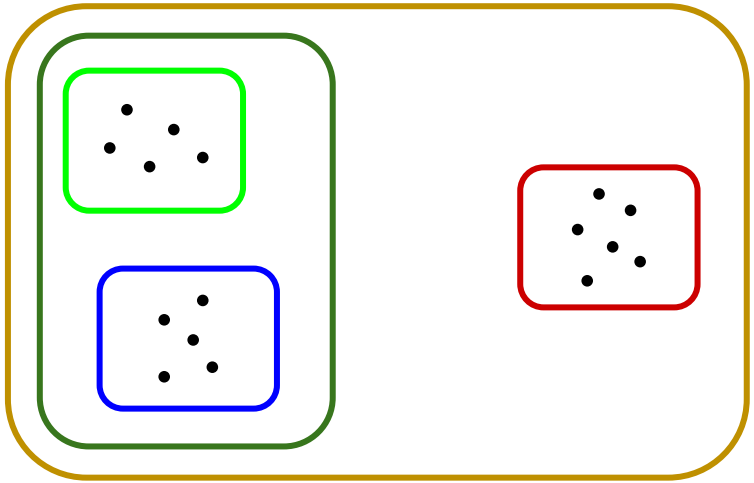
6	1

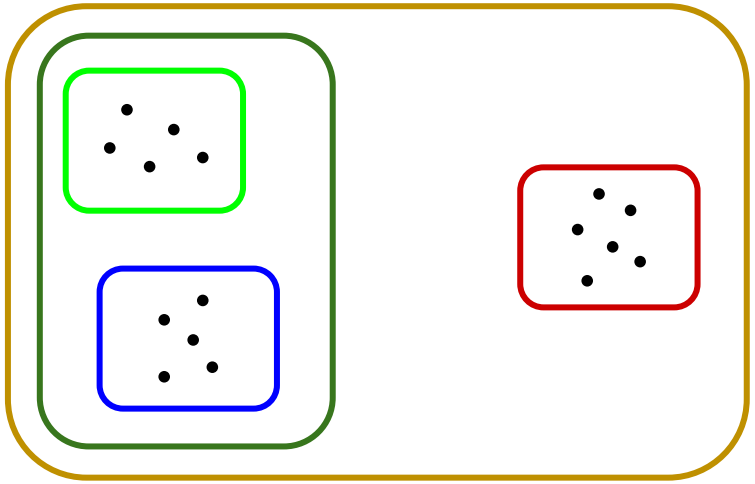
VEGA - 2023 edition

- What does it do?
  - Everything that the 2018 version did
  - Hierarchical grouping
    - Iterative Radii
    - Add Group Features



VEGA - 2023 edition

- What does it do?
  - Everything that the 2018 version did
  - Hierarchical grouping
    - Iterative Radii
    - Add Group Features
      - “Bottom-up” only
      - Naturally identify number of levels of hierarchy
      - More straightforward to interpret groups
      - Radius driven by object/group positioning
      - Less computationally intense

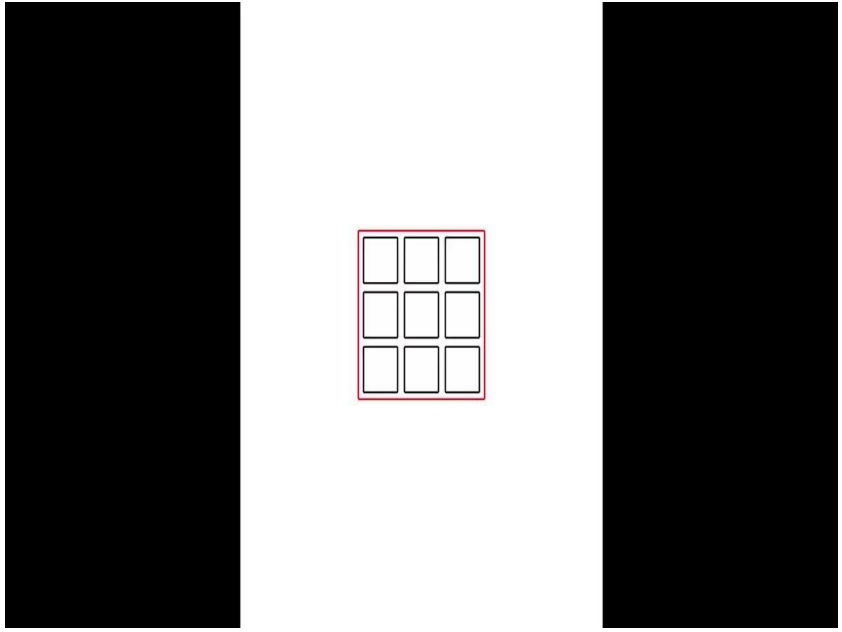


VEGA - 2023 edition

- What does it do?
  - Everything that the 2018 version did
  - Hierarchical grouping
    - Iterative Radii
    - Add Group Features
  - New collision method

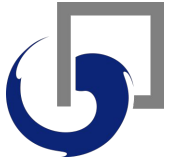
VEGA - 2023 edition

- What does it do?
  - Everything that the 2018 version did
  - Hierarchical grouping
    - Iterative Radii
    - Add Group Features
  - New collision method
    - Consideration of multiple attributes of visual objects
      - Proximity
      - Alignment
        - Centroids on vertical/horizontal axes
        - Edges
      - Difference in area
      - “Identity”



Experiments

- So far, have performed a set of three experiments to test and validate the implemented grouping theory.
  - Experiment 1
    - Participants given a set of visual scenes, and asked to indicate perceived groups by hand. Instructions prompt participants to signify hierarchy in group perception.
  - Experiment 2:
    - Participants are show a series of visual scenes. For each scene, they are first asked to consider their perception of any potential visual groups, and then select from a set of four different groupings of that scene.
  - Experiment 3:
    - A refinement of experiment 2, where the stimuli are varied more consistently, and the response set is limited to three options.



Experiments

Looking forward

- Refinement of hierarchical grouping processes and multi-feature collision
  - Interaction between the two? (expt 1)
- Temporal inheritance of grouping information
- Self-contained module as an addon to ACT-R
- Not just visual grouping, but perceptual grouping
  - Grouping in other senses
    - Audicon
  - Cross-modal grouping
    - Co-occurring stimuli
      - Visuo-auditory temporal delay
  - Integration of ACT-R modules

Thanks!

- Mike Byrne
- Xianni Wang, Fabrizio Chavez, Teddy Taffese, Charlie Weeks
- Linda Mao, Ariana Zhu, Emily Wu
- CHIL Lab!

chil
THE COMPUTER-HUMAN INTERACTION LABORATORY AT RICE UNIVERSITY

VEGA - Visual Entity Grouping Algorithm

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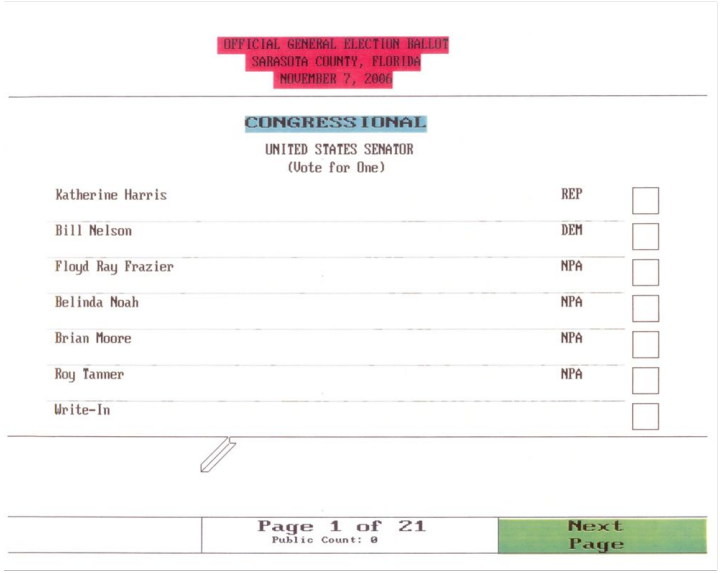
  - John Lindstedt, now at SUNY Oswego
- Motivated by observation of behavioral error associated with certain ballot designs



OFFICIAL GENERAL ELECTION BALLOT
SARASOTA COUNTY, FLORIDA
NOVEMBER 7, 2006

CONGRESSIONAL

UNITED STATES SENATOR
(Vote for One)

Katherine Harris	REP
Bill Nelson	DEM
Floyd Ray Frazier	NPA
Belinda Noah	NPA
Brian Moore	NPA
Roy Tanner	NPA
Write-In	

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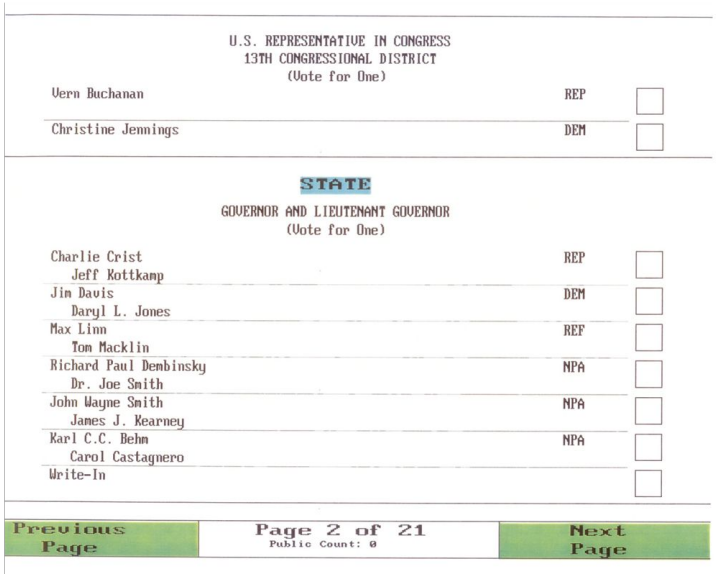

U.S. REPRESENTATIVE IN CONGRESS
13TH CONGRESSIONAL DISTRICT
(Vote for One)

Vern Buchanan	REP
Christine Jennings	DEM

STATE

GOVERNOR AND LIEUTENANT GOVERNOR
(Vote for One)

Charlie Crist Jeff Kottkamp	REP
Jim Davis Daryl L. Jones	DEM
Max Linn Tom Macklin	REF
Richard Paul Dembinsky Dr. Joe Smith	NPA
John Wayne Smith James J. Kearney	NPA
Karl C.C. Behm Carol Castagnero	NPA
Write-In	

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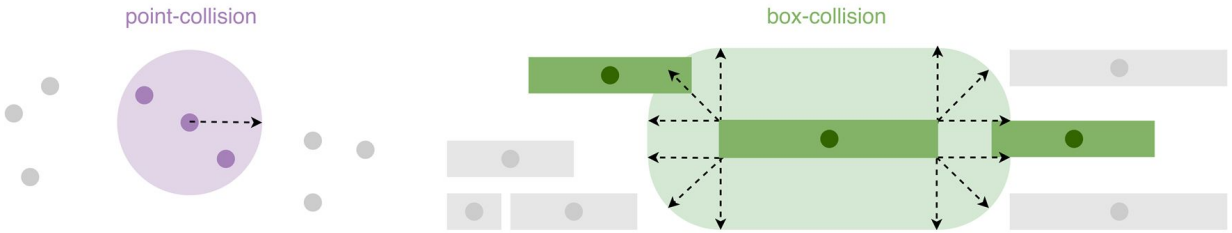
VEGA - Visual Entity Grouping Algorithm

- How did it work?
  - Two core concepts:
    - Collision methods



VEGA - Visual Entity Grouping Algorithm

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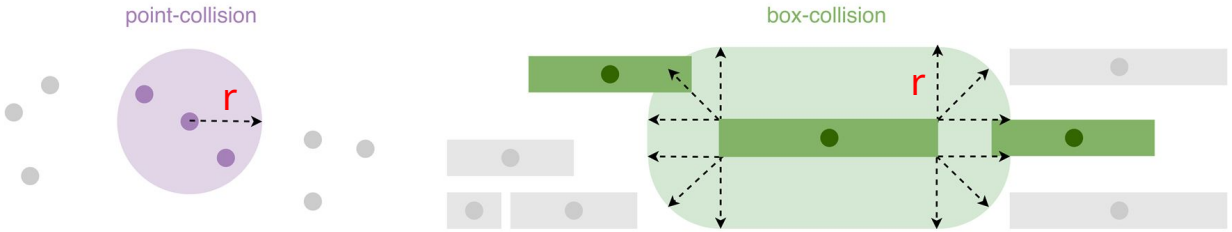

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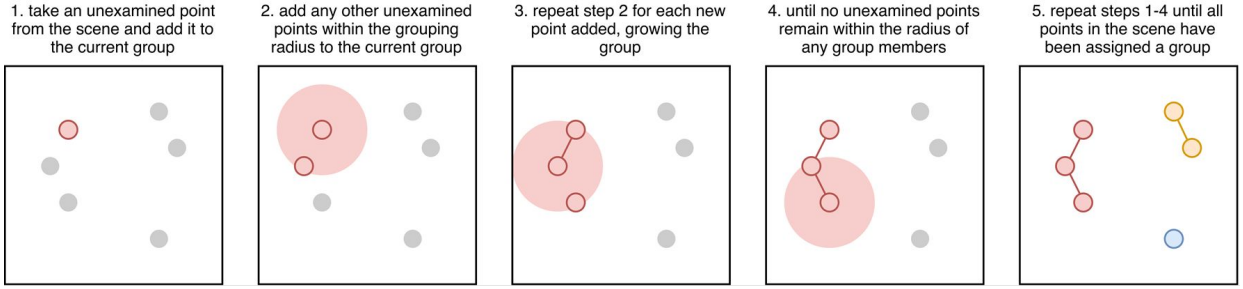
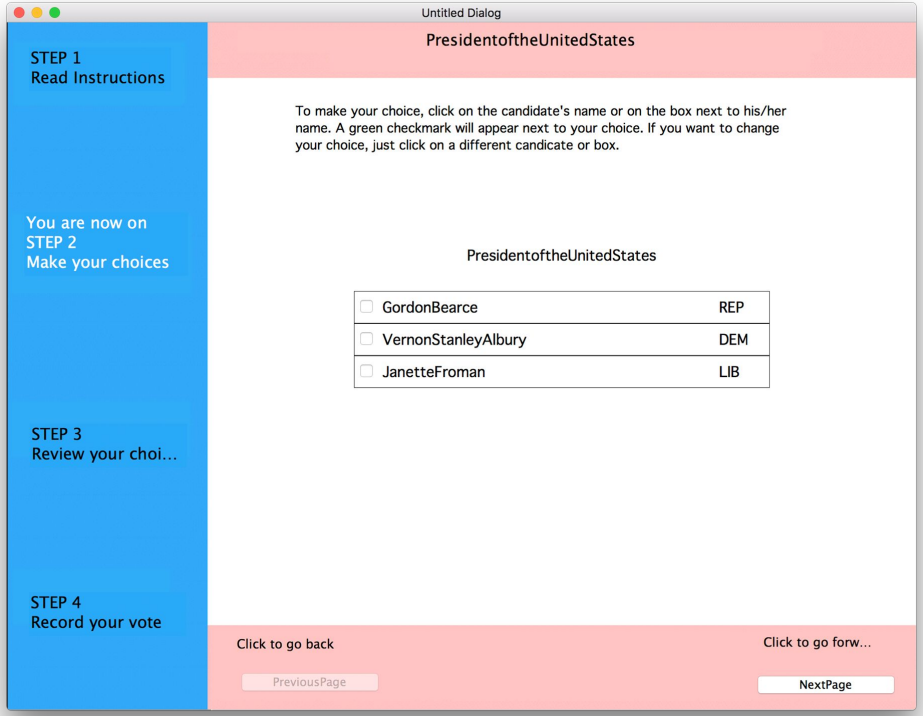


VEGA - Visual Entity Grouping Algorithm

- What could it do?



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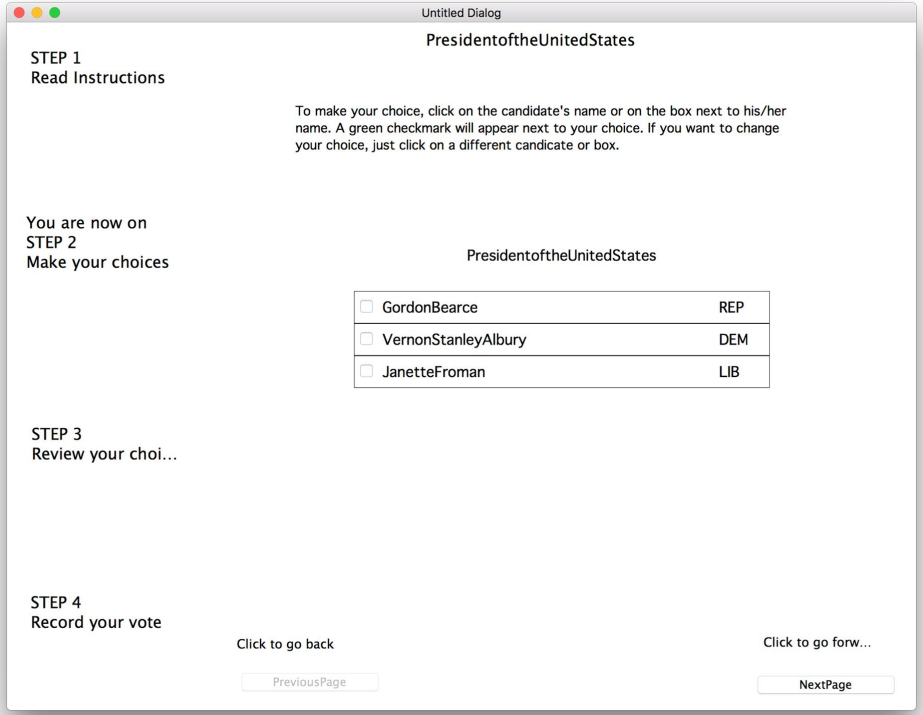

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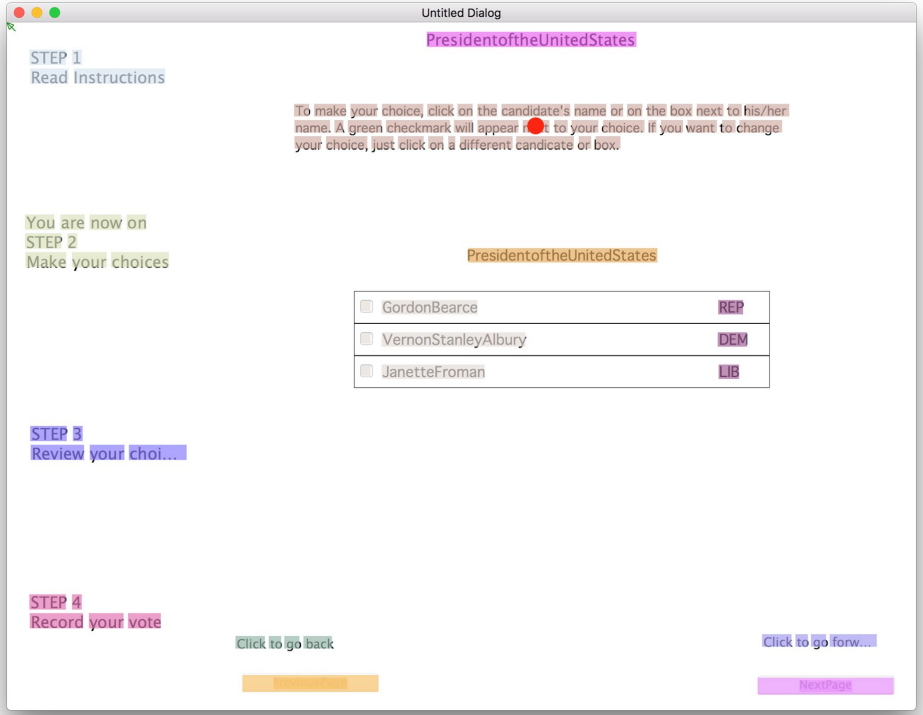
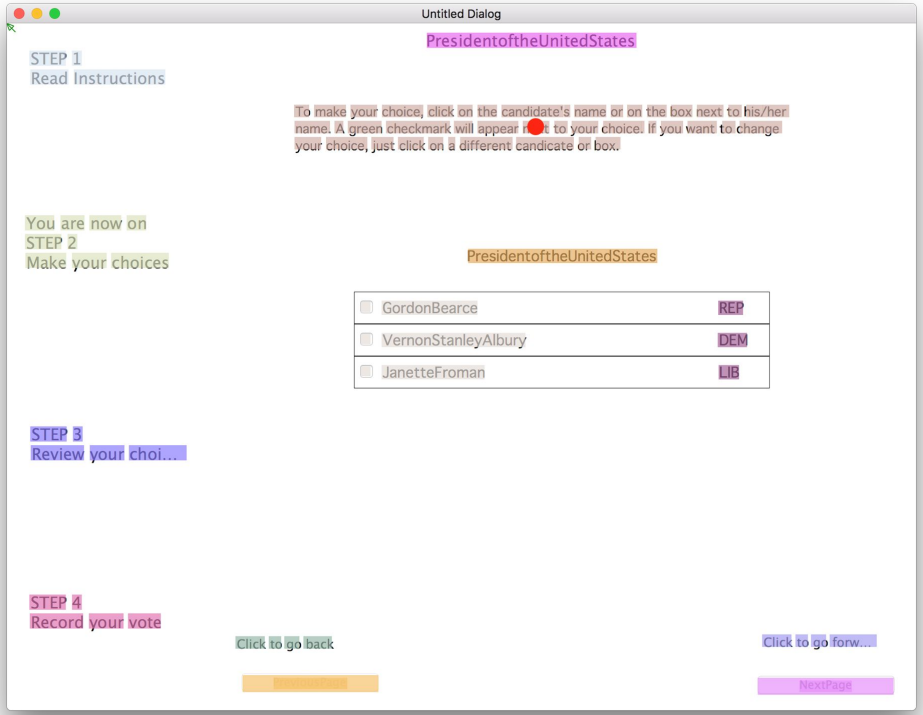


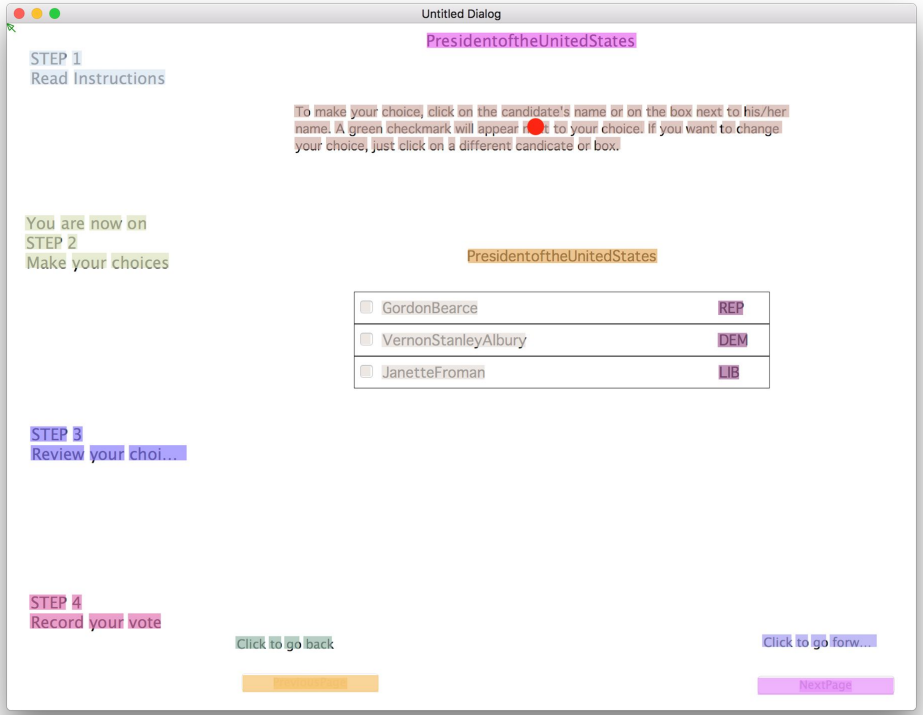
VEGA - Visual Entity Grouping Algorithm

- What couldn't it do?



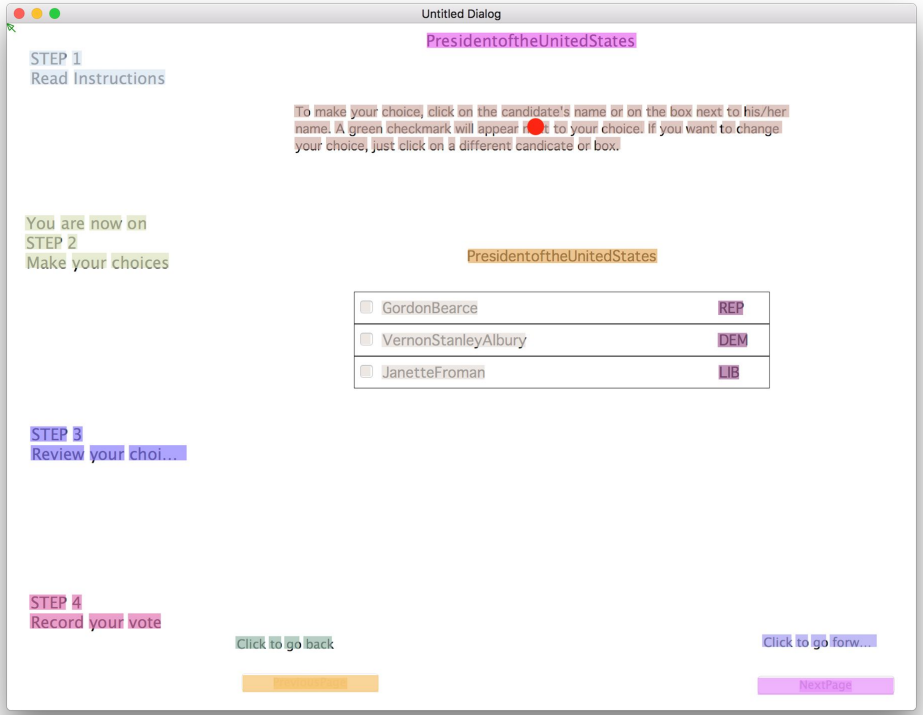
VEGA - Visual Entity Grouping Algorithm

- What couldn't it do?
  - Clear distinctions between objects in close proximity
    - Just select "best" radius value



VEGA - Visual Entity Grouping Algorithm

- What couldn't it do?
  - Clear distinctions between objects in close proximity
    - Just select "best" radius value
  - Hierarchical groups



VEGA - Visual Entity Grouping Algorithm

- What couldn't it do?
  - Clear distinctions between objects in close proximity
    - Just select "best" radius value
  - Hierarchical groups
  - ...work!

VEGA - Visual Entity Grouping Algorithm

- How did it break?
  - Implemented as an around method for (build-vis-locs-for), which was deprecated with the API changes to support the RPC interface (version 7.11?)