



# RESEARCH ETHICS BOARDS

## APPLICATION FORM

### Prospective Research

This form should only be used if new data will be collected. For research involving only secondary use of existing information (such as health records, student records, survey data or biological materials), use the *REB Application Form – Secondary Use of Information for Research*.

This form should be completed using the [\*Guidance for Submitting an Application for Research Ethics Review\*](#).

### SECTION 1. ADMINISTRATIVE INFORMATION

[File No: office only]

Indicate the preferred Research Ethics Board to review this research:

[ ] Health Sciences OR [ ] Social Sciences and Humanities

**Project Title: Visualizing Uncertainty with Chromatic Aberration (VUWCA)**

#### 1.1 Research team information

Lead researcher (at Dalhousie)	Name	Md Rashidul Islam		
	Email (@dal)	md313724@dal.ca	Phone	+88 01731841299
	Banner #	B00870359	Academic Unit	Comp Sci
Co-investigator names, affiliations, and email addresses	Dr. Stephen Brooks, sbrooks@cs.dal.ca			
Contact person for this submission (if not lead researcher)	Name			
	Email		Phone	
Study start date	May 5, 2021	Study end date	May 10, 2021	

#### 1.2 For student submissions (including medical residents and postdoctoral fellows)

Degree program	Masters of Computer Science
----------------	-----------------------------

Supervisor name and department	Dr. Stephen Brooks		
Supervisor Email (@dal)	sbrooks@cs.dal.ca	Phone	902-494-2512
Department/unit ethics review (if applicable). <b>Undergraduate minimal risk research only.</b>			
Attestation: [ ] I am responsible for the unit-level research ethics review of this project and it has been approved.			
Authorizing name: Date:			

<b>1.3 Other reviews</b>			
Other ethics review (if any) for this research	Where?		
	Status?		
Scholarly/scientific peer review (if any)			
Is this a variation on, or extension of, a previously approved Dal REB submission?	[ ] No [ ] Yes Dal REB file # _____		
<b>If yes,</b> describe which components of the current submission are the same as the previously approved submission (list section numbers), and which components are different from the previously approved submission (list section numbers). You may also use highlighting to clearly indicate revised text.			

<b>1.4 Funding</b>			[x] Not Applicable
Funding (list on consent form)	Agency		
	Award Number		
	Institution where funds are/will be held	[ ] Dalhousie University [ ] Other: _____	
Was a Dal release of funds agreement issued for this award?	[ ] Yes	Date of RoF Agreement:	_____

<b>1.5 Attestation(s).</b> The appropriate boxes <i>must</i> be checked for the submission to be accepted by the REB
[x] I am the <b>lead researcher</b> (at Dalhousie) named in section 1.1. I agree to conduct this research following the principles of the Tri-Council Policy Statement <i>Ethical Conduct for Research Involving Humans</i> ( <a href="#">TCPS</a> ) and consistent with the University <a href="#">Policy on the Ethical Conduct of Research Involving Humans</a> .
I have completed the TCPS Course on Research Ethics ( <a href="#">CORE</a> ) online tutorial.

Yes  No

Hy0p-----0

For Supervisors (of student / learner research projects):

I am the **supervisor** named in section 1.2. I have reviewed this submission, including the scholarly merit of the research, and believe it is sound and appropriate. I take responsibility for ensuring this research is conducted following the principles of the [TCPS](#) and University [Policy](#).

I have completed the TCPS Course on Research Ethics ([CORE](#)) online tutorial.

Yes  No

## SECTION 2. PROJECT DESCRIPTION

### 2.1 Lay summary

2.1.1 In **plain language**, describe the rationale, purpose, study population and methods to be used.

Include a summary of background information or literature to contextualize the study. What new knowledge, or public or scientific benefit is anticipated? [maximum 500 words]

In recent years an increasing array of research are being conducted by researchers in the field of visualization and in time series forecasting by employing various machine learning models. Since COVID-19 is a respiratory infectious disease caused by novel coronavirus (also known as SARS-CoV-2) and due to its unprecedented challenges over time and global impact, World Health Organization (WHO) has recognized it as a global pandemic.

After conducting more than yearlong research, several companies manufactured vaccines with different names and as a result, immunization has started in many countries and that significantly helps to reduce the spread and severity of the infections, for example: during the surge of the pandemic the death toll in the United States were few thousands whereas after conducting vaccines among large number of people, it is reduced to few hundreds.

From the very beginning scientists and researchers are investigating the perceived data to discover the cause, find the patterns in different countries or demographic areas. So, in this study, we come up with a novel idea for a visualization to present predictive model uncertainties and visualize textures to represent a third property in 2D space. We utilized some common and existing machine learning models to obtain the predicted results and find the model uncertainties for the most impacted countries with respect to number of new cases, total cases, death rate and recovery rate for different countries.

Finally, we visualize the calculated model uncertainties in terms of chromatic aberration and textures in an interactive fashion, which is helpful for decision making for community leaders or analyses for the researchers.

This is a pilot study.

This is a fully developed study.

2.1.2 Phased review. If a phased review is being requested, describe why this is appropriate for this study, and which phase(s) are included for approval in this application. Refer to the [guidance document](#) before requesting a phased review.

[x] Not applicable

## 2.2 Research question

State the research question(s) or research objective(s).

The prime focus of the research is to calculate uncertainty from the forecasted results of some machine learning models and then represent these uncertainties in visualization in terms of chromatic aberration and textures, which in turn can be beneficial to the community admittatars or researchers.

## 2.3 Recruitment

2.3.1 Identify the study population. Describe and justify any inclusion / exclusion criteria. Also describe how many participants are needed and how this was determined.

The study population will be post-secondary students or professionals who have some mathematics or geometric knowledge with discerning eyes to distinguish very insignificant visual items in chart or drawings. This is because our study presents some visualization stuffs including circles/bubbles, textures, transition/animation, lines, parallel coordinates, impact chart, horizontal chart, etc.

Since the study uses COVID data for the whole world and impacts on different countries varies, there are some simple mathematical formulas are used to data generation and final presentation in the form of charts. So, during scrutiny process we will make sure the participants have enough knowledge about the things e.g.: finding the maximum aberrated country from the bubble chart.

In addition to those, they must have proper knowledge on how to use internet because the entire study will be conducted online. The study program will be deployed in a server and participants need to make sure they have internet connection in their computer/laptop, and they can access and use it.

Primarily, we have decided to pick-up around 10-15 participants for our study. It can be changed later based on the demand of the situation.

2.3.2 Describe recruitment plans and append recruitment instruments. Describe who will be doing the recruitment and what actions they will take, including any screening procedures.

Recruitment will be conducted by the primary researcher with the close supervision of the supervisor. Due to COVID restrictions imposed by the provincial authority and for the sake of health priority of Dal community we decided to contact with the participants through email or over phone or social networking sites like Facebook, Twitter and LinkedIn.

2.3.3 If you require permission, cooperation, or participation from a community, organization or company to recruit your participants, describe the agreement obtained from the relevant group(s). Attach correspondence indicating their cooperation and/or support (required). Describe any other community consent or support needed to conduct this research. (If the research involves Indigenous communities complete section 2.11).

[x] Not applicable

#### **2.4 Informed consent process**

2.4.1 Describe the informed consent process:

A) How, when and by whom will the study information be conveyed to prospective participants?

How will the researcher ensure prospective participants are fully informed?

Prospective participants will receive a copy of the consent letter (Appendix A) and a sample email (Appendix B) through email after they indicated an interest in participating in the study. They will be instructed to read the consent letter before giving their consent. The email will also indicate to prospective participants that they can ask clarifying questions regarding the study.

B) Describe how consent will be documented (e.g. written signature, audio-recorded, etc).

Consent will be recorded via a web survey (hosted at surveys.dal.ca).

Participants who opt not to provide consent and not to participate will receive a “Thank you” message and will not be able to proceed to participate in the survey.

[ X ] Append copies of all consent information that will be used (e.g. written consent document, oral consent script, assent document/script, etc).

*Note: If the research will involve third party consent (with or without participant assent), and/or ongoing consent, ensure these are described above.*

2.4.2 Discuss how participants will be given the opportunity to withdraw their participation (and/or their data) and any time (or content) limitations on this. If participants will not have opportunity to withdraw their participation and/or their data explain why.

2.4.3 If an alteration/exception to the requirement to seek prior informed consent is sought, address the criteria in TCPS article [3.7A](#). If the alteration involves deception or nondisclosure, also complete section 2.4.4.

[ ] Not applicable

2.4.4 Describe and justify any use of deception or nondisclosure and explain how participants will be debriefed.

[ ] Not applicable

#### **2.5 Methods, data collection and analysis**

## 2.5.1

### A) Where will the research be conducted?

Research will be conducted remotely using Skype or Microsoft Teams or Facebook Messenger based on the participant's convenience. So, the participants will be able to participate in the study from their homes and it will help to choose their own schedule in worst cases.

### B) What will participants be asked to do?

We have developed a web application for our thesis and for this reason participants do not need to install any software in his/her own machine for this study purpose other than communicating one, for example: Skype. We will provide a public URL and then participants will be asked to navigate to the application. For the sake of simplicity, we have eliminated to login features and so they will directly get full access to review the features. Images of the screenshots are given in Appendix C. They will be asked to share their screen using Skype or MS Teams to show the running application. The static application will present a guided tour with various features from our main application. These features will be directly connected with the questionnaire module (Appendix D). The participants need to deeply observe and understand the features to answer correctly, and we will brief them to understand the contents if needed.

### C) What data will be collected using what research instruments? (*Note that privacy and confidentiality of data will be covered in section 2.6*)

The following data will be collected:

- answers to the questionnaire questions (Appendix D) will be collected using Opinio at <https://surveys.dal.ca/opinio/admin/folder.do>
- video and audio recording of screenshare session will be collected using Microsoft Teams or Skype or Facebook Messenger.

### D) How much of the participant's time will participation in the study require?

Approximately 2 hours should be good enough. The participant should go through the presentation in dynamic web application for 1 hour and another 1 hour is anticipated for the completion of questionnaire section which is the main component of the survey.

Append copies of all research instruments (questionnaires, focus group questions, standardized measures, etc)

This is a clinical trial (physical or mental health intervention) – ensure section 2.12 is completed

## 2.5.2 Briefly describe the data analysis plan. Indicate how the proposed data analyses address the study's primary objectives or research questions.

After using the main web application, the participant will be asked to complete the questionnaire (Appendix D). The questionnaire will ask how much they agree with the statements about each question with answer options (Strongly Disagree/Somewhat Agree/Neither Agree nor

disagree/Somewhat agree/Strongly agree). The interview results will be tabulated to provide a scoring for each question. Scoring will be conducted by assigning the following numbers to each checkbox:

- Strongly Disagree = -2
- Somewhat Disagree = -1
- Neither agree nor disagree = 0
- Somewhat agree = +1
- Strongly Agree = +2

In some cases, where the statement is negative towards the tool VUWCA, then the scoring will be reversed. For example, “Tracing aberration is confusing” would consider “Strongly Disagree” as +2 instead of -2.

Participants’ feedback is also requested in written form. This feedback, in addition to comments made by the user during the screenshare, will be used as suggestions for future work.

2.5.3 Describe any compensation that will be given to participants and how this will be handled for participants who do not complete the study. Discuss any expenses participants are likely to incur and whether/how these will be reimbursed.

It is entirely voluntary. So, the participants will not be compensated for their time.

## 2.6 Privacy and confidentiality

### 2.6.1

A) Describe who will have knowledge of participants’ identities.

Only the researcher will know the relationship between participant’s name and unique participant IDs.

B) Describe the level of identifiability of the study data (anonymous, anonymized, de-identified/coded, identifying) (see [TCPS Chapter 5A – types of information](#) for definitions).

Data from this study will be associated to participants IDs (Coded Information).

C) Specify which members of the research team (or others) will have access to participants’ data and for what purpose.

Project supervisor might have access on participants information for validation and justify their achievement with their qualification. In other word to find out how much the educational background or knowledge level helps to answer the questionnaire properly.

D) Describe measures to ensure privacy and confidentiality of study documents and participant data during the data collection and analysis phase. [*Note that plans for long term storage will be covered in 2.6.2*]

- Address: handling of documents/data during data collection; transportation or transfer of documents/data; storage of documents/data (during the study).
- If a key-code will be maintained, describe how it will be kept secure.
- For electronic data, describe electronic data security measures, including file encryption and/or password protection as applicable.
- For hard copy documents, describe physical security measures (specify location).

We will use one of the recommended Dal online survey solutions named “Opinio” for the questionnaire. The questionnaire will include multiple choice questions and written responses to questions. Personal information from the questionnaire will be stripped to a separate file. Data will always refer to encoded Participant ID.

This research involves personal health records (ensure section 2.13 is completed)

2.6.2 Describe plans for data retention and long-term storage (i.e. how long data will be retained, in what form and where). Will the data eventually be destroyed or irreversibly anonymized? If so, what procedures will be used for this? Discuss any plans for future use of the data or materials beyond the study currently being reviewed.

Survey responses will be stored in “Opinio” on the Dalhousie Servers. Recorded audio and video from the screenshare will be stored on a secure encrypted server at the Faculty of Computer Science, Dalhousie University. Since we have limited licenses for Opinio, access will typically be restricted to a 2-month duration. If there need longer duration of persistency, then we must contact the proper authority for the extension. Alternately, the researcher can store another copy of the data in their own secure repositories. Only the researchers listed in the consent form will have access to the data collected in this study.

This research will be deposited in a data repository (ensure section 2.14 is completed)

#### 2.6.3

Describe if/how participant confidentiality will be protected when research results are reported:

A) For quantitative results - In what form will study data be disseminated?

- Only aggregate data will be presented
- Individual de-identified, anonymized or anonymous data will be presented
- Other. If “other”, briefly describe dissemination plans with regard to identifiability of data.
- Not applicable, only qualitative data will be presented

B) For qualitative results - Will identifiable data be used in research presentations/publications? If participants will be quoted, address consent for this and indicate whether quotes will be identifiable or attributed.

- Not applicable, only quantitative data will be presented

Participants are given the option to allow or not researchers to use quotes when disseminating results in the consent form. These quotes would be collected from the written questions in the questionnaire (Appendix D) and from the recorded audio capture during the user study. We will use participant IDs for quotes.

2.6.4 Address any limits on confidentiality, such as a legal duty to report abuse or neglect of a [child](#) or [adult in need of protection](#), and how these will be handled. Ensure these are clear in the consent documents. (See the [guidance document](#) for more information on legal duties and professional codes of ethics).

[X] Not applicable

2.6.5 Will any information that may reasonably be expected to identify an individual (alone or in combination with other available information) be accessible outside Canada? And/or, will you be using any electronic tool (e.g. survey company, software, data repository) to help you collect, manage, store, share, or analyze personally identifiable data that makes the data accessible from outside Canada?

[X] No

[ ] Yes. If yes, refer to the University [Policy for the Protection of Personal Information from Access Outside Canada](#), and describe how you comply with the policy (such as securing participant consent and/or securing approval from the Vice President Research and Innovation).

## 2.7 Risk and benefit analysis

2.7.1 Discuss what risks or discomforts are anticipated for participants, how likely risks are and how risks will be mitigated. Address any particular ethical vulnerability of your study population. Risks to privacy from use of identifying information should be addressed. If applicable, address third party or community risk. (If the research involves Indigenous communities also complete section 2.11)

There are no anticipated physical, mental, economic or social risks associated with participation beyond those associated with everyday computer use. There may be some minor discomforts for participants in that they will be using a new software application for the first time if someone didn't have the similar experience. We do not anticipate that this will exceed the usual levels of ambiguity or confusion commonly experienced when someone uses new software for the first time.

2.7.2 Identify any direct benefits of participation to participants (other than compensation), and any indirect benefits of the study (e.g. contribution to new knowledge).

Participating in the study might benefit participants in terms of knowledge which will help them to participate in paid surveys in future, conduct and contribute on their own survey if needed ever in future, help other people's voluntary surveys easily.

## **2.8 Provision of results to participants and dissemination plans.**

2.8.1 The TCPS encourages researchers to share study results with participants in appropriate formats. Describe your plans to share study results with participants and discuss the process and format.

Participants are given a chance to add their e-mail address to receive the results of this study when it has been accepted for publication. Those participants that provided their email addresses for this purpose will receive a summary of the findings after the results are published but nobody will know other participants information.

2.8.2 If applicable, describe how participants will be informed of any material incidental findings – a discovery about a participant made in the course of research (screening or data collection) that is outside the objectives of the study, that has implications for participant welfare (health, psychological or social). See [TCPS Article 3.4](#) for more information.

[ X ] Not applicable

2.8.3 Describe plans for dissemination of the research findings (e.g. conference presentations, journal articles, public lectures etc.).

Results from this study will be used for the lead researcher's MCS thesis paper and possibly for publication in Computer Science journals or conferences or in final thesis defense presentation.

## **2.9 Research Team**

2.9.1 Describe the role and duties of all research team members (including students, RA's and supervisors) in relation to the overall study.

Dr. Brooks is a faculty member (Professor) in Computer Science. He will provide his thoughtful and intelligent insights during the study trials and will take part in proper analysis after the event. Investigator Rashidul Islam has developed the study design under the direction of Dr. Brooks. This study is an integral part of his MCS Thesis component.

2.9.2 Briefly identify any previous experience or special qualifications represented on the team relevant to the proposed study (e.g. professional or clinical expertise, research methods, experience with the study population, statistics expertise, etc.).

Dr. Brooks has extensive experience in designing and executing user studies in the field of data visualization. Investigator Rashidul Islam is novice in conducting such user studies.

## **2.10 Conflict of interest**

Describe whether any dual role or conflict of interest exists for any member of the research team in relation to potential study participants (e.g. TA, fellow student, teaching or clinical relationship), and/or study sponsors, and how this will be handled.

Not applicable

## 2.11 Research involving Indigenous peoples

Consult TCPS [Articles 9.1 and 9.2](#) in determining whether this section is applicable to your research.

Not applicable – go to 2.12

2.11.1 If the proposed research is expected to involve people who are Indigenous, describe the plan for community engagement (per TCPS Articles [9.1 and 9.2](#)). If community engagement is not sought, explain why the research does not require it, referencing TCPS article 9.2.

2.11.2 State whether ethical approval has been or will be sought from [Mi'kmaw Ethics Watch](#) and if not, why the research does not fall under their purview. If the research falls under the purview of other Indigenous ethics groups, state whether ethical approval has been or will be sought.

2.11.3 Describe plans for returning results to the community and any intellectual property rights agreements negotiated with the community with regard to data ownership (see also 2.11.4 if applicable). Append applicable research agreements.

2.11.4 Does this research incorporate OCAP (Ownership, Control, Access, and Possession) principles as described in TCPS [Article 9.8](#)?

Yes. Explain how.

No. Explain why not.

## **2.12 Clinical trials**

Not applicable – go to 2.13

2.12.1 Will the proposed clinical trial be registered?

No. Explain why not.

Yes. Indicate where it was/will be registered and provide the registration number.

2.12.2 If a novel intervention or treatment is being examined, describe standard treatment or intervention, to indicate a situation of clinical equipoise exists (TCPS [Chapter 11](#)). If placebo is used with a control group rather than standard treatment, please justify.

2.12.3 Clearly identify the known effects of any product or device under investigation, approved uses, safety information and possible contraindications. Indicate how the proposed study use differs from approved uses.

[ ] Not applicable

2.12.4 Discuss any plans for blinding/randomization.

2.12.5 What plans are in place for safety monitoring and reporting of new information to participants, the REB, other team members, sponsors, and the clinical trial registry (refer to TCPS [Articles 11.6, 11.7, 11.8](#))? These should address plans for removing participants for safety reasons, and early stopping/unblinding/amendment of the trial. What risks may arise for participants through early trial closure, and how will these be addressed? Are there any options for continued access to interventions shown to be beneficial?

### **2.13 Use of personal health information**

[ X ] Not applicable – go to 2.14

2.13.1 Research using health information may be subject to Nova Scotia's [Personal Health Information Act](#). Describe the personal health information ([definition explained in the guidance document](#)) required and the information sources, and explain why the research cannot reasonably be accomplished without the use of that information. Describe how the personal health information will be used, and in the most de-identified form possible.

2.13.2 Will there be any linking of separate health data sets as part of this research?

[ ] No

[ ] Yes

If yes:

- A) Why is the linkage necessary?
- B) Describe how the linkage will be conducted (it is helpful to append a flow diagram)
- C) Does that linkage increase the identifiability of the participants?

2.13.3 Describe reasonably foreseeable risks to privacy due to the use of personal health information and how these will be mitigated.

## 2.14 Data Repositories

[X] Not applicable

2.14.1 Identify and describe the data repository in which the research data will be deposited. What is its focus, who are its target users, who can access deposited data and under what circumstances? For how long will the data be kept in the repository?

The raw COVID data is available free of cost from ourworldindata.org. Then some machine learning models in Python environment are used to generate the usable data for the visualization. Researcher, Investigator, Data Analyst are target users for the processed data. The processed data is stored in public GitHub repository along with source code and it will be kept for an indefinite period.

2.14.2 Describe the data set to be released to the repository. If there is personal and/or sensitive information in the data, describe how you will prepare the data for submission to the repository and mitigate risks to privacy. Identify all fields that will be included in the final data set (include as an appendix).

As said the processed data to be released in GitHub repository. Since the data is generated from a publicly accessible dataset so there is no personal and/or sensitive information and no risks are anticipated regarding this, because the repository has only read-only permission so nobody can destroy it. In worst case if we somehow loose it then we can regenerate the data again by our own program.

2.14.3 Is agreeing to have one's data deposited a requirement for participation in the study? If yes, provide a justification. If no, indicate how participants can opt in or out.

No, participants do not need to do anything regarding data but go through visualization output from our web application. Participants opt in or out is based on their experience or knowledge about the visualization output as stated in section 2.3

## SECTION 3. APPENDICES

**Appendices Checklist.** Append all relevant material to this application in the order they will be used. This may include:

[ ] Reference list

[ ] Permission or support/cooperation letters (e.g. Indigenous Band Council, School Board, Director of a long-term care facility, anyone whose permission you need to conduct recruit participants or conduct research)

[ ] Research agreements (required for research involving Indigenous communities)

[X] Recruitment documents (posters, oral scripts, online postings, invitations to participate, etc.)

- Screening documents
- Consent/assent documents or scripts
- Research instruments (questionnaires, interview or focus group questions, etc.)
- Debriefing and/or study results templates
- List of data fields included in data repository
- Confidentiality agreements

### **Consent Form Templates**

Sample consent forms are provided on the [Research Ethics website](#) and may be used in conjunction with the information in the [\*Guidance\*](#) document to help you develop your consent form.



## CONSENT FORM

**Project title:** Visualizing Uncertainty with Chromatic Aberration (VUWCA)

**Lead researcher:** Md Rashidul Islam, Dalhousie University, md313724@dal.ca, +8801731841299

**Other researchers**

Dr. Stephen Brooks, [sbrooks@cs.dal.ca](mailto:sbrooks@cs.dal.ca)

**Funding provided by:** NIL

### **Introduction**

We invite you to take part in a research study being conducted by Rashidul Islam, who is an MCS (Master of Computer Science) student at Dalhousie University. Choosing whether or not to take part in this research is entirely your choice. There will be no impact to you if you decide not to participate in the research. The information below tells you about what is involved in the research, what you will be asked to do and about any benefit, risk, inconvenience or discomfort that you might experience.

You should discuss any questions you have about this study with Rashidul Islam or Dr. Stephen Brooks. Please ask as many questions as you have and we will happy to answer your all questions. If you have questions later, please contact Rashidul Islam.

### **Purpose and Outline of the Research Study**

The aim of this study is to get feedback on the use of uncertainty visualizations in terms of chromatic aberration and textures to indicate the deviation between predictive model output and actual results. Since the dynamic application has more features in compact way which requires some basic idea on selecting dynamic parameters, the researcher can instruct to achieve this knowledge. On top of that the participants can go through questionnaire section where there is a description beside every image explaining the corresponding purpose of visualization.

The application has several sections. Since those sections are driven by dynamic parameters and that may be difficult to learn for the participants, we have created a main menu to direct access the specific visualization content. Also, there are start, next, back buttons to navigate here and there smoothly to/from the main menu.

The user is provided with a set of questionnaire based on the provided images taken from the web application to evaluate each visualization and to provide general feedback/answer for the respective questions. To simplify the question answering section, we have made it to multiple choice questions where the answers are in a form that mostly representing the degree of agreement by the participant. For example: Strongly agree, strongly disagree, Partially Agree and so on.

## **Who Can Take Part in the Research Study**

Anyone can participate in this study who have some basic geometric and math knowledge to recognize basic shapes like circle, rectangles, ellipse, partial filling of circles etc. They also need to have access to a computer browser; for instance, Chrome, have good internet connection, and have a microphone connected to the computer to communicate with researcher. Most importantly they must have good eyes and intelligent enough to look on the charts and read the respective side notes in English about the visualization content and take their own decision based on the understanding.

## **What You Will Be Asked to Do**

If you decide to participate in this research, you will be asked to navigate to a dynamic web application through your computer browser. You will be asked to connect to a meeting with an audio connection. You will be recommended to close all other applications besides the downloaded application and the communication software itself. You will be requested to share your screen with the researcher so that he can help you whenever needed.

You will be asked to select and view each sections images and corresponding description. Upon completion of the tutorial, you will be asked if you have any questions regarding the content or anything is unclear, then researcher can explain you by going through the corresponding section until you are satisfied with your understanding.

## **Possible Benefits, Risks and Discomforts**

**Benefits:** Participating in the study might not benefit you directly and instantly, but you might learn things that will enrich your knowledge-base and which in turn help in your later life.

**Risks:** No significant risks are anticipated with this study; there are no known risks for the participation in this research beyond being bored or fatigued, or confused by using a new piece of software just like what you may feel for using any other new software. To reduce these discomforts, we will offer you breaks between activities whenever you need.

During the user study, you need to share your screen and audio with the researcher. For future use, your screen and conversation might be recorded.

## **Compensation / Reimbursement**

Since our study policy is completely voluntary, participants will not be compensated or reimbursed in any way for their participation.

## **How your information will be protected:**

Before starting the study we will inform you that your screenshare, questionnaire/answers, conversation will be recorded for future use and these information will be stored by the research team and only they will know about your participation information.

The information that we will take from you will remain highly confidential and secure. Only the research team at Dalhousie university who work with us have access to this information and all of us have an obligation to keep all these study information protected from any kind of unauthorized access. Your identity information (name and contact information) also be securely stored separately in an encoded

way. Instead of using your name or contact information, we will create a new ID number by encrypting your base information and which will be used as your participation number. In addition to that, all information will be kept secure in an encrypted file on the researcher's password-protected computer, and we will not maintain any paper/printed documents.

Since the study is a core component of our thesis research, we will explain and share our findings in the researcher's thesis and thesis's defense. But the report will not include any individual information but group results. This means that nobody will be able to identify a single participant from our reports.

No information about your participation will be disclosed by us unless it requires by law or our professional obligations. If you inform us about abuse any kind of information, we are required by law to contact authorities. If we notice that you are at an immediate risk of harming yourself or other people, we will definitely and instantly seek for assistance from proper authority by our professional code of ethics so that they take necessary steps for the remedy.

You will be given a choice in the questionnaire form to either allow or not allow your written feedback to be quoted and collected from the form in use. You can opt-in and opt-out of having your quotes used as part of the disseminating results of this study in our reports.

We will delete your all-personal information from our repositories once the study is completed. Only questionnaire information and answers will be stored in our repositories where any personal identifying information will be cleaned up. Despite these measures, we cannot guarantee your anonymity or cannot ensure how/who will use those data in which way.

### **If You Decide to Stop Participating**

You are fully free to leave the study at any time. If you want to stop participating during the study, you can also decide whether you want to allow us to use or remove any of the information that you have given us up to that point. If you want not to keep your participation in the study after completing the study and want us to remove your data, then you can decide for up to 1 week. After that time, it will be impossible for us to remove your data because after that time it will be anonymized and so there will be no way to trace your data.

### **How to Obtain Results**

At the end of the study, we will provide you with a short description of group results but not individual results. Even if you want to get individual results then we cannot provide it due to the anonymity issue. You can obtain these results by providing your contact information at the time of participation.

### **Questions**

You are always welcome to reach out us with whatever questions or concerns you may have about your participation in this research study. Please contact at any time to Md Rashidul Islam at +8801731841299, md313724@dal.ca or Dr. Stephen Brooks at sbrooks@dal.ca with your questions, suggestions, comments, or concerns about the research study.

If you have any ethical concerns about your participation in this research, you may also contact Research Ethics, Dalhousie University at (902) 494-3423, or email: ethics@dal.ca (and reference REB file # 20XX-XXXX).

**Signature**

Signatures will not be required as part of this informed consent process. Downloading and running the application and communicating with researcher is taken as an implied consent.

Good day Everyone,

We are recruiting participants to take part in research study of Master of Computer Science, Dalhousie University. The user study aims to get user feedback on the uncertainty realization in terms of chromatic aberration through web based visualization. A potential benefit could be that you learn introductory knowledge on chromatic aberration, texture representation and review various charts of visualization.

This study consist of a single session and will be conducted completely online to ensure participants and researcher safety and respect the imposed special measures during the COVID-19 pandemic. We created a dynamic web application that allows testing and evaluating various features related to our thesis context. After an initial privacy check, the participant would be requested to browse the application from their own computer and share their screen with the researcher while using it. With the help of screen sharing and audio conversation, participants get clarified from researcher about any questions or confusions they might have.

The web application will help the participant to go through and digest different approaches of representing chromatic aberration. Since they are accessing the application from their own machine, they have full control on it and ask any question arises in mind to the researcher who remains connected with participant online. The participant can keep note if they find any inconsistency or suggestion to improve during the session so that they add it in the questionnaire form comment section.

After the review the application portion, the participant is provided with a questionnaire which asks for feedback on each proposed questions. A series of statements are provided about each visualization features with multiple choice questions and the participant decides by choosing one of them to represent what extent they agree with the statement. For each visualization, the participant is provided an opportunity to provide a written feedback to the researchers. After completing these sections, the participant is provided an opportunity to provide a general but holistic written feedback on the reviewed system.

The participation is fully voluntary, and we will not compensate for it. The following requirements are necessary for participation to qualify as participant in the study:

- You must be a current or former professional navigator with at least one year of experience in navigating ships at sea.
- You must have access to a laptop/computer.
- You must have an internet connection suitable to audio-video conferencing.
- You must be able to install required software like MS-Teams or Skype for conversation.
- You must be willing to audio/video conferencing and share your screen with the researcher and allowed to record it.
- You must be willing to download the static application and able to run it in your browser.
- You must be willing to share your screen with the researcher, including downloading any

Thank you for your consideration. If you agree to participate, please contact the main researcher at [md313724@dal.ca](mailto:md313724@dal.ca) for a list of potential time slots to schedule the session.

Thank you,

## Appendix B – Sample Email

Md Rashidul Islam  
+8801731841299  
MCS Student  
Dalhousie University  
6299 South St, Halifax, NS B3H 4R2

## QUESTIONNAIRE MODULE

**Project title:** Visualizing Uncertainty with Chromatic Aberration (VUWCA)

**Lead researcher:** Md Rashidul Islam, Dalhousie University, md313724@dal.ca, +8801731841299

**Other researchers**

Dr. Stephen Brooks, [sbrooks@cs.dal.ca](mailto:sbrooks@cs.dal.ca)

**Funding provided by:** NIL

## Questions

**1. Do you consent to the researchers quoting text you write in feedback sections below?**

- Yes, I consent to my written feedback in this questionnaire being quoted anonymously.
- No, I do not consent to my written feedback in this questionnaire being quoted.

## Application Overview

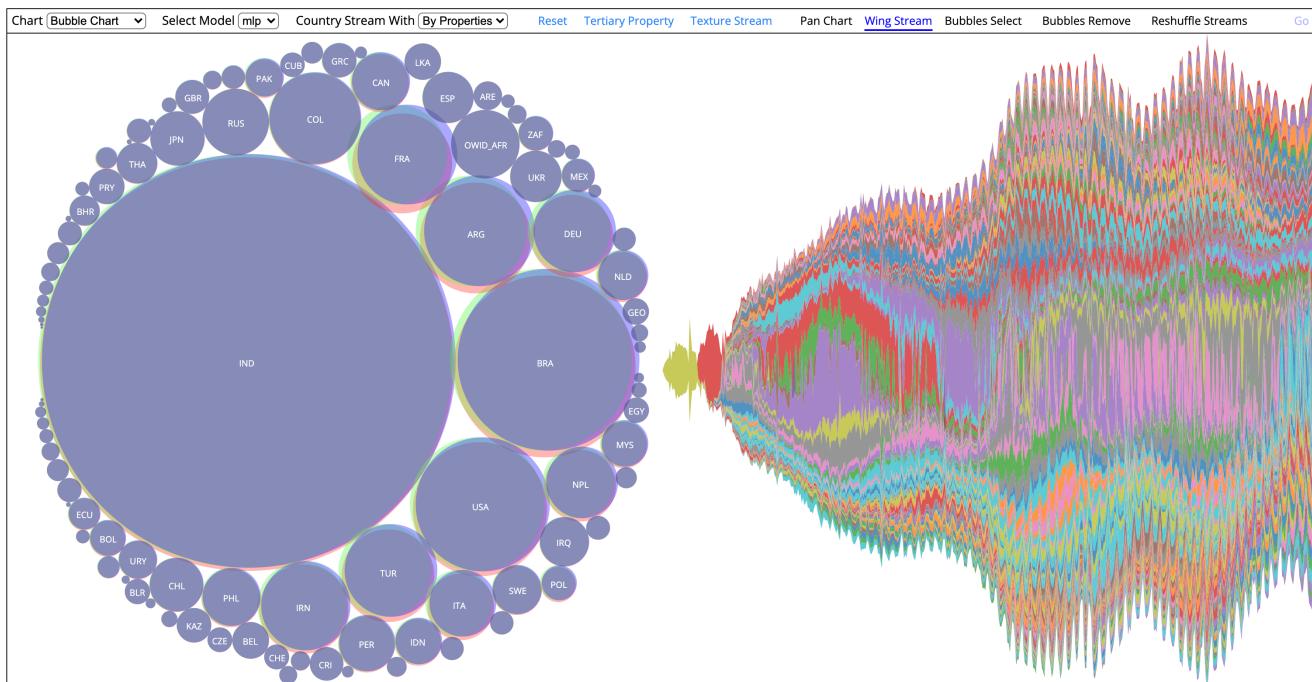


Figure-1: Overview screen

**Description:** At top of the Figure-1, we see there is a toolbar with many input fields which are used to draw types of charts and for allowing user to perform different activities like zooming, panning, filtering, selecting/deselecting bubbles to redraw bubble chart and stream chart. Among the two big charts we call the left chart as bubble chart and right one as streamgraph. In the bubble chart the colorful edges for each circle represents the Chromatic Aberration which will be shown more clearly in later images with smaller number of countries. In this view, we have drawn both charts for top 100 countries having maximum number of COVID infections, so they look a bit clumsy.

**2. Select the degree to which you agree or disagree with each of the following statements:**

- a. The overview screen of VUWCA is a bit incongruous due to excessive components

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

**3. Please provide any additional comments/suggestions you wish the researchers to know/share regarding this section.**

.....

.....

.....

### **VUWCA for single Country**

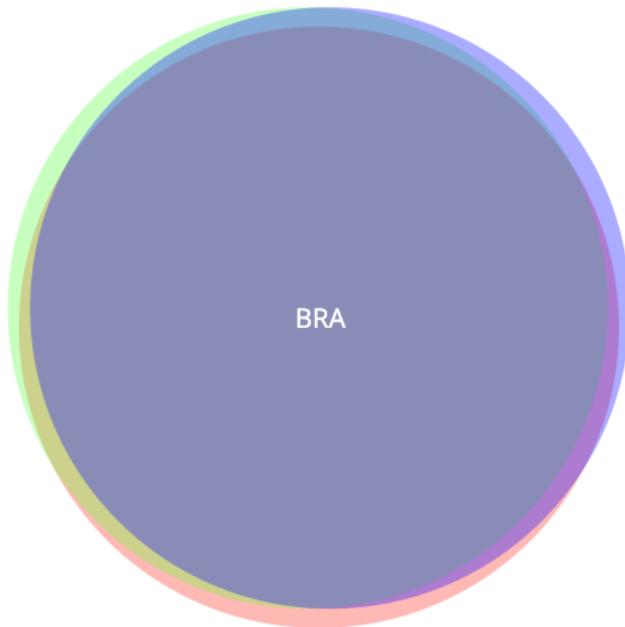


Figure-2: Bubble chart for Single country

**Description:** In Figure-2, we see a single bubble only but the surrounding colorful edges beautiful and crystal clear for normal user view. That colorful portion of the circle represents the area of uncertainty which call here as Chromatic Aberration.

#### **4. Select the degree to which you agree or disagree with each of the following statements:**

- a. The colorful chromatic aberration is clearer than overview screen.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- b. The thickness of the aberrated area is roughly one tenth compared to the radius of the circle.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- c. There is no gradual blurring of colorful edge.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

d. There are six different colors shown in edges.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

e. The color choices help to determine the uncertainty representing area in the visualization.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

**5. Please provide any additional comments/suggestions you wish the researchers to know/share regarding this section.**

.....  
.....  
.....

**VUWCA for three Countries**

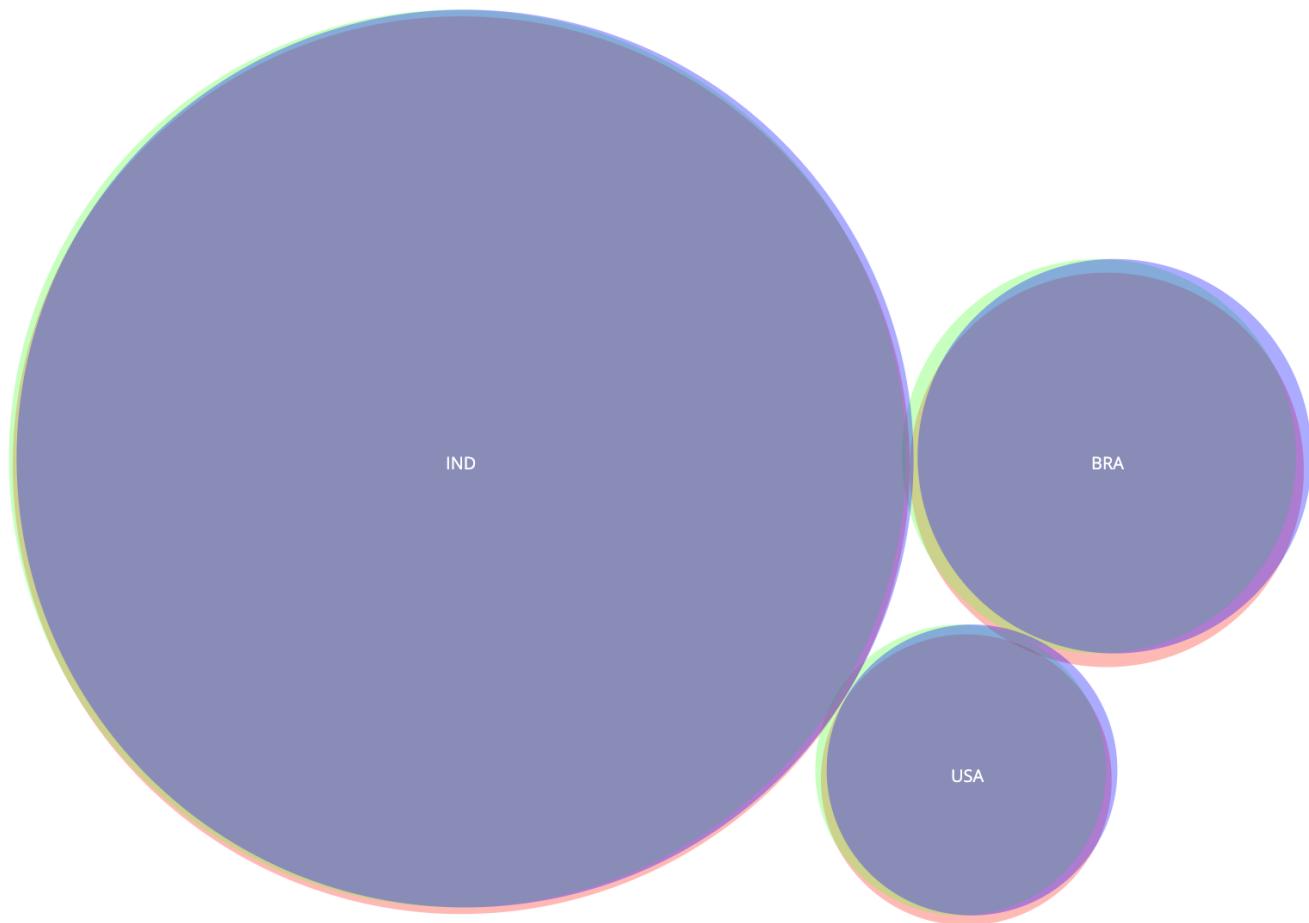


Figure-3: Bubble chart with three countries

**Description:** This chart is drawn with three countries only to gradually introduce the difference to the user. Since Figure-2 had only one country so there was nothing to compare side by side but here in Figure-3 user can compare both uncertainty and number of infections count.

**6. Select the degree to which you agree or disagree with each of the following statements:**

- a. Brazil (BRA) shows maximum uncertainty among three.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

## Appendix C – Questionnaire Module

b. United States (USA) gets second maximum uncertainty among three.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

c. India (IND) got maximum number of infections.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

d. Brazil (BRA) has second maximum number of infections.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

e. Based on Figure-3 uncertainty is irrelevant to the number of infections because India has maximum count but not maximum uncertainty.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

**7. Please provide any additional comments/suggestions you wish the researchers to know/share regarding this section.**

.....  
.....  
.....

**VUWCA for Ten Countries**

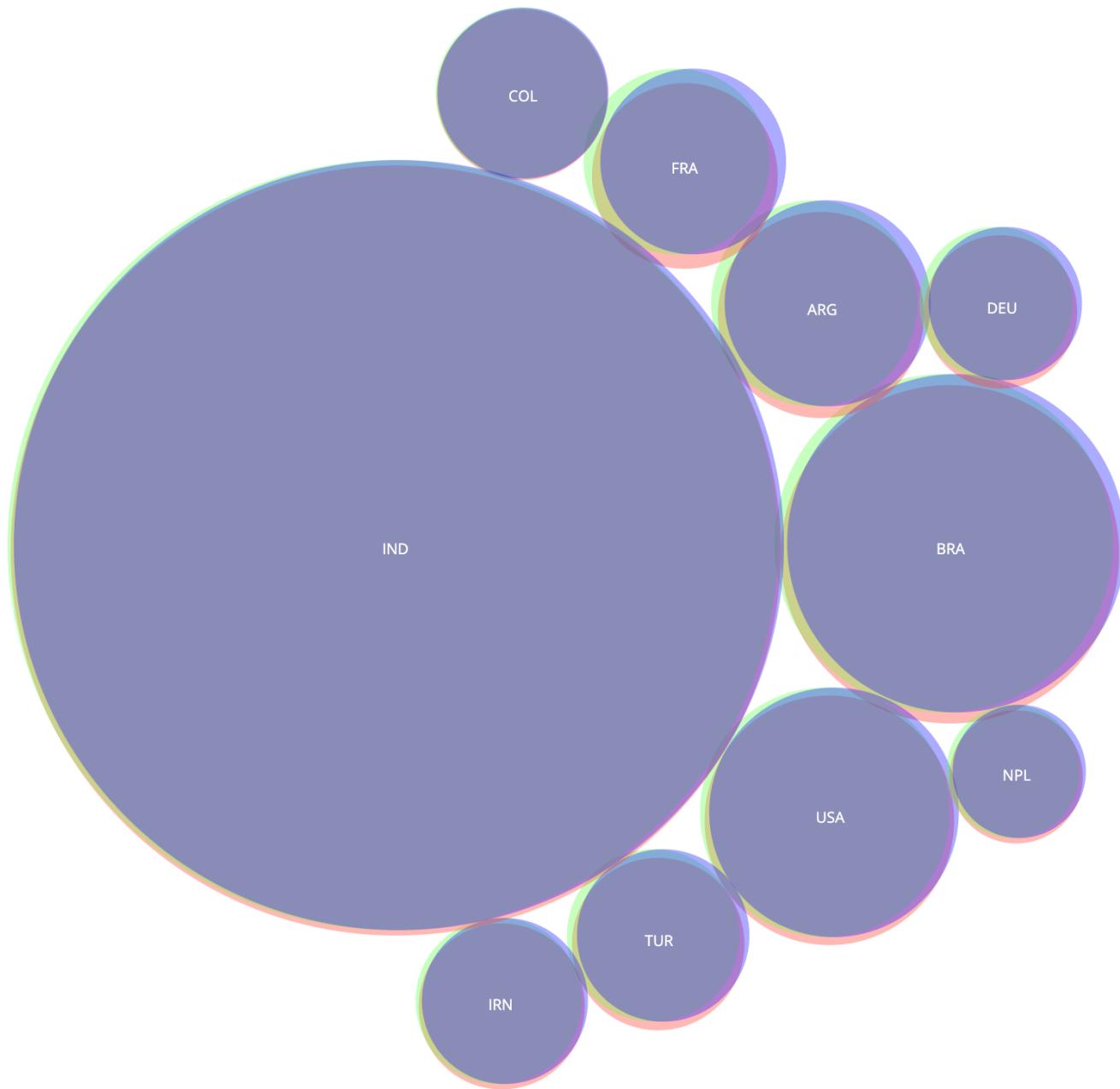


Figure-4: Bubble chart with ten countries

**Description:** This is an extended version of Figure-3 where we have used data for 10 countries. All of the three countries from the earlier figure are also here but the order of uncertainties changed so, that is especially noticeable here.

**8. Select the degree to which you agree or disagree with each of the following statements:**

a. France (FRA) shows maximum uncertainty among tens.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

b. Colombia (COL) shows minimum uncertainty among tens.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

c. Uncertainty of Argentina (ARG) and Brazil (BRA) are ambiguous in terms of maximum value.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

d. Though uncertainties are similar, but Brazil (BRA) has more infections count than Argentina (ARG).

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

e. United States (USA), Germany (DEU) and Turkey (TER) have similar uncertainty values.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

f. Still in Figure-4 uncertainty is irrelevant to the number of infections of the countries.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

**9. Please provide any additional comments/suggestions you wish the researchers to know/share regarding this section.**

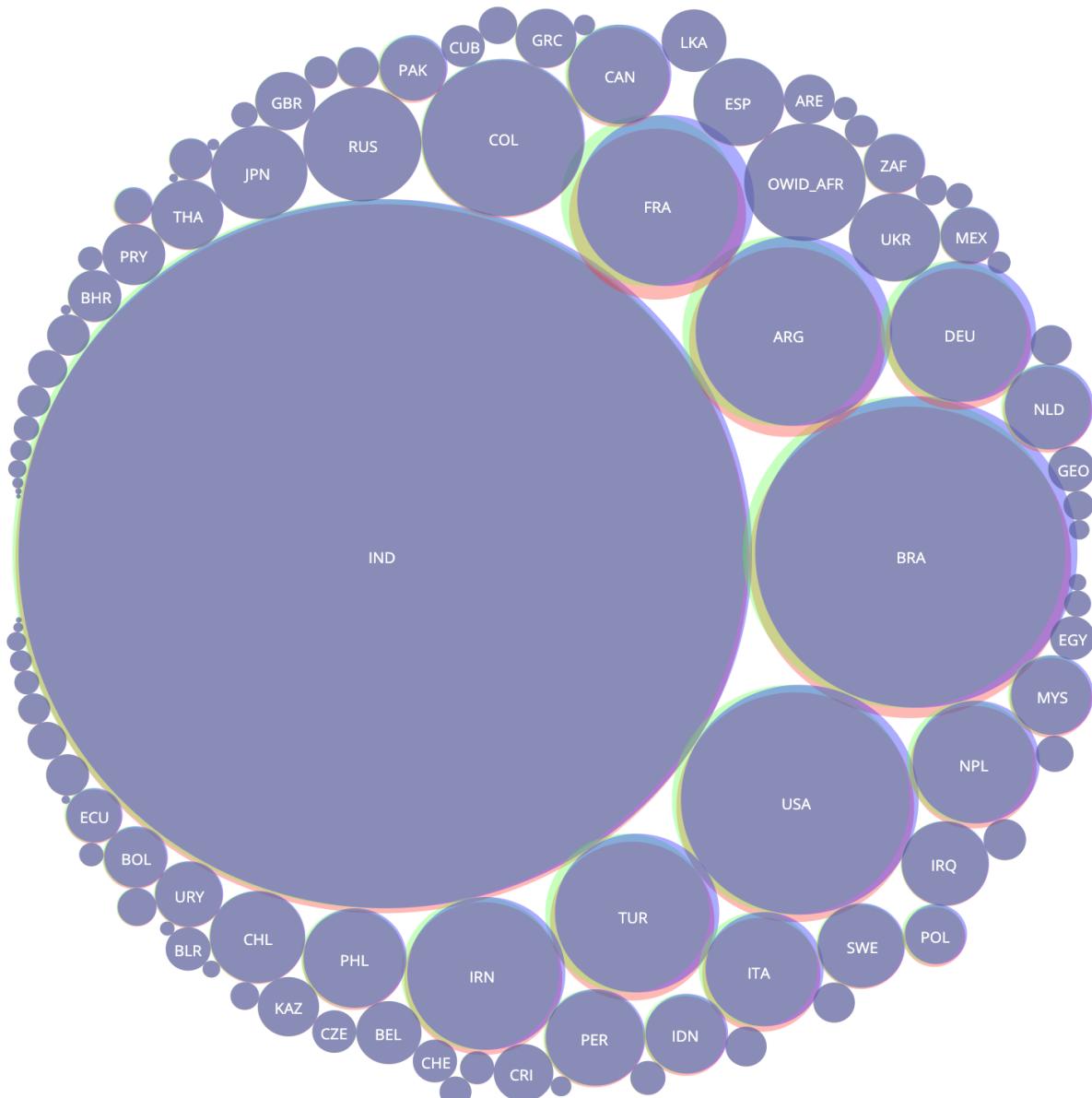


Figure-4: Bubble chart for 100 countries

**Description:** We have trained the machine learning models for top 100 countries based on the number of infections. In this Figure-4, we have utilized data for all countries. Since the chart is zoomable, we have not shown label for the smaller circumference countries due to insufficient space to accommodate and can be zoomed-in to see the corresponding label of the country. We are skipping those countries to make any question regarding them.

**10. Select the degree to which you agree or disagree with each of the following statements:**

- a. France (FRA) shows maximum uncertainty.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- b. Quite impossible to find the minimum uncertainty country.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- c. Second and third largest uncertainty countries are still confusing.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- d. United States (USA) has higher uncertainty than Turkey (TUR)

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

- e. Difficult to justify with naked eye if some countries have uncertainties like Kazakhstan (KAZ).

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

## Appendix C – Questionnaire Module

- f. All countries still maintain the irrelevance of uncertainty with number of infections of the countries.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

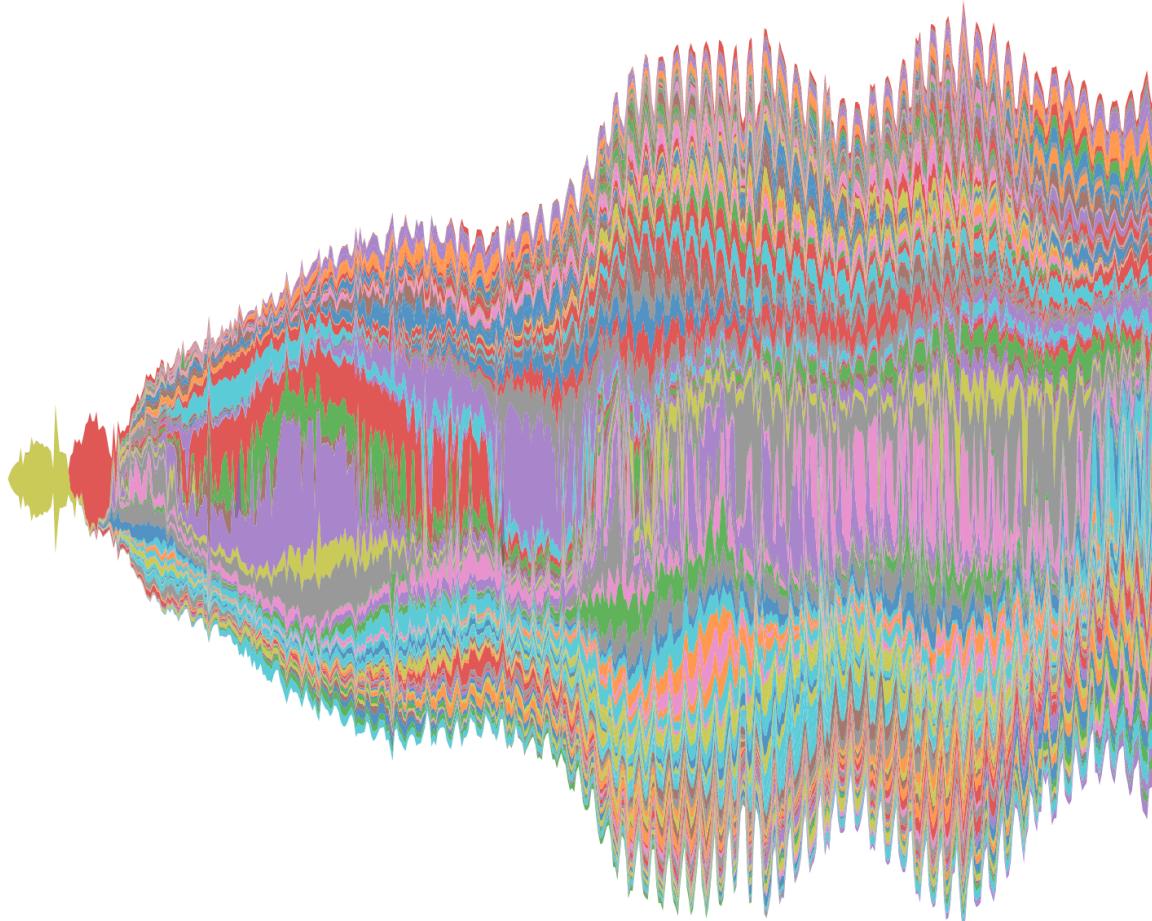
**11. Please provide any additional comments/suggestions you wish the researchers to know/share regarding this section.**

.....

.....

.....

### Streamgraph (filled with color)



**Figure-5: Colored Streamgraph**

## Appendix C – Questionnaire Module

**Description:** This stream graph is filled with color. Each color flow in the graph is named as stream and that represents a country. On mouse hover each stream shows the corresponding country name as tooltip. Intensity of colors do not have any relation with uncertainty. Along x-axis it represents date and y-axis represent the counts.

### 12. Select the degree to which you agree or disagree with each of the following statements:

a. It is very easy to distinguish the flow for each country.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

b. There are unique colors for each country.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

c. Identification of some countries are difficult.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

d. Same color in different stream refers to same country.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

e. Red and bright colors are easily identifiable and those have higher uncertainties.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

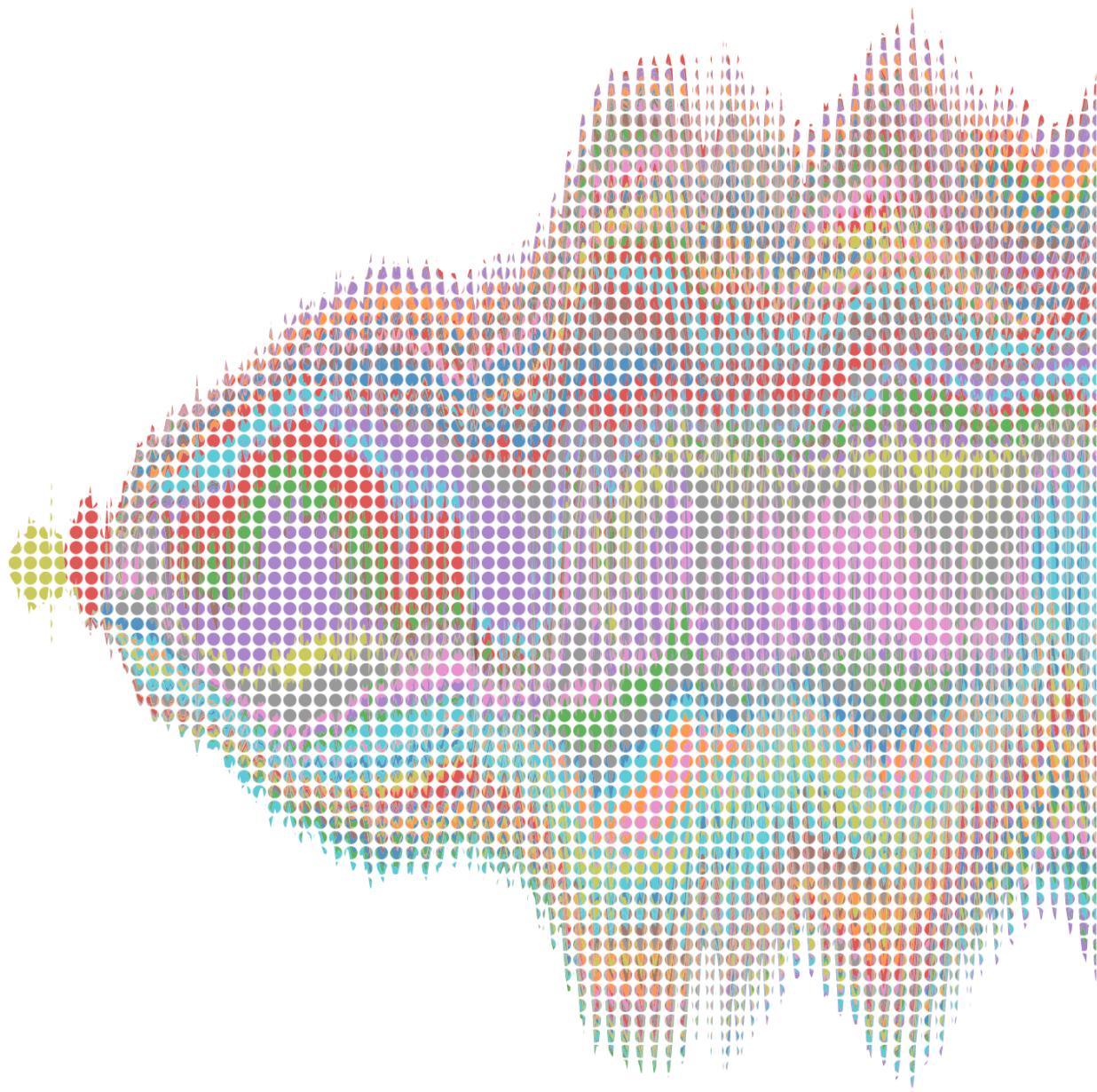
f. Top streams may have higher uncertainties than bottom stream countries.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

13. Please provide any additional comments/suggestions you wish the researchers to know/share regarding this section.

.....  
.....  
.....

**Texture Streamgraph**



**Figure-6: Streamgraph with textures**

## Appendix C – Questionnaire Module

**Description:** This chart is generated from the Figure-5 by just replacing the filling color with textures where still texture maintains colored stream flow. Axes presentations are same as that of colored fill version.

### 14. Select the degree to which you agree or disagree with each of the following statements:

a. The stream gains flow continuity in texture version.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

b. Difficult to trace aberrated countries here.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

c. Single bullet doesn't represent multiple color.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

d. All country streams start at the same date.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

e. Overall counts increase with time whereas for some countries it decreases.

Strongly agree	Partially agree	Neither agree nor disagree	Partially disagree	Strongly disagree
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

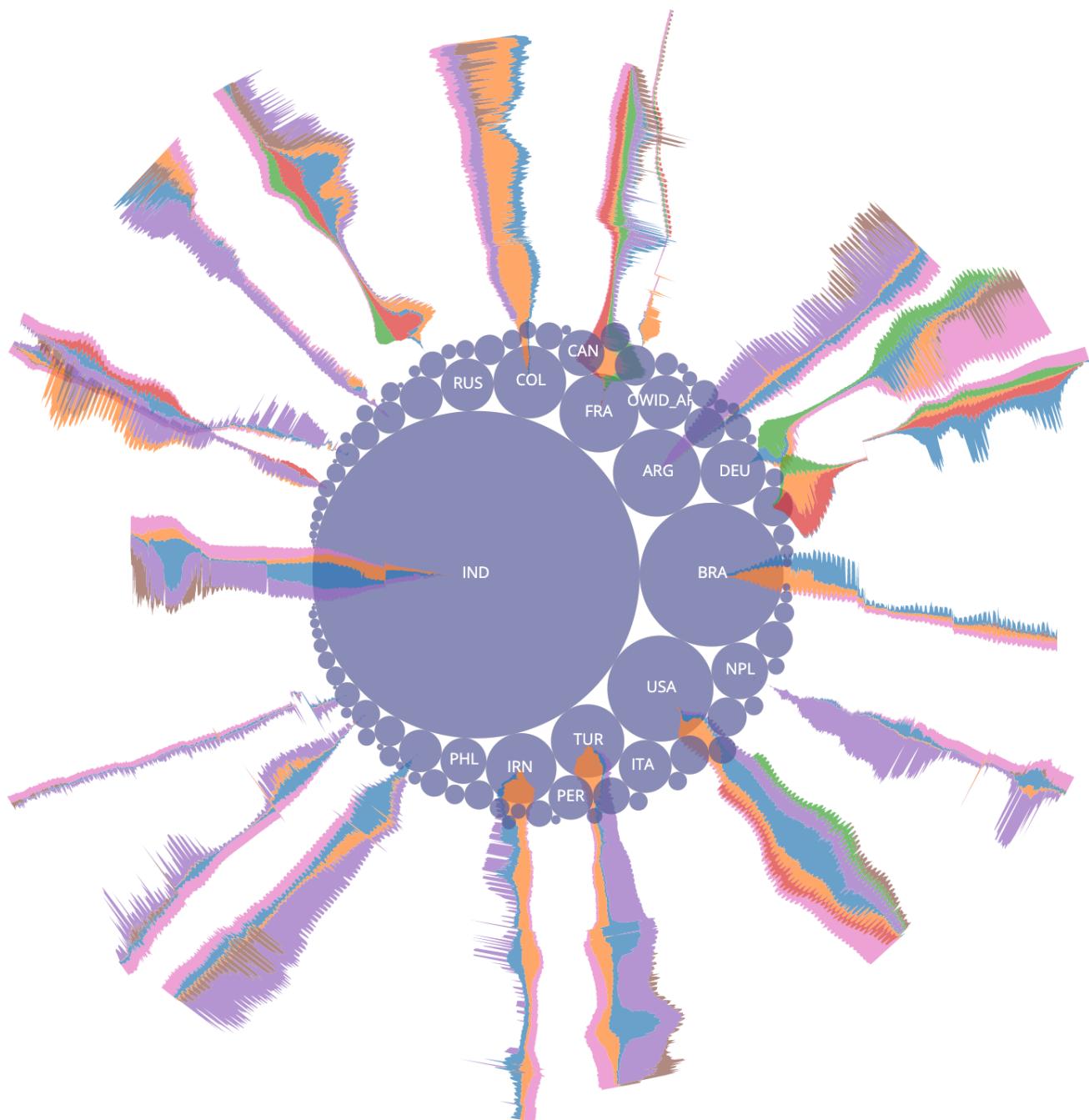
15. Please provide any additional comments/suggestions you wish the researchers to know/share regarding this section.

.....

.....

.....

### **Starfish layout**



**Figure-6: Bubble chart with star-fish layout**

**16. Select the degree to which you agree or disagree with each of the following statements:**

a. India has smaller stream because it has lower uncertainty.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

b. Some countries have thinner wing due to higher number of counts and uncertainty.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

c. Smaller circles do not have bigger stream wing.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

d. Smaller circles may or may not have bigger stream wing.

Strongly agree <input type="checkbox"/>	Partially agree <input type="checkbox"/>	Neither agree nor disagree <input type="checkbox"/>	Partially disagree <input type="checkbox"/>	Strongly disagree <input type="checkbox"/>
--	---	--	--	---

## General Feedback

17. Please provide any additional comments/suggestions you wish the researchers to know/share about the visualization of VUWCA.

Appendix C – Questionnaire Module

.....

.....

.....

.....

.....

.....