September 29, 2016

Re: **CVDI Year 4 Intellectual Property Report – Response Due by Tuesday, January 3rd 2017.**

Dear IAB Members:

We are pleased to invite expressions of interest to use the output from the CVDI Year-4 projects. You are eligible to license any copyrightable software or patentable inventions that are developed in the course of the project year, per the CVDI Industry Membership Agreement and By-Laws.

Enclosed you will find the following:

- Year-4 CVDI Intellectual Property Reports
    - Project 1 - Information Retrieval on Multiple Data Sources Using Graph-Based Methods, Dr. Ali Shokoufandeh
    - Project 2 - Predicting Future Relations: Incremental and Robust Link Prediction, Dr. Raghavan (Co-PI, Ryan Benton)
    - Project 3 - Big Data Analysis in Social Media Applications, Dr. Xiaohua Tony Hu (Co-PI, Drexel University), Moncef Gabbouj (Co-PI, Tampere University of Technology)
    - Project 4 - Graph Sampling, Summarization, and Touch-Based Visual Analytics for Large Complex Systems, Dr. Christoph Borst (Co-PI, Mehmet Tozal)
    - Project 5 – Online Mining for Association Rules and Collective Anomalies in Data Streams, Dr. Jian Cheng (Co-PI, Jennifer Lavergne & Ryan Benton)
    - Project 6 - Transforming Data Adaptation Science and Service: An Innovative Visual Ontology Application, Dr. Jane Greenberg (PI), Dr. Xia Lin
    - Project 7 - Holistic Approach to Meme Evolution in Social Graphs, Petri Myllymäki (Helsinki University)
    - Project 8 - Let the Image Speak, Moncef Gabbouj (Tampere University of Technology)
    - Project 9 - Learn-to-segment by Operational Object Segmentation Networks, Moncef Gabbouj (Tampere University of Technology)

- Forms for indicating Year-4 IP licensing intentions for the Industry Member that you represent - **your response is due by Tuesday, January 3rd 2017**

Should your company require a paper original of this letter for your records, please notify Dr. Raju Gottumukkala (nrg0821@louisiana.edu) and we will deliver to you a hard copy.

As a reminder, based on feedback received during the Year-1 IP selection cycle, the following non-exclusive licensing options are now available for CVDI IP, in addition to the Exclusive License option:

1. **Non-Exclusive Internal Use License.** This license allows for internal-use of the licensed IP for non-commercial purposes by an Industry Member as well as its subsidiaries and affiliates, is royalty-free and no longer requires payment of patent costs. The internal-use license remains available beyond the 90-day time for response to this invitation, and may be requested by an Industry Member at any time.

2. **Non-Exclusive Commercial Distribution License.** This license allows for internal commercial use as well as commercial distribution. This license is a royalty-bearing license and requires reimbursement of related patent costs.

We would also like to convey two important notes regarding patent applications:

1. As a general practice, Academic Members will not pursue US or Foreign patent protection for CVDI projects, unless an Industry Member has indicated an interest in patent protection for a specific project.

2. If the Industry Member that you represent would like to see an Academic Member file US or Foreign patent applications for a particular project, please inform the Academic Member within the reply period.

Although the internal-use license is available beyond this 90-day window, we still require an initial response by **Tuesday, January 3rd 2017** due date, so that we can determine the disposition of each IP item with regard to commercial license availability. This will also enable us to make software available and execute patent filings in a timely manner. It is important that you consider your commercial interest during this time, to ensure you have the opportunity to obtain a commercial distribution license. If after the 90-day period has expired, no member has indicated interest in a commercial license, the commercial license options will remain available to CVDI-members, and will also be made available to non-CVDI entities on a first-come basis. Once an exclusive commercial license is executed, the IP will no longer be available for exclusive or non-exclusive commercial licensing.

After the 90-day window has expired, the Academic Member(s), will subsequently contact each Industry Member indicating interest in at least one IP asset to discuss the disposition and next steps.

Year-4 CVDI IP Report

The following tables list the Intellectual Property (IP) items developed for each Year-4 project that are available for licensing, along with a description of key features. Project reports containing detailed information about the associated research results will be sent separately. The ID numbers that appear in the tables are identified by the following patterns: IP Item: Project-[Project #]-[Item #]

CVDI Project 1 - Information Retrieval on Multiple Data Sources Using Graph-Based Methods, Dr. Ali Shokoufandeh

IP Item Description
P-1-1 - A software prototype capable of extracting image features, generating directed complete graph representation of the feature sets, generating HST(hierarchically well separated tree) representation of the graphs, matching images through a matching mechanism over the resulting HSTs, and an approximate primal-dual matching mechanism that achieves matching with better performance. Languages/technologies: C++, OpenCV, lp_solve, CGAL
Key Concept 1: Representing images with hierarchical trees (HST) where the internal nodes of the tree correspond to constellations of image features and the leaves correspond to the actual image features.
Key Concept 2: Achieving image matching through matching hierarchical tree representations of the images
Key Concept 3: Performing matching at various levels of detail by carrying out matching at different layers of the hierarchical tree.
Key Concept 4: Formulating the matching problem as a combinatorial optimization problem, and state it as a linear program.
Key Concept 5: Providing a primal-dual approximation version of the matching algorithm to improve the performance of the matching
Key Concept 6: Provide a pattern recognition system that retrieves relevant images by applying a "sieve" approach, that is, it eliminates irrelevant images by performing matching at a loose layer and carries out an intense matching at finer layers for more similar images.

IP Item Description
P-1-2 - A software prototype capable of answering questions that are provided in natural language by using an information retrieval approach. The system treats the question answering problem as an instance of the metric labeling problem and uses its linear programming formulation to retrieve similar questions and their corresponding answers from a question/answer dataset. The system also provides a primal-dual approximation version of the matching algorithm for improving the performance of the matching. Languages/technologies: C++, lp_solve, JAVA, Stanford NLP
Key Concept 1: Tackle the question answering problem using the linear programming formulation of the metric labeling problem.

Key Concept 2: Given the graph representation of a question that is stated in natural language, retrieve the similar questions from a question/answer dataset using the matching algorithm.
Key Concept 3: Improve the performance of the matching by applying the primal-dual approximation scheme to the linear programming formulation of the metric labeling.

CVDI Project 2 - Predicting Future Relations: Incremental and Robust Link Prediction, Dr. Raghavan (Co-PI, Ryan Benton)

IP Item Description
P-2-1 - A software that provides robust and efficient link prediction method using ensemble and incremental approaches. Experimental results demonstrated higher accuracy and stability of ensemble method. Additionally, incremental learning approach was developed to reduce the time complexity of training process by updating the model in response to new data occurrences. The visualization system helps the user to query, view and interact with the analytic system. Please see corresponding project report for details. Languages/technologies: Input / Output / Tools/Libraries/Languages 1. Raw datasets (XML, JSON, Web services, etc.,) Receives queries to perform on the stored graph Output: Graph; Response to the graph queries Tools/Libraries/Languages: Neoj4 graph database, Java, Apache Hadoop, Apache Oozie, Apache Pig 2. Accepts graph data from graph storage Interactive requests from the visualization server Output: Link Prediction results; Subgraph to visualize Tools/Libraries/Languages: Apache Hadoop, Apache Oozie, Apache Pig, Java, Jung API, Weka 3. A query from user through UI Prediction results after the analysis Graph data to visualize Output: Visualize Results and graph using web browser or the desktop application Tools/Libraries/Languages: D3js, JavaScript, Jetty, Jung API, Java
Key Concept 1: Improving the performance and stability of link prediction problem by combining different models;
Key Concept 2: Exploring different approaches in generating the models depending on the data
Key Concept 3: Enhancing the prediction model by incorporating the historical data efficiently

Key Concept 4: Developing the incremental approach to support online learning of the model
Key Concept 5: Developing an interactive and efficient visual interface to complement the analytic engine.

CVDI Project 3 - Big Data Analysis in Social Media Applications, Xiaohua Tony Hu (Co-PI, Drexel University), Moncef Gabbouj (Co-PI, Tampere University of Technology)

IP Item Description
P-3-1 - A software prototype a Semi-Supervised Dirichlet-Hawkes Process (SDHP) to deal with topic detection and tracking from social media Languages/technologies: Java, Stanford NPL, dynamic LDA,
Key Concept 1: A new method SDHP can reveal the underlying mechanisms that drive a topic's generation and evolution
Key Concept 2: SDHP allows topics to interact with each other, and reveals their correlations

IP Item Description
P-3-2 - Software prototype of automatic generation of ImageTags (hashtags) to encode the representation of shared visual content using a binary feature synthesis algorithm (ImageTags).
Key Concept 1: With the introduction of the ImageTag concept to social media, new links among different posts will be founded immediately according to the shared visual content. This will incorporate the visual multimedia information to social media analysis in a fast and efficient way.

CVDI Project 4 - Graph Sampling, Summarization, and Touch-Based Visual Analytics for Large Complex Systems, Dr. Christoph Borst (Co-PI, Mehmet Tozal)

IP Item Description
P-4-1 - A software system supporting graph sampling and characteristic summarization with graph visualization and touch/gesture support. For a dataset in the GraphML format , a SQLite database file can be generated and loaded into our software. A graph sample can then be created, visualized, analyzed, and saved to a GraphML file. The graph sampling algorithms are also provided as a module compatible with igraph. Our experimental evaluations also contribute practical knowledge about information loss in graph sampling. The relationships between sampling methods and graph characteristics were demonstrated for the path sampling, approach and effective uses of sampling for visualization were explored. We proposed a new algorithm to achieve an unbiased sampling algorithm. Please see corresponding project report for details.

CVDI Project 5 - Online Mining for Association Rules and Collective Anomalies in Data Streams, Dr. Jian Cheng (Co-PI, Jennifer Lavergne & Ryan Benton)

IP Item Description

P-5-1 - A software that employs an online mining framework for data streams that uses (a) a scalable algorithms for processing large volumes of data for the mining of association rules over time frames, which address issues with data processing latency that results in data depreciating in value, (b) a distributed batch processing algorithms for building a model using high-volume historical data available, and (c) an online distributed stream processing algorithms for continuously comparing fast incoming data with the model, and evaluating them to detect collective anomalies. The framework is promising for online association mining or online sequence-based anomaly detection applications. It is scalable so it is suitable for big data and at the same time is able to generate near real time response before the value of the output deprecates. Please see corresponding project report for details.
Key Concept 1: Distributed association mining
Key Concept 2: Online sequence-based anomaly detection
Key Concept 3: Integration of association mining and anomaly detection

CVDI Project 6 - Transforming Data Adaptation Science and Service: An Innovative Visual Ontology Application, Dr. Jane Greenberg (PI), Dr. Xia Lin

IP Item Description
P-6-1 - A software prototype capable of automatically extract sentences containing certain text strings and keywords from text files. Text extracted from target sentences using vector that includes software name and terms (e.g. reuse, use, etc.), can help predict reuse types based on the keywords. Languages/technologies: Java, Apache TIKA
Key Concept 1: A streamlining method to extract and classify software reuse-based rules.
Key Concept 2: An implementation of machine learning technique that is applied to all scholarly resources.

IP Item Description
P-6-2 A software prototype that automatically generates an online network visualization, leverage metadata and the ontology of reuse relationships. Software prototype also includes keyword cloud presenting reuse types between the papers and the software, with user-controllable features. Languages/technologies: R, D3.js
Key Concept 1: Automatically created third-party-hosted online applications displaying the network and word cloud based on user-selected scope of papers and parameters.

CVDI Project 7 - Holistic Approach to Meme Evolution in Social Graphs, Petri Myllymäki (Helsinki University

IP Item Description
P-7-1 – Software prototype for dimensionality reduction for categorical data combining feature hashing and random projections (under consideration, work not yet complete)
Key Concept 1: No need for expensive dictionaries for categorical data.
Key Concept 2: Projection matrix is implicit thus there are no limits for the dimensionality, i.e number of categories. Feature hashing implies extremely high but sparse dimensions, which alleviates the process further.
P-7-2 – Software prototype for multilingual feature extraction and similarity estimation over languages (under consideration, work not yet complete)
Key Concept 1: Black box feature extraction over different languages for textual documents.
Key Concept 2: Aspectual similarity can be estimated between documents as a distance between feature vectors regardless of the language.
P-7-3 – Software prototype for ("social") graph structure estimation of textual content producing entities. (under consideration, work not yet complete)
Key Concept 1: Relations between different content producing entities can be estimated given the produced content and other data.

CVDI Project 8 - Let the Image Speak, Moncef Gabbouj (Tampere University of Technology)

IP Item Description
P-8-1 – A software prototype for image classification system with 4000 object classes P-8-2 - A software prototype for Sliding window based Object Proposal P-8-3 - A software prototype for Segmentation based Object Proposal P-8-4 - A software prototype for training Object detectors using Deep CNN and the proposed Object proposal methods
Key Concept 1: A novel approach for computing object proposals using localization ability of CNNs and edge information. We showed a great potential of using CNNs in boosting existing techniques while merging low level segments, superpixels based on similarity or sliding window fashioned object proposal methods.

CVDI Project 9: Learn-to-segment by Operational Object Segmentation Networks, Moncef Gabbouj (Tampere University of Technology)

IP Item Description
P-9-1 – A software prototype for Convolutional Segmentation Networks for salient object extraction. P-9-2 – A software prototype for 1-layer Convolutional Kernel Networks combined with Quantum Cuts for salient object extraction.

Key Concept 1: The innovation of the first approach in this project, Convolutional Segmentation Networks, lies within its specific design for exploiting deep convolutional networks for image segmentation.
Key Concept 2: the innovation of Convolutional Kernel Networks based approach is concatenating CKNs with the state-of-the-art salient object detection method Quantum Cuts. This way, we can train an end-to-end system which can make use of high capability of CKNs for affinity prediction together with the globally optimal salient object detection with QCut from these affinities.

Using the enclosed sheets please indicate the licensing intentions for the Industry Member that you represent, checking all license-types that are of interest for each item.

Please note that if only one Industry Member wishes to obtain a non-exclusive commercial license, that Industry Member will have the option to obtain an exclusive commercial license. For that reason, please be sure to indicate whether you might like to obtain an exclusive commercial-distribution license, if available.

If Academic Member(s) do not receive a response by the due date, the non-response will be interpreted as an indication that "No License" is desired for any Year-4 IP item at this time. **A non-response will constitute a formal forfeiting of entitlement rights only to a commercial license of CVDI Year-4 IP**.

Please return a signed copy of this letter and the attached sheets (**on which you must check your licensing interests**) by **Tuesday, January 3rd 2017** by e-mail to the sender of this letter or by mail to the addresses affixed on the attached sheets.

Sincerely,

Robert B. McGrath
Senior Associate Vice Provost
Drexel University

C. Dean Domingue
Director, Office of Innovation Management
University of Louisiana at Lafayette

Ulla Ruotsalainen
Vice President for Research
Tampere University of Technology

Read and Accepted.

_____ _____ _____

Name Signature Date

Drexel University
Office of Technology Commercialization
The Left Bank Building
3180 Chestnut Street
Suite 104
Philadelphia, Pennsylvania 19104

Re: CVDI Year 4 Intellectual Property Report

Dear Dr. McGrath:

Please see the below tables, where we have indicated our licensing interests for each of the IP assets associated with all CVDI project that Drexel has contributed to:

CVDI Project 1 - Information Retrieval on Multiple Data Sources Using Graph-Based Methods, Dr. Ali Shokoufandeh

P-1-1			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

P-1-2			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

CVDI Project 3 - Big Data Analysis in Social Media Applications, Xiaohua Tony Hu (Co-PI, Drexel University), Moncef Gabbouj (Co-PI, Tampere University of Technology)

P-3-1			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

P-3-2			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

CVDI Project 6 - Transforming Data Adaptation Science and Service: An Innovative Visual Ontology Application, Dr. Jane Greenberg (PI), Dr. Xia Lin

P-6-1			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

P-6-2			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

_____	_____	_____	_____
Company	Name	Signature	Date

University of Louisiana at Lafayette
Office of Innovation Management
PO Box 43610
Lafayette, LA 70504

Re: CVDI Year 4 Intellectual Property Report

Dear Mr. Domingue:

Please see the below tables, where we have indicated our licensing interests for each of the IP assets associated with all CVDI project that UL Lafayette has contributed to:

CVDI Project 2 - Predicting Future Relations: Incremental and Robust Link Prediction, Dr. Raghavan (Co-PI, Ryan Benton)

P-2-1			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

CVDI Project 4 - Graph Sampling, Summarization, and Touch-Based Visual Analytics for Large Complex Systems, Dr. Christoph Borst (Co-PI, Mehmet Tozal)

P-4-1			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

CVDI Project 5 - Online Mining for Association Rules and Collective Anomalies in Data Streams, Dr. Jian Cheng (Co-PI, Jennifer Lavergne & Ryan Benton)

P-5-1			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

Company _____ Name _____ Signature _____ Date _____

Tampere University of Technology
Korkeakoulunkatu 10
33720 Tampere
Finland

Re: CVDI Year 4 Intellectual Property Report

Dear Dr. Ruotsalainen,

Please see the below tables, where we have indicated our licensing interests for each of the IP assets associated with all CVDI project that TUT has contributed to:

CVDI Project 3 - Big Data Analysis in Social Media Applications, Dr. Xiaohua Tony Hu (Co-PI, Drexel University), Moncef Gabbouj (Co-PI, Tampere University of Technology)

P-3-2			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
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CVDI Project 7 - Holistic Approach to Meme Evolution in Social Graphs, Petri Myllymäki (Helsinki University)

P-7-1 *under consideration, work not yet complete*			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
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P-7-2 *under consideration, work not yet complete*			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
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P-7-3 *under consideration, work not yet complete*			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
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CVDI Project 8 - Let the Image Speak, Moncef Gabbouj (Tampere University of Technology)

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P-8-2			
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P-8-3			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
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P-8-4			
Non-Exclusive Internal-Use License	**Non-Exclusive Commercial License**	**Exclusive Commercial License**	**No License**
☐	☐	☐	☐

CVDI Project 9 - Learn-to-segment by Operational Object Segmentation Networks, Moncef Gabbouj (Tampere University of Technology)

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P-9-2			
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☐	☐	☐	☐

Company	Name	Signature	Date