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SYN-ENERGENE

Synthetic Biology – Engaging in Responsible Governance of New and Emerging Science and Technology in Responsible Governance of the Science and Society Relationship

Deliverable

D 6.2 Assessment report on online public opinion about SynBio

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Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
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Table of Content

1   Goals and conceptualization process

The work package 6 comprises many activities regarding communication and dissemination within the SYNENERGENE project. Specifically speaking, the aim is to raise attention to the project SYNENERGENE itself as well as to reach out to actors beyond the already participating MMLAP consortium partners by assessing online opinions and providing information (comp. Annex I - "Description of Work", p. 33).

This report focuses on task 6.2. It includes the assessment of online public opinion about SynBio (synthetic biology) by identifying actors and arenas in the online sphere that "talk" about that topic.

Therefore, this task combines two missions: first - to find the "speakers" and second - to analyse and interpret the "talk". During the conceptualization process, accomplishing the first mission turned out to be rather straightforward, whereas the second one turned out to be more difficult to solve, requiring significant resources if done on a very detailed level and involving a high level of risk. Content analysis of online talk is still a novel research field without well-established methods to apply to any given content.[1] Given that studies of the discourse on synthetic biology – though not based on online talk – already exist,[2] the partners involved in this task decided to focus on the first mission which promised to yield results more efficiently and of higher relevance to the goals of SYNENERGENE, while not neglecting the second one.

The Mobilisation and Mutual Learning Action Plan of the European Union is the frame of the SYNENERGENE project and it is its goal to foster a two-way dialogue between researchers and other stakeholders - our so-called "speakers". In order to get in touch with relevant stakeholders it is necessary to find them in the first place. This will be the foremost contribution of the first mission: the creation of a database of "speakers", people or institutions, which have an interest in SynBio or neighbouring fields of science in the widest sense. The "speakers" will be classified in different categories, e.g. from which country they come from or whether they are an institution (governmental, research, other), company, media portal etc. We will also distinguish whether they are already actively engaged in the discourse of synthetic biology or rather in "neighbouring" fields like biotechnology. The search strategy and the coding scheme for the database will be particularized in the following chapters.

Following the web analysis, we will present a communication concept how the arenas and actors found can be addressed and activated as multipliers of and/or participants in the SYNENERGENE project. Actors could be asked, for example, to place a SYNENERGENE banner or to integrate the available SYNENERGENE feeds on their own website, to mention the project in their newsletter, or to become a member in one of the open fora. With that, we aim to strengthen the SYNENERGENE community as well as to increase the public visibility of the SYNENERGENE project (including the platform SYNENERGENE.eu). In the longer run, such communication activities contribute to the goal of fostering the discourse on synthetic biology from the perspective of responsible research and innovation (RRI) and to doing this in a sustainable way, i.e. starting in the context of SYNENERGENE, but lasting longer than the project itself.

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[1] Cf. Hanna, A. (2013). Computer-aided content analysis of digitally enabled movements. *Mobilization* 18, 367-388; Grimmer, J., Stewart, B.M. (2013). Text as Data. *Political Analysis* 21, 267-297.
[2] See e.g. Stemerding, D., Reirimassie, V. (2013). Discourses on Synthetic Biology in Europe. Working Paper 1305, Den Haag: Rathenau Instituut; Torgersen, H., Schmidt, M. (2013). Frames and comparators. *Futures* 48, 44-54.

Moreover, the result of the web analysis, the database of SynBio "speakers", has a unique value as it is probably one of the first repositories that list so many stakeholders regarding synthetic biology (another database of SynBio actors is maintained by SYNENERGENE partner WWICS at www.synbioproject.org/inventories/maps-inventory, its focus being on research in the field of SynBio, but also listing community labs and social science and policy researchers). It can be used in various ways for other partners of the consortium or scientists to analyse the public debate on SynBio. To contribute to the second mission, the analysis of online talk about SynBio, University of Southern Denmark (SDU) conducted a frequency and sentiment analysis on the basis of the repository in order to extract some rudimentary facts about the content of the conversation in these texts. Although preliminary, this analysis helped to corroborate the results by highlighting some characteristics of the online discourse that correspond to the expectations. Furthermore, the analysis sheds light on the way the identified actors are involved in the discourse on SynBio, and it contributes to the growing research field of online content analysis.[3]

2   Method of data collection

The web analysis, or the "speakers" search, required some conceptual thinking regarding the formulation of queries that would lead to relevant findings. The formulation of search queries is an important first step in the analysis of online content.[4] In cooperation with the partners from the Karlsruhe Institute of Technology and the University of Southern Denmark, 79 query terms had been identified based on literature research and the criterion that these terms should grasp the field of SynBio in all its current areas. This corresponds to the goal of identifying actors engaged in the discourse from all relevant stakeholder groups. Subsequently, the search was executed with the help of an online-tool called "brandwatch" as well as manually. The data was then classified and enriched with further information (further information on the substeps of the web analysis are described in the regarding subchapters)

Languages included in the web analysis were English and German. The reasons for this choice are that a) a very widespread language was sought to cover a large part of discourse on the Internet. English was chosen with special regard to the fact that the field of SynBio is being dominated by actors from the United States (especially researchers). The second reason is that b) besides English, another language should be represented in the analysis, one in which a relevant number of actors was expected to talk online about SynBio, to cope for cultural differences in different discourse communities based on different languages. For pragmatic reasons also (competence in that language on the side of the researchers), German was chosen as this second language.

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[3] Cf. Albrecht, S., Coenen, C., Yang, M., Trénel, M. (2010). Perception of Nanotechnology in Internet-based Discussions. BfR-Wissenschaft 8/2010, Berlin: Federal Institute for Risk Assessment; Cacciatore, M.A. et al. (2012). Coverage of emerging technologies. New Media & Soeicty 14, 1039-1059.
[4] Arora, S.K. et al. (2013). Capturing new developments in an emerging technology. *Scientometrics* 95, 351-370.

2.1 Queries

The queries were gathered from different fields of synthetic biology and neighbouring fields of science. As the queries set the foundation for the range of stakeholders that will be found during the web analysis, the partners aimed at finding many diverse and covering terms (concerning application areas such as, e.g., health, technology, informatics, etc.).

	Primary query	Secondary query
	- Printing - Nanoscience - Bottom-up - Top-down - Biomineratization - Pharmaceutical - Vaccination - Biodiversity - do-it-yourself - open source - biomass - Man-made - unconventional computing	Synthetic bio
	- Biocomputing - biology - life - organism - cell - chromosome - DNA - creating life - genes - microfluidic - metabolic engineering - regulatory circuits - orthogonal biosystems - protein engineering - molecular motors - cell factories - minimal genomes - synthetic pathways - gene therapy - xenobiology - Xeno Nucleic Acid - genetic alphabet - unnatural amino acid - non-canonical amino acid - biobased chemicals - green chemicals - live vaccines - Playing God	synthetic
	- SynBio - biosafety - biosecurity - bioeconomy - igem - biofuel - biopatent - patents of life - bioethic	Standalone

- biopolitics
- Biohacking
- BioBricks
- Protocell
- minimal cell
- artificial cell
- Genetic engineering
- artificial organism
- artificial life
- artificial photosynthesis
- DNA manipulation
- genome manipulation
- genetic manipulation
- Craig Venter
- living technology
- bio-info-nano-cogno
- bionanoscience
- biochemical information communication technology
- cell free expression system
- DNA computing
- biotechnology
- biological engineering
- genetic engineering
- Genetics, Biology and Science
- responsible research and innovation
- MMLAP
- Mutual Learning Action Plan
- Science ethics
- Bioethics

2.2 Manual Websearch

For the manual web search the prominent search engine "Google" was utilized, since it has one of the best-engineered algorithms to find current and fitting search-result pages. It is also the most widely used search engine, implying that the search results presented by it resemble what most other Internet users get when they search the web (see below for a consideration of the methodological problems from personalisation). Because of the range of queries, only one search engine could be adduced.

The investigation period was determined to a time span between 1st of April 2013 and 31th of March 2014 (the web search was carried out in April 2014). With that approach the most current actors and online-spaces surrounding synthetic biology could be identified. For each query the first 20 search-resultshave been assessed to whether those are relevant findings or not. Non-relevant search-results were pages that had no connection to the respective query (e.g. http://www.rugcleaningnyc.net/2014/02/09/organic-carpet-cleaning/ that appeared using the query ""green chemicals" synthetic*") or could only be accessed by registration (e.g. repositories for academic journals, articles or other publications). The latter might be relevant for the discourse of SynBio, but they have not been available for the research conducted here and they also would not be available to the common Internet user, so omitting them seems well justified.

The findings are, nevertheless, limited in their objectivity. When using the same search settings and repeating the procedure, slightly other search-result pages are likely to appear. That is because

Google search uses a personalised search that builds on preceding queries and the IP location of the computer used in order to produce the most fitting results for each user. Since the manual websearch generated a long and diverse list of relevant URLs the possible variations in the search results may be acceptable.

2.3 Automated Websearch

In addition to the manual web search an automated web search was executed. The online-tool "brandwatch" was chosen for that particular use. Brandwatch is a monitoring tool that "collects mentions from millions of online sources, from news articles and blog posts to tweets and Facebook statuses, so you can discover the conversation that matters most to your brand." (http://www.brandwatch.com/brandwatch-analytics/) It has been used by Zebralog before for an internal analysis regarding the public opinion on topics such as sustainable consumption on behalf of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (the document is unfortunately not for distribution). Brandwatch got best marks for its performance and data volume as it covers more web sources and produces more search-results than other tools[5].

All defined queries were associated with appropriate search operators. The complete search request can be found in the appendix. In accordance with the manual search, the time span for the investigation period was set alike. The online-tool then listed all websites found in sequence based on a so-called "MozRank" (http://moz.com/learn/seo/mozrank). That factor can be compared to Google's PigeonRank™ that represents an algorithm for a link popularity score. The first 100 results were taken into account and checked for relevance. Different website types were included in the automated websearch, e.g. blogs, news, twitter, and general websites.

2.4 Classification of data set

The outcome of the two web searches was an unordered list of URLs. The different websites were then submitted to a closer examination. Different categories and dimensions were defined, so that different analyses can be drawn from the data. The coding scheme is explained in the following.

1	internet address
Original URL found during manual and automated search - it hyperlinks a specific blog post, research department or other entry on the website that included the respective query	

2	Front page of website
initial or main web page of the website found	

3	Type of website
A first differentiation between informative or interactive websites	

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[5] http://www.emart-digital.com/brandwatch-social-media-monitoring-review/
http://www.goldbachinteractive.ch/insights/fachartikel/toolreport14-monitoring-tools

1	online-space	An interactive website where users can leave comments: e.g. blogs, facebook groups, online media
2	actor	An informative website for commercial or private purposes or other on-topic websites: e.g. organizations, research institutions, NGOs, other EU projects, businesses
3	other	Mostly events or projects

4	Title or name of the actor or online-space
E.g. name of the university or news platform	

5	Type of actor or online-space
A more detailed differentiation between informative or interactive websites; for that the website in general was examined and the actors who run the website. If actors (e.g. an NGO) are publishing posts in a forum website, the website will be categorised as "forum" not as "other society" because there could be many diverse actors in such an online-space .	

1	media	news platforms or online-magazines that publish articles
2	governmental institution	Like EU commission or others
3	research institution	institution with a primary academic mission, like universities
4	other institution	e.g. civil society organisations
5	education	Platforms that provide online-courses or anything similar
6	blog	Private web spaces where people publish articles
7	forum	Platforms where people can post questions and threads
8	youtube channel	Channel on the video platform youtube.com
9	company	Commercial organisations that distribute some kind of biological product
10	network	an affiliation of different actors for various purposes either private, commercial, academic or anything else
11	event	e.g. symposiums, competitions, international meetings, etc.
12	project	temporary or pilot undertakings
13	website	General websites that do not fit in any other category

6	Country
If possible it refers to the headquarters of e.g. media publishers, companies, research institution etc.	

7	Description of websites purpose	
mostly part of the "about" page of the distinctive URL or first parts of the respective Wikipedia article to get a quick overview of the relevance		

8	Type of engagement with synthetic biology	
Categorize whether the actor or online-space is more affiliated with synthetic biology, neighbouring fields of science or rather subordinate topics like ethics or science in general		
1	actively engaged in the discourse on synthetic biology	Only those actors/online-spaces were labelled with that category who specifically talk about "synthetic biology"
2	notably engaged in "neighbouring" fields of synthetic biology such as biotechnology, bioengineering, nanotechnology and information technology	To be in line with the indefinite definition of synthetic biology, other websites that not directly related to "synthetic biology" as a term or talked about other scientific fields like biotechnology were labelled with that category
3	engaged in the areas of Science and Technology, responsible research and innovation, ethics	Superordinate institutions or special departments for ethical issues are labelled with that category
4	make the topic more prominent within the "general public"	Especially media or other institutions that aim at fostering public discourse and involvement

3   Part 1: Analysis of the "speakers" or stakeholders

After the web analysis and the classification of the derived and enriched data, a quantitative evaluation was conducted. Within the category "Type of engagement with synthetic biology" we will take a closer look what types of actors and online-spaces are prominent. The first four types (in sequence of their frequency) are displayed and shortly analysed. For the most frequent type of actor/online-space the specific websites are listed below.

All in all, most of the stakeholders identified are engaged in "neighbouring fields of synthetic biology". This is not so much of a surprise as the coding scheme is very strict with the label "actively engaged in the discourse on synthetic biology". The "potential multipliers" consisted mostly of media platforms. Those websites normally have a good search engine optimisation; therefore they are more likely to appear in higher positions in the search-results.

Remark:
It may be criticised that some well-known top actors are not among the results such as the Craig Venter institute. That can be traced back to the time span applied within the web analysis. During the last year there was a high media attention to Craig Venters findings like the "Digital Biological

Converter"[6]. As stated above, media website are more likely to appear on the first search-result pages.

actively engaged in the discourse on synthetic biology	77
engaged in "neighboring" fields of synthetic biology	240
engaged in the areas of Science and Technology, responsible research and innovation, ethics	121
Potential multipliers to make the topic more prominent within the "general public"	265

3.1 Engagement in Synthetic Biology

research institution	29	38%
project	9	12%
event	8	10%
company	8	10%

Within the category "actively engaged in the discourse on synthetic biology", the research institutions and projects account for the majority of the overall findings. A lot of American universities and laboratories are among the results which may indicate the greater prevalence of the topic "SynBio" within the scientific community in the US.

http://www.helmholtz.de	Helmholtz-Gemeinschaft	research institution	**Germany**
http://synbio.mit.edu/	Massachusetts Institute of Technology - Synthetic Biology Center	research institution	**USA**
http://www.synberc.org	Synthetic Biology Engineering Research Center	research institution	**USA**
http://synbio.berkeley.edu/	The Synthetic Biology Institute at UC Berkeley (SBI)	research institution	**USA**
http://www.bioss.uni-freiburg.de/cms/index.php	BIOSS Centre for Biological Signalling Studies	research institution	**Germany**
https://sites.google.com/a/uw.edu/uw-center-for-synthetic-biology/	University of Washington Center for Synthetic Biology (CSB)	research institution	**USA**
http://syntheticmicrobe.bio.lmu.de/	Ludwig-Maximilians-University (LMU) Munich, Department Biology I, Microbiology	research institution	**Germany**

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[6] http://www.theguardian.com/science/2013/oct/13/craig-ventner-mars

http://systemsbiology.ucsf.edu/	University of California, San Francisco (UCSF) center for systems & synthetic biology an NIGMS national systems biology center	research institution	**USA**
http://synbio.ku.dk/	Center for Synthetic Biology - University of Copenhagen)	research institution	**Denmark**
http://www3.imperial.ac.uk/syntheticbiology	Centre for Synthetic Biology and Innovation (CSynBI)	research institution	**UK**
http://www.fas.nus.edu.sg	Faculty of Arts and Social Sciences (FASS) of the National University of Singapore	research institution	**Singapore**
http://www.med.upenn.edu/milonelab/Milonelab/Welcome.html	Laboratory for Applied Synthetic Biology Department of Pathology and Laboratory Medicine	research institution	**USA**
http://igem.org/Main_Page	International Genetically Engineered Machine (iGEM) Foundation	research institution	**USA**
http://www.medicine.uiowa.edu/genomeediting/	University of Iowa Carver College of Medicine - Genome Editing Facility	research institution	**USA**
http://barricklab.org/twiki/bin/view/Lab	Barrick Lab	research institution	**USA**
http://www.ncl.ac.uk/computing/#	Newcastle University Computing Science	research institution	**UK**
http://ico2s.org/index.html	Interdisciplinary Computing and Complex BioSystems (ICOS) research group	research institution	**UK**
http://www.gla.ac.uk/	University of Glasgow	research institution	**Scotland**
http://www.synbio.leeds.ac.uk/index.php	Synthetic Biology Center at Leeds University	research institution	**UK**
http://synbio.ku.dk/	Center for Synthetic Biology at University of Copenhagen	research institution	**Denmark**
http://www.tudelft.nl/en/	TU Delft	research institution	**The Netherlands**
http://www.cshl.edu/	Cold Spring Harbor Labatory	research institution	**USA**
http://www.synbio.group.shef.ac.uk/synbio/	Synthetic Biology@Sheffield	research institution	**UK**
http://www.seas.ucla.edu/~liaoj/index.html	Metabolic Engineering and Synthetic Biology Laboratory	research institution	**USA**
http://www.synthsys.ed.ac.uk/	SynthSys - Centre for Synthetic and Systems Biology of University of Edinburgh	research institution	**Scotland**

http://www2.warwick.ac.uk/fac/sci/lifesci/	School of Life Sciences (SLS)	research institution	**UK**
http://www.wageningenur.nl/en.htm	Wageningen UR (University & Research centre)	research institution	**The Netherlands**
http://cri-paris.org/	CENTER for RESEARCH and INTERDISCIPLINARITY	research institution	**France**
http://www.synmikro.com/en/	LOEWE center for synthetic microbiology (SYNMIKRO)	research institution	**Germany**

3.2 Engagement in Neighbouring Fields of Synthetic Biology

research institution	79	33%
company	34	14%
blog	23	10%
media	21	9%

Similar to the category "actively engaged in the discourse on synthetic biology" mostly research facilities are found among the stakeholders. That can also be traced back to the set of queries that included many scientific terms that may be mainly used by the scientific community.

http://www.rimls.nl/	Radboud Institute for Molecular Life Sciences (RIMLS)	research institution	**The Netherlands**
http://www.pratt.duke.edu	Duke's Pratt School of Engineering	research institution	**USA**
http://www.northwestern.edu/	Northwestern University (NU)	research institution	**USA**
https://www.neb.com	New England Biolabs (NEB)	research institution	**UK**
http://www.washington.edu/news/	University of Washington	research institution	**USA**
http://www.amolf.nl	FOM Institute AMOLF	research institution	**The Netherlands**
http://www.szbk.u-szeged.hu	Biological Research Centre (BRC) of the Hungarian Academy of Sciences	research institution	**Hungary**

http://www.biotechcampusdelft.nl	Delft University (Biotech Campus)	research institution	**The Netherlands**
http://casimir.researchschool.nl	Casimir Research School (Casimir)	research institution	**The Netherlands**
http://www.bioe.uh.edu/	University of Houston - Department of Biomedical Engineering	research institution	**USA**
http://www.sheffield.ac.uk/chemistry/index	University of Sheffield - Department of Chemistry,	research institution	**UK**
http://www2.le.ac.uk/departments/interdisciplinary-science	University of Leicester - Centre of Interdisciplinary Science	research institution	**UK**
http://intelligence.org	Machine Intelligence Research Institute (MIRI)	research institution	**USA**
http://guides.boisestate.edu/	Boise State University - Guides	research institution	**USA**
http://www.scripps.edu	The Scripps Research Institute (TSRI)	research institution	**USA**
http://huttenhower.sph.harvard.edu/	Harvard School of Public Health - Huttenhower Lab, Department of Biostatistics	research institution	**USA**
http://www.vib.be/en/	VIB	research institution	**The Netherlands**
http://www.uni-potsdam.de/cell2fab	Cell2Fab	research institution	**Germany**
http://www.eastscotbiodtp.ac.uk	EASTBIO	research institution	**Scotland**
http://hms.harvard.edu/	Harvard Medical School	research institution	**USA**
http://www.northwestern.edu/	Northwestern University (NU)	research institution	**USA**
http://angenent.bee.cornell.edu/	The Angenent Lab	research institution	**International**
http://www.cgrb.oregonstate.edu/	Center for Genome Research and Biocomputing at Oregon State University	research institution	**USA**
http://www.ucalgary.ca/	Biocomputing Group at University of Calgary	research institution	**Canada**
http://www.cns.caltech.edu/index.html	Computation & Neural Systems California Institute of Technology	research institution	**USA**

http://biochemistri.es/	Biochemistri	research institution	**Spain**
http://www.bu.edu/hic/	The Rafik B. Hariri Institute for Computing and Computational Science & Engineering at Boston University	research institution	**USA**
http://www.jbei.org/	The Joint BioEnergy Institute (JBEI)	research institution	**USA**
http://www.rimls.nl/	Radboud Institute for Molecular Life Sciences (RIMLS)	research institution	**The Netherlands**
http://www.sommerlab.com/	Sommer Lab	research institution	**Denmark**
http://www.tifr.res.in	Department of Chemical Sciences, TIFR	research institution	**India**
https://ibmb.unibas.ch/home/	Institute for Biomedical Ethics at University of Basel	research institution	**Switzerland**
http://jsnn.ncat.uncg.edu/	Joint School of Nanoscience & Nanoengineering	research institution	**USA**
http://www.bristol.ac.uk/	Centre for Nanoscience and Quantum Information	research institution	**UK**
http://www.nusnni.nus.edu.sg/	NUS Nano Science and Nano Technology Institute of Singapure	research institution	**Singapure**
https://www.toyo.ac.jp/site/english/	Toyo University	research institution	**Japan**
http://sys-bio.org/	Sauro Lab: Networks, Control and Software	research institution	**International**
http://bel.kaist.ac.kr/	Biomolecular Engineering Lab - Department of Biological Sciences	research institution	**Republic of Korea**
http://systemdesign.illinois.edu/	Engineering System Design Lab at the Univeristy of Illinois	research institution	**USA**
http://www.aka.fi/en-GB/A/	Academy of Finland	research institution	**Finland**
http://cbe.nd.edu/	Chemical and Biomolecular Engineering Department at University of Notre Dame	research institution	**France**
http://che.umass.edu/	Department of Chemical Engineering University of Massachusetts	research institution	**USA**
http://www.crg.eu/en	Centre for Genomic Regulation (CRG)	research institution	**Spain**

http://www.purdue.edu/	Purdue University	research institution	**USA**
http://www.benferinga.com/index.php	Feringa group at university of Groningen	research institution	**The Netherlands**
http://www.nano.lth.se/home	The Nanometer Structure Consortium at Lund University	research institution	**Sweden**
http://www.bbe.caltech.edu/	Biology and Biological Engineering (BBE) of California Institute of Technology	research institution	**USA**
http://biosel.eng.ucsd.edu/	Shyni Varghese's Research Group	research institution	**USA**
http://www.fz-juelich.de/portal/EN/Home/home_node.html	Institute of Bio- and Geosciences	research institution	**Germany**
http://www.sintef.no/home/	SINTEF	research institution	**Norway**
http://cbrc.kaust.edu.sa/cbrcweb/home/index.php	Computational Bioscience Research Center at King Abdullah University of Science and Technology	research institution	**Saudi Arabia**
http://www.micalis.fr/micalis_eng	Micalis institute	research institution	**France**
http://ki.se/en/labmed/startpage	Molecular Cell Biology and Gene Therapy Science at Karolinska Institutet	research institution	**Sweden**
http://www.chem.vu.nl/en/index.asp	Department of Chemistry and Pharmaceutical Sciences at University of Amsterdam	research institution	**The Netherlands**
http://www.aciesbio.com/	ACIES BIO	research institution	**Slovenia**
http://www.biologia.unige.it/	Corsi di Laurea in Biologia - Universitâ Degli Studi Di Genova	research institution	**Italy**
http://www.chem.ufl.edu/	Department of Chemistry at the University of Florida	research institution	**USA**
http://english.big.cas.cn/	Beijing Institute of Genomics (BIG) - Fei Chen's Group	research institution	**China**
http://www.neuroscience.univ-bordeauxsegalen.fr/fr/index.html	Bordeaux Neurocampus	research institution	**France**
http://vaccines.emory.edu/index.html	Emory Vaccine Center at Emory University	research institution	**USA**

http://www.rwth-aachen.de/go/id/bkvh/lidx/1	Cluster of Excellence "Tailor-Made Fuels from Biomass" (TMFB) at University of Aachen	research institution	**Germany**
http://www.gru.edu/	Biological Safety Office - Georgia Regents University	research institution	**USA**
http://www.news.gatech.edu/	Georgia Tech	research institution	**USA**
http://www.utexas.edu/	The University of Texas	research institution	**USA**
http://www.nrel.gov/	National Renewable Energy Laboratory (NREL)	research institution	**USA**
http://geography.exeter.ac.uk/research/groups/nambio/	University of Exeter - NAMBIO group	research institution	**UK**
http://dbtindia.nic.in/index.asp	Department of Biotechnology (DBT)	research institution	**India**
http://www.kuleuven.be/english	KU Leuven - Faculty of Bioscience Engineering (FBSE)	research institution	**Belgium**
http://www.bsse.ethz.ch/bel	ETH Zürich - Bio Engineering Laboratory	research institution	**Switzerland**
http://www.ugent.be/bw/en	Faculty of Bioscience Engineering (FBE) of Ghent University	research institution	**The Netherlands**
http://tricities.wsu.edu/	Washington State University	research institution	**USA**
http://www.colorado.edu/	University of Colorado Boulder	research institution	**USA**
http://www.hzg.de/index.html.en	Helmholtz-Zentrum Geesthacht	research institution	**Germany**
http://www.cmu.edu/index.shtml	Carnegie Mellon University	research institution	**USA**
http://www.ucl.ac.uk/sts	University College London - Department of Science and Technology Studies	research institution	**UK**
http://www.epsrc.ac.uk/	Engineering and Physical Sciences Research Council	research institution	**UK**
http://biomechanics.berkeley.edu/	University of California, Departments of Bioengineering and Mechanical Engineering	research institution	**USA**
www.lbl.gov/	Berkeley Lab	research institution	**USA**
https://www.amacad.org/default.aspx	American Academy of Arts and Science	research institution	**USA**

3.3 Engagement in Science and Technology, Responsible Research or Ethics in general

research institution	21	17%
project	16	13%
gov. institution	15	12%
other institution	14	12%

Actors and arenas that were more engaged in Science and Technology in general were labelled with research institution, project, governmental or other institution alike. Many EU projects concerning technological progress or involvement of the public in the agenda setting process are included in that list. Other projects and research institutions were more involved in ethical issues or responsible research.

http://www.aka.fi	Academy of Finland	research institution	**Finland**
http://www.tfrc.org.uk/	Textile Futures Research Centre	research institution	**UK**
http://www.bbsrc.ac.uk/home/home.aspx	Biotechnology and Biological Sciences Research Council (BBSRC)	research institution	**UK**
http://www.agence-nationale-recherche.fr/en/	The French National Research Agency	research institution	**France**
http://www.pratt.duke.edu/	Duke University - Pratt School of Engineering	research institution	**USA**
http://www.memphis.edu/	Office of Environmental Health and Safety - University of Memphis	research institution	**USA**
http://researchcompliance.iu.edu/	Indiana University - Office of Research	research institution	**USA**
http://ehs.georgetown.edu/	Georgetown University - Office of Environmental Health & Safety	research institution	**USA**
http://research.uncc.edu/	UNC Charlotte - Research & Economic Development	research institution	**USA**
https://www.admin.ox.ac.uk/	University of Oxford	research institution	**UK**
http://www.hioa.no/eng/Research-and-Development/Our-research/Research-groups/The-Oslo-Research-Group-on-	The Oslo Research Group on Responsible Innovation	research institution	**Norway**

Responsible-Innovation			
http://www.pnnl.gov/	Pacific Northwest National Labortory	research institution	**USA**
http://orrp.osu.edu/	Office of Responsible Research Practices - Ohio State University	research institution	**USA**
http://www.compliance.iastate.edu/	Iowa State University	research institution	**USA**
https://sts.univie.ac.at/en/home/	University of Vienna - Department of Science and Technology Studies	research institution	**Austria**
http://www.bep.ox.ac.uk/home	University of Oxford's Faculty of Philosophy - Institute for Science and Ethics	research institution	**UK**
http://www.bristol.ac.uk/	University of Bristol - Faculty of Science Research Ethics	research institution	**UK**
http://www.neuroethics.ox.ac.uk/	The Oxford Center of Neuroethics	research institution	**UK**
https://ibmb.unibas.ch/home/	University of Basel, Institute for Biomedical Ethics	research institution	**Switzerland**
https://kennedyinstitute.georgetown.edu/	Georgetown University- Kennedy Institute of Ethics	research institution	**USA**
http://corporateeurope.org/	Corporate Europe Observatory	research institution	**EU**

3.4 Potential multipliers to make the topic more prominent in the general public

media	200	75%
blog	25	9%
other institution	9	3%
website	8	3%

The "potential multipliers" are to three-quarters media websites. Those have generally a wide reach and "speak" a more citizen-orientated language. The websites are quite diverse in their own thematic focus; some are general news platform like BBC or The Guardian while others follow a more specific tenor, for example Science Daily or Geek.com.

http://www.newscientist.com	New Scientist	media	**UK**
http://www.independent.co.uk/	The Independent	media	**UK**
http://www.livescience.com	LiveScience	media	**International**
http://www.sciencechannel.com	Science	media	**USA**
http://www.csmonitor.com	The Christian Science Monitor	media	**International**
http://www.ft.com	The Financial Times	media	**International**
http://onpoint.wbur.org	NPR's Onpoint	media	**USA**
http://discovermagazine.com	Discover (magazine)	media	**USA**
http://online.wsj.com	The Wall Street Journal	media	**USA**
http://www.theguardian.com	The Guardian	media	**International**
http://www.bbc.com	British Broadcasting Corporation (BBC)	media	**UK**
http://www.abc.net.au	Australian Broadcasting Corporation (ABC)	media	**Australia**
http://www.blastr.com/	blastr	media	**USA**
http://www.popularmechanics.com/	Popular Mechanics	media	**USA**
http://www.nature.com/	nature.com	media	**USA**
http://www.the-scientist.com	The Scientist: Magazine of Life Sciences	media	**International**
http://www.bbc.co.uk	BBC	media	**UK**
http://www.economist.com/	The Economist	media	**UK**
http://www.reuters.com/	Reuters	media	**UK**
http://www.livescience.com/	LiveScience	media	**International**
http://www.dailymail.co.uk	MailOnline	media	**USA**
http://www.thewire.com/technology/	The Wire	media	**USA**

http://www.nbcnews.com/science	NBC News	media	**International**
http://www.nationalgeographic.com/	National Geographic	media	**USA**
http://www.technologyreview.com	MIT Technology Review	media	**USA**
http://www.theguardian.com	The Guardian	media	**International**
http://guardianlv.com	Guardian Liberty Voice	media	**International**
http://www.nature.com/	http://www.nature.com/	media	**USA**
http://www.newscientist.com/	New Scientist	media	**UK**
http://www.bbc.com/	British Broadcasting Corporation	media	**International**
http://www.engineering.com	ENGINEERING.com	media	**International**
http://www.technologyreview.com	MIT Technology Review	media	**USA**
http://www.zeit.de	Die Zeit	media	**Germany**
http://www.heise.de	Heinz Heise	media	**Germany**
http://www.nationalgeographic.com/	National Geographic	media	**USA**
http://www.wired.co.uk/	wired	media	**International**
http://www.reuters.com/	Reuters	media	**UK**
http://www.theguardian.com	The Guardian	media	**International**
http://www.bio-itworld.com	Bio-ITWorld.com	media	**International**
http://www.xconomy.com/	Xconomy	media	**USA**
http://cen.acs.org/index.html	Chemical & Engineering News (C&EN)	media	**USA**
http://www.space.com	Space.com	media	**International**
http://www.zeit.de	Die Zeit	media	**Germany**
http://www.zeit.de	Die Zeit	media	**Germany**
http://www.heise.de	Heinz Heise	media	**Germany**
http://www.thedailybeast.c	The Daily Beast	media	**International**

om			
http://www.golem.de	Golem.de	media	**Germany**
http://brighterbrains.org	BrighterBrains.org	media	**International**
http://www.popsci.com	Popular Science (PopSci)	media	**USA**
http://www.bbc.com/	British Broadcasting Corporation	media	**International**
http://www.policymic.com	PolicyMic	media	**International**
http://mashable.com	Mashable	media	**International**
http://www.reuters.com/	Reuters	media	**UK**
http://topinfopost.com/	Top Information Post	media	**UK**
http://www.independent.co.uk/	The Independent	media	**UK**
http://rt.com/	RT	media	**Russia**
http://www.nytimes.com	New York Times (NYT)	media	**USA**
http://www.nbcnews.com	NBC News	media	**USA**
http://www.popsci.com	Popular Science (PopSci)	media	**USA**
http://www.dailymail.co.uk	MailOnline	media	**USA**
http://www.technology.org	The Technology Org website	media	**International**
http://www.gizmag.com/	Gizmag	media	**International**
http://timesofindia.indiatimes.com/home/science	Times of India	media	**India**
http://www.ft.com	The Financial Times	media	**International**
http://www.wissensschau.de/index.php	wissenschau.de	media	**Germany**
http://www.wissensschau.de/index.php	wissenschau.de	media	**Germany**
http://www.heise.de	Heinz Heise	media	**Germany**
http://www.newscientist.com/	New Scientist	media	**USA**
http://www.wired.co.uk/	wired	media	**International**
http://www.independent.co.uk/	The Independent	media	**UK**
http://www.foxnews.com	Fox News	media	**USA**

http://www.reuters.com/	Reuters	media	**UK**
http://www.theverge.com	The Verge	media	**USA**
http://www.nbcnews.com	NBC News	media	**USA**
http://www.nature.com/	http://www.nature.com/	media	**USA**
http://www.bbc.com/	British Broadcasting Corporation	media	**International**
http://www.the-scientist.com	The Scientist: Magazine of Life Sciences	media	**International**
http://www.gizmag.com/	Gizmag	media	**International**
http://www.sciencedaily.com	Science Daily	media	**USA**
http://www.nationalgeographic.com/	National Geographic	media	**USA**
http://www.dailymail.co.uk	MailOnline	media	**USA**
http://www.smh.com.au	Sydney Morning Herald (SMH)	media	**Australia**
http://cleantechnica.com/	CleanTechnica	media	**USA**
http://www.medicalnewstoday.com/	Medical News Today (MNT)	media	**UK**
http://www.dw.de/about-dw/who-we-are/s-3325	Deutsche Welle	media	**Germany**
http://www.telegraph.co.uk/	The Daily Telegraph	media	**International**
http://www.nytimes.com	New York Times (NYT)	media	**USA**
http://www.redorbit.com/	RedOrbit.com	media	**USA**
http://www.huffingtonpost.com	Huffington Post	media	**USA**
http://www.nationalgeographic.com/	National Geographic	media	**USA**
http://grist.org	Grist	media	**USA**
http://www.bbc.com/	British Broadcasting Corporation	media	**International**
http://www.kqed.org/	KQED	media	**USA**
http://www.vancouversun.com	Vancouver Sun	media	**Canada**
http://www.dailymail.co.uk	MailOnline	media	**USA**

http://www.livescience.com/	LiveScience	media	**International**
http://www.sciencedaily.com	Science Daily	media	**USA**
http://www.nytimes.com	New York Times (NYT)	media	**USA**
http://www.rsc.org/chemistryworld/	Chemistry World	media	**EU**
http://www.wired.co.uk/	wired	media	**International**
http://www.geek.com/	Geek.com	media	**International**
http://hereandnow.wbur.org/	Here & Now	media	**USA**
http://online.wsj.com/	The Wall Street Journal	media	**USA**
http://rt.com/	RT	media	**Russia**
http://www.nytimes.com	New York Times (NYT)	media	**USA**
http://www.theguardian.com	The Guardian	media	**International**
http://www.foxnews.com	Fox News	media	**USA**
http://www.pbs.org/	Public Broadcasting Service	media	**USA**
http://www.timeshighereducation.co.uk	Times Higher Education (THE)	media	**UK**
http://www.relevantmagazine.com	RELEVANT	media	**USA**
http://www.theguardian.com	The Guardian	media	**International**
http://www.smh.com.au/	The Sydney Morning Herald	media	**Australia**
http://www.psmag.com/	Pacific Standard	media	**USA**
http://www.theverge.com	The Verge	media	**USA**
www.abqjournal.com/	Albuquerque Journal	media	**USA**
http://www.cnet.com/	cnet	media	**USA**
http://www.sciencedaily.com	Science Daily	media	**USA**
http://www.sciencedaily.com	Science Daily	media	**USA**
http://www.wired.co.uk/	wired	media	**International**

http://www.rsc.org/chemistryworld/	Chemistry World	media	**EU**
http://www.rsc.org/chemistryworld/	Chemistry World	media	**EU**
http://hplusmagazine.com/	h+	media	**International**
http://eandt.theiet.org/	Engineering and Technology Magazine	media	**USA**
http://www.newsobserver.com/	& Newsobserver	media	**USA**
http://www.rsc.org/chemistryworld/	Chemistry World	media	**EU**
http://www.the-scientist.com	The Scientist: Magazine of Life Sciences	media	**International**
http://www.redorbit.com/	RedOrbit.com	media	**USA**
http://guardianlv.com/	Guardian Liberty	media	**USA**
news.discovery.com	Discovery News	media	**USA**
http://www.livescience.com/	LiveScience	media	**International**
http://www.businessweek.com/	Bloomberg Businessweek	media	**USA**
http://www.cnet.com/	cnet	media	**USA**
http://www.wissensschau.de/index.php	wissenschau.de	media	**Germany**
http://www.european-biotechnology-news.com/	European Biotechnology News	media	**Europe**
http://www.nanowerk.com/	Nanowerk	media	**International**
http://www.nature.com/	nature.com	media	**USA**
http://www.rsc.org/	Chemistry World	media	**EU**
http://www.hngn.com/	Headlines & Global News	media	**USA**
http://www.the-scientist.com	The Scientist: Magazine of Life Sciences	media	**International**
http://www.natureworldnews.com/	Nature World News	media	**USA**
http://www.bio-itworld.com/	Bio-IT World	media	**USA**

http://indianexpress.com/	The India Express	media	**India**
http://www.iol.co.za/	IOL	media	**South Africa**
http://bionews-tx.com/	BioNews Texas	media	**USA**
http://www.scidev.net/global/	SciDev.Net'	media	**UK**
http://www.cbrneportal.com/	CBRNePortal.com	media	**USA**
http://www.collective-evolution.com/	Collective Evolution	media	**USA**
http://www.asiabiotech.com/	Asia Pacific Biotech News (APBN)	media	**International**
http://www.genengnews.com/	Genetic Engineering & Biotechnology News	media	**USA**
http://www.sciencebuzz.org/	ScienceBuzz	media	**USA**
http://www.medicaldaily.com/	Medical Daily	media	**International**
http://www.the-scientist.com	The Scientist: Magazine of Life Sciences	media	**International**
http://www.sciencedaily.com	Science Daily	media	**USA**
http://www.biofuelsdigest.com/	Biofuels Digest	media	**USA**
http://www.chemweek.com/home/	Chemical Week	media	**USA**
http://biotechnologyfocus.ca/	Biotechnology Focus	media	**Canada**
http://www.nbcnews.com/science/cosmic-log	NBC Cosmic Log News	media	**USA**
news.discovery.com	Discovery News	media	**USA**
http://www.sovereignindependentuk.co.uk/	Sovereign Independent UK	media	**UK**
http://www.cbrneportal.com/	CBRNePortal.com	media	**USA**
http://www.isciencemag.co.uk/	I, Science	media	**UK**
http://www.foreignaffairs.com/	Foreign Affairs	media	**International**

http://www.sciencenewsline.com/	ScienceNewsline	media	Japan
http://www.economist.com/	The Economist	media	UK
http://www.eureporter.co/	EU Reportr	media	International
http://www.wired.com	wired	media	International
http://www.eurekalert.org/	EurekAlert!	media	International
http://www.siliconrepublic.com/	siliconrepublic	media	Ireland
http://www.examiner.com/	Examiner.com	media	USA
http://www.biofuelsdigest.com/	Biofuels Digest	media	USA
http://www.laborwelt.de/	Laborwelt	media	Germany
http://www.telegraph.co.uk/	The Daily Telegraph	media	International
http://www.energypost.eu/	EnergyPost	media	EU
http://www.economist.com/	The Economist	media	UK
http://www.theguardian.com	The Guardian	media	International
http://www.bbc.com/	British Broadcasting Corporation	media	International
http://whyfiles.org/	Why Files	media	USA
http://www.reuters.com/	Reuters	media	UK
http://www.taz.de/	Die Tageszeitung	media	Germany
http://buzz.naturalnews.com/	Buzz.NaturalNews	media	USA
http://www.livescience.com/	LiveScience	media	International
http://www.bbc.com/	British Broadcasting Corporation	media	International
http://www.nytimes.com	New York Times (NYT)	media	USA
http://www.scientificamerican.com/	Scientific America	media	USA
http://www.sciencedaily.com	Science Daily	media	USA

http://www.bio-itworld.com/	Bio-IT World	media	**USA**
http://www.euroscientist.com/	EuroScientist	media	**Europe**
https://answers.yahoo.com/	Yahoo! Answer	media	**USA**
http://www.nature.com/	nature.com	media	**USA**
http://www.sciencenewsline.com/	ScienceNewsLine	media	**USA**
http://www.livescience.com/	LiveScience	media	**International**
biomassmagazine.com/	Biomass Magazine	media	**International**
http://www.bioportfolio.com/	BioPortfolio.com	media	**USA**
http://www.topix.com/	Topix	media	**USA**
http://phys.org/	Phys.org	media	**USA**
www.scientificamerican.com/	Scientific American	media	**USA**
http://www.feedthegrid.net/	FeedtheGrid	media	**International**
http://aeon.co/magazine/	Aeon Magazine	media	**UK**
www.wired.com	wired	media	**International**
www.popsci.com	Popular Science	media	**USA**

3.5 Concept of addressing relevant multipliers

The first mission, to find relevant „speakers", was just the first step. Next, it should be evaluated how those stakeholders can be addressed in order to create incentives to make them participate in the SYNENERGENE project or to engage other contacts in the discourse about SynBio.

The concept is structured after the different types of actors and online-spaces as they represent different interest groups that have to be addressed accordingly. It has to be taken into account that the following measures are recommendations above all. There may be some adjustments when they are translated into an action plan.

Media

Actors in the area of the media are usually interested in concrete events. The following measures are therefore suggested to target the actors and multipliers in the section „media":

- Define a concrete event within the SYNENERGENE project that is newsworthy.

- Formulate a press release including a description of the project.

- Publish an interview with Christopher Coenen (KIT): "Why should Synthetic Biology play a more important role in public discourse?" Send this interview to the media, ideally combined with a concrete event.

- Media in different countries may have to be targeted in different languages. Partners can be involved in the translation of a press release or the interview.

Research institutions, governmental institutions and other institutions

Institutions of all kinds are the most engaged actors in synthetic biology and neighbouring scientific fields. Some of them are pure research facilities while others may be interested in or assigned to foster the dialogue between science and politics or the public. Therefore, there are quite interesting actors to be found that can contribute to the SYNENERGENE or MMLAP goals in various ways and from various perspectives. The Science Science Café Wageningen, for example, is an original format to engage people in a scientific conversation:

> *"What is a Science Café? Well, it's definitely not an obligatory monologue in a bulb-lighted college room. Rather it's an informal meeting between scientists and those who love science, or who love to debate the impact of science on our society. So: in a cafe, with live music, and with a moderator for a lively debate. And if you are not inspired, you can leave whenever you want…"*
> (comp. http://sciencecafewageningen.nl/what-is-a-science-cafe/

Other inspirations or cooperation could be drawn from institutions that combine different parts of science and society like the "Finnish Bioart Society" or the "Waag Society, institute for art, science and technology".

- Connect the institutions to the respective open fora. Discuss together with the open fora leaders how these institutions can be involved. If there are any already existing connections between partners of the SYNENERGENE consortium and stakeholders listed in the database, those connections should be utilized.

- Formulate a letter including information about the project and ways how these institutions can get involved. Ideally the institutions should be addressed directly by the open fora leaders.

- The letter should also include the suggestion to a) register on SYNENERGENE.eu and post blog articles, to b) comment other articles and to c) follow SYNENERGENE on twitter.

- Institutions that are not already actively engaged in synthetic biology should be addressed individually in a way that they understand the relevance of the topic for their own work.

- Research institutions that are already engaged in synthetic biology can also be invited to use the repository of stakeholders to perform their own analyses

- Perform a deeper analysis which formats or ideas for engaging with the public can be copied in the SYNENERGENE project or may be utilised in cooperation with the respective institution

Education

Educating the public about synthetic biology or neighboring scientific fields like biotechnology is the precursor for a profound public debate. During the web analysis, some websites for self-education occurred that provide a range of online-material on various scientific topics. "Moleclues", a website that offers a lot of videos regarding molecular science, or "iBiology", which offers free seminars on biological topics, are only two examples of other interesting education websites. Those already existing platforms should be promoted by the SYNENERGENE project if found appropriate. Maybe even partners of the consortium could contribute materials or learning videos.

- Provide links to appropriate education platforms on SYNENERGENE.eu
- Approach the operator of the website and offer own materials or videos
- Perform a deeper analysis of youtube channels that have a greater reach and address a younger audience (e.g. "asapscience" with more than a million views per video)

Blog

Bloggers should be addressed individually by e-mail. Mostly they represent individuals that enjoy the public's trust as they are usually not following a political or commercial interest.

- They should be invited to blog on the SYNENERGENE online platform, to integrate the SYNENERGENE banner on their website, to follow SYNENERGENE on twitter, to integrate our blog in their blog via RSS.
- The editorial management of the SYNENERGENE platform could formulate an own blogpost to summarize and promote interesting blogs.

Forum

Forums are platforms on which diverse perspectives are shared and discussed. It would be very helpful to foster own discourses on the forums identified and analyze the public debate. "Yahoo Answers", for example, is a much consulted page for every day mysteries as well as specific questions on scientific research. More science focused forums are for example DIYbio.org or Sciforums.com.

- The SYNENERGENE-Website should be promoted in online forums with the help of a short forum post, ideally with and interesting question and a link to our blog section. As this might raise ethical questions, a more discreet approach would be for SYNENERGENE partners who engage in such forum discussions to use a footer in their messages that includes a link to the SYNENERGENE website.

Company

Companies that manufacture synthetic biology products feel apparently uncertain about how to deal with SynBio in their communication with consumers. Some companies actively promote products involving synthetic biology as innovative, even long before they are actually available on the market, e.g. Shamees Aden's 3D-printed, regenerative running shoes (comp. http://www.dezeen.com/2014/02/19/movie-shamees-aden-protocells-regenerating-trainers/). Some companies are reluctant to use terms like synthetic biology, fearing that doing so would

ward off potential customers (cf. www.nytimes.com/2014/05/31/business/biofuel-tools-applied-to-household-soaps.html). It will be interesting to engage with both sorts of companies and get to know how they feel they are perceived by the public or how they think the scientific agenda on synthetic biology will or should develop.

- Companies offering synthetic biology products as well as companies offering products based (at least to a certain degree) on synthetic biology products or processes can be invited to participate in the Open „Business" Fora.

Network

Different networks found on the web connect various actors from several fields of science of society all over the world. Those networks are brilliant multipliers. Mostly they are engaged in learning processes or special objectives like "The Science Network" (TSN)

"The mission of The Science Network (TSN) is to build an online science and society agora, or public square, dedicated to the discussion of issues at the intersection of science and social policy. By engaging a diverse community of concerned constituencies in conversation, on and offline through signature meetings, video programming, and in developing partnerships with public television stations, TSN is creating a scientific no-spin zone - a trusted destination free from the tyranny of the sound bite." (comp. http://thesciencenetwork.org)

- Identify an appropriate partner of the SYNENERGENE consortium to approach member of the respective network personally.
- Invite members of the networks to SYNENERGENE events like the Open Fora.

Events

Since the investigation time of the web analysis is set in the past, most of the events found are already terminated. Nevertheless, some of them are reoccurring events that can be of interest in the following year. The list of all events can be looked up in the appendix. Moreover, those will be made available on the SYNENERGENE platform for all partners.

Projects

Various projects could be found during the web analysis. Some of them have an apparently similar mission to the SYNENERGENE project like the German project "Forschungswende":
"Civil society organizations are important pioneers in the transition to a participatory and transparent scientific and research culture. The platform "Forschungswende" supports the discourse of science in civil society organizations and between CSOs, academia and politics."
http://www.forschungswende.de/index.php

The consortium should network with such projects since they already have many contacts in the respective countries all over Europe. Other projects had a more specific mission, like monitoring the development in the field of genetics (www.gentechnologiebericht.de). All in all, it should be identified how synergies can be found to promote each other's work. Therefore, personal contacts should be established.

- They should be invited to blog on the SYNENERGENE online platform, to integrate the SYNENERGENE banner on their website, to follow SYNENERGENE on twitter, to integrate our blog in their project newsroom via RSS, at least if that corresponds to their established communication strategy.

- If projects host an interesting event, partners from the SYNENERGENE project could attend and network with other interesting stakeholders

Website

Some findings in the web analysis could not be put into a special category. Those websites have different purposes; many attempt to disseminate information on synthetic biology, biotechnology or similar fields of science. "GetSynBio", for example, is open for everyone's "[…] own research, a cool video, an upcoming event or anything else SynBio" (comp. http://www.getsynbio.com/9436-2/). It has to be checked, however, whether such websites simply work as "link farms" to promote other websites for a fee.

- Use the contact form to send out information about the SYNENERGENE project

4   Part 2: Analysis of "talk" or discourse

The presented results from the data mining of synthetic biology online texts, is a result of a collaboration between Zebralog and SDU within the SYENERGENE project. In this context, the purpose of our data mining is to extract some rudimentary facts about the content of the conversation in these texts.

Compiling word frequencies from single words, a sequence of words (also called n-grams) is one of the simplest automated ways to obtain insight about the content of the text. A frequency analysis is simply done by counting how many times specific words or n-grams occur in a given range. When it is known how many times each word or n-gram occurs, the data can be sorted such that it is possible to see which words are most frequently used. This will likely indicate which topics are mentioned, or thought of the most. Filtering (removing) common words necessary for sentence construction is usually applied, to get rid of non-informative words, the so-called stop words.

Word frequency analysis is a low level parsing procedure, with almost no parsing and thus relatively easy to conduct. The interpretation is totally relying on the person who reads the results.

However, counting words and n-grams from natural language text is not trivial as one should think, because of the necessary pre-processing of the texts, which we shall discuss in the next section, where we conduct a n-gram analysis of the online SynBio repository.

More sophisticated automated text analysis is also possible. For example, it is possible to determine whether a text is mainly negative or mainly positive towards a given topic. Sentiment

analysis is an example of such a method. A feasibility study of this method in connection to the SynBio online repository is discussed in the following section.

Sentiment analysis seeks to draw judgment from the overall emotional feeling expressed, or associated with, the text. Automated sentiment analysis done by a computer can be more or less objective than a personal analysis, depending on how well the computer is trained. Training is called supervised leaning and is also done by a person. Supervised learning is basically giving the learning algorithm a set of sentiment data, which are already recognized (classified) to have a certain sentiment value. This can i.e. positive or negative if that is what needs to be accessed. So the quality and relevance of the analysis is very dependent on the quality and quantity of the classified dataset provided as well as the method (algorithm) by which the learning system is trained.

An advantage of computerized sentiment analysis is that it can be plentiful, reproducible and consistent in its sentiment classification, since it uses the same method on all subjects. Results can be compared with equal reference. Sentiment analysis can be a high level language parsing procedure, depending on the amount and complexity of preprocessing of the learning data sets, and it is usually quite complicated and time consuming to conduct automated sentiment analysis.

All results and details (data and code) for conducting the computational analysis are provided. For more details (raw data and code) please see: http://flint.sdu.dk/index.php?page=data-mining

4.1 Word frequency and n-gram analysis

Word frequency (also called n-gram) analysis is one of the simplest means to obtain information about the content of a text. It is done through a combination of data mining and text processing. In this case we have (i) downloaded text (data) from Internet sources, (ii) processed and stripped the text of irrelevant words (data) and (iii) counted the remaining word occurrences.

For the data mining we have used the software package RapidMiner version 5.3.015 (free edition)

https://rapidminer.com/, with the extensions; "Web mining" and "Text mining".

(i) Data Import

The needed data is provided through a large excel table of links and their metadata created by Zebralog. For the data import and processing we have used the data mining software tool Rapid Miner (RM). RM is not trivial to use as it has many options (buttons to push and dials to turn), so it is important to choose the right names, labels and id's for the attributes and values that comprise the data, when importing the data to RM. A snippet of the large excel sheet is seen in Figure 1.

	B	C	D	E	F	G	H	I	J	K
1	Link	Query	searc	short URL	type of we	Name	type of organis	country	short info	field
2	http://syntheticbiology	synthetic	manual	http://syntheti	Online-Space	*Synthetic*	network	USA	We are a grou	actively engaged in the discourse on synthetic biology
3	http://www.helmholtz.c	synthetic	manual	http://www.he	Actor	*Helmholtz-*	research institution	Germany	Die Helmholtz	actively engaged in the discourse on synthetic biology
4	http://www.synbioproje	synthetic	manual	http://www.sy	Actor	*Woodrow*	project	USA	The Synthetic	actively engaged in the discourse on synthetic biology
5	http://synbio.mit.edu/	synthetic	manual	http://synbio.r	Actor	*Massachus*	research institution	USA	The goal of sy	actively engaged in the discourse on synthetic biology

Figure 1. The data is provided in an extensive excel table of links and their metadata created by Zebralog. A snippet of this excel file is shown here. This file defines our data import.

In RM the Data Import is done by the Read Excel operator, where the operator's parameters must be chosen according to the data and as needed. For example the "Link" column represents a

"file_path" in RM speak, a directory of where to find the data to be processed, see Figure 1. Figure 2 shows the overall process of the mining and text processing in RM.
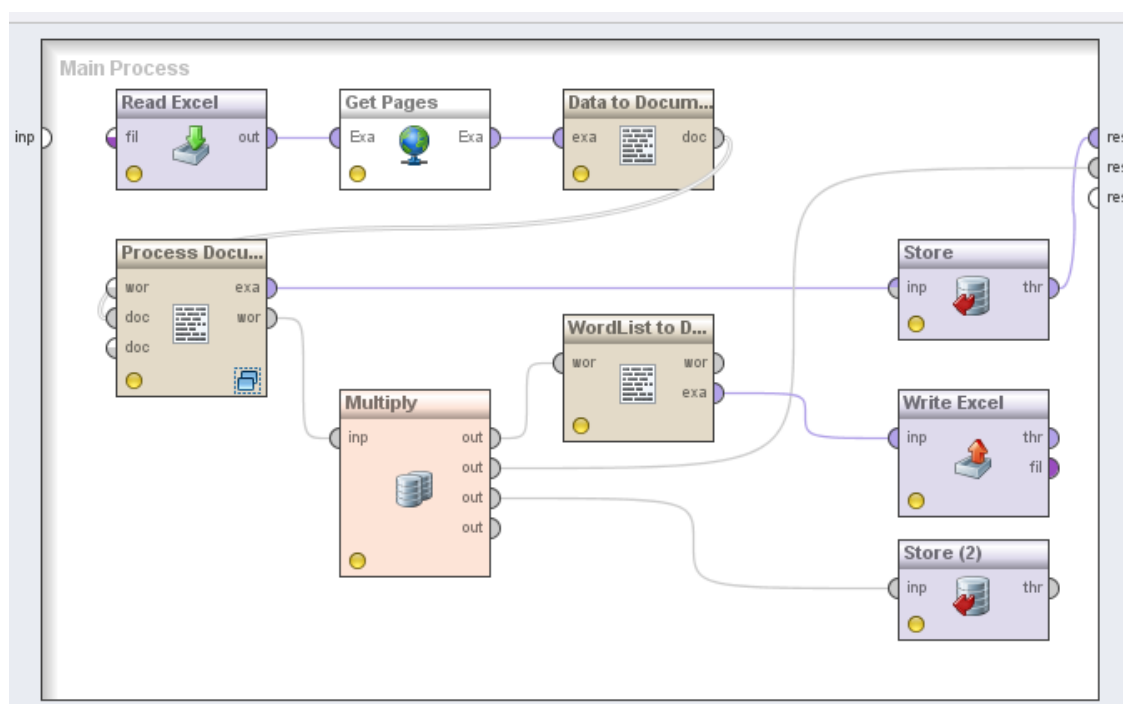
(ii) Data Processing

The overall process shown in Figure 2 is composed of a number of operations in RM:

Figure 2(a) After RM reads the excel table (Read Excel), it connects to the website and downloads all the data (Get Pages) of the specific websites in html code. This data is then transformed into another type of data called "document" (Data to Document) in order for RM to work, since the next process expects that format.

The next operator (Process Document) is a so called nested process, which has underlying levels. These underlying levels are shown in Figure 2(b). It is essentially here, the bulk of the text processing happens (Process Document). As a result of the processing, two data sets are produced, one called "exampleset" (abbr: exa) and another called "WordList" (abbr: wor). The exampleset is then stored (Store) and shown as a result of the overall process (res).

(a)

(b)
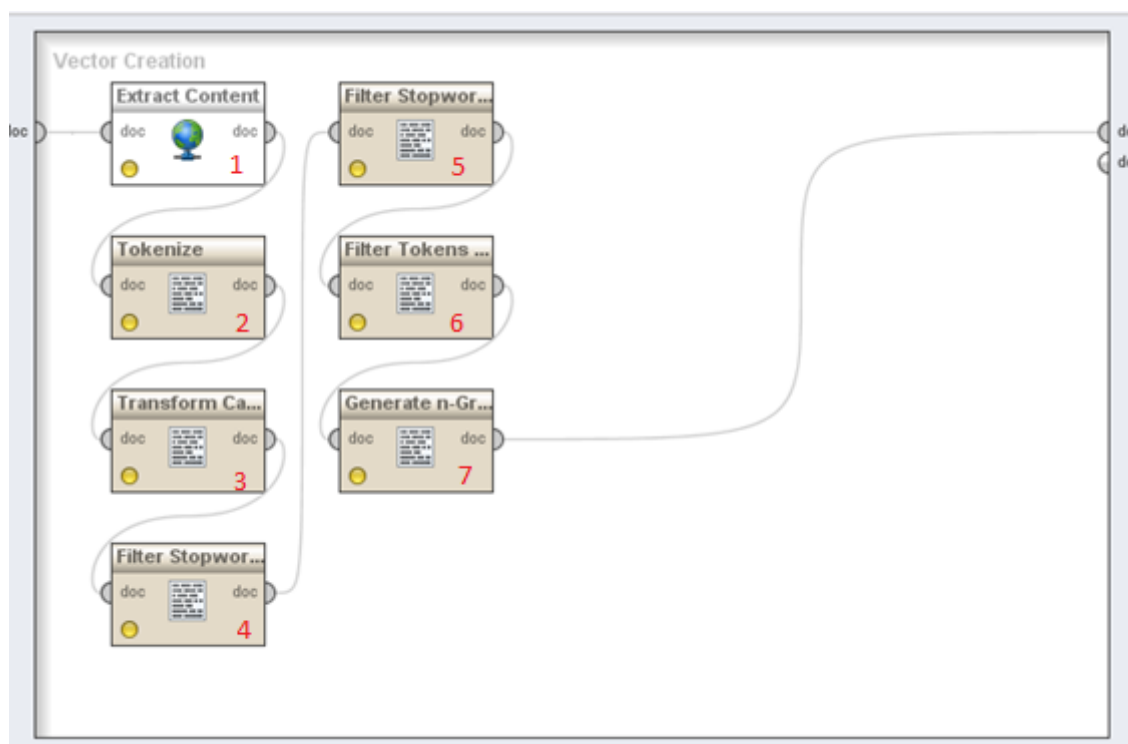
Figure 2 (a). Overall data process flow. The details of the successive text processing operations may seem a bit complicated, but the overall process is simple: (i) access data; (ii) clean data from irrelevant words, which are words used in any natural language text and/or reducing the amount of noise by sifting the data through several filters; finally (iii) count frequencies of remaining words or composition of words. Examples of words removed from the document include "and", "or", "I", "you", "at" etc. (b) Details of the nested process under Process Document in (a).

The wordlist output (wor) of Process Documents is multiplied to three outputs (Multiply), simply because it is easier to track the overall process. Top output (from multiply) is converted to document format (WordList to Document), because the "Write Excel" operator expects that input. The Wordlist is then written to an Excel file (Write excel). Middle output (from multiply) is connected to the result display of the overall process (res sink). Bottom output is connected to the "store(2)" operator, for later retrieval in Rapid Miner.

It is from the Excel data set we can generate the word frequencies in Figure 3, 4, 5 and 6.

The details of the nested data processing under Process Document in Figure 2(a) are shown in Figure 2(b) and follows here.

The first filter (Extract Content (1)) looks at the HTML code of the websites, and only allows blocks of text longer than five words though. It only extracts the text in HTML tags, which signify that they contain the main textual content such as <p> for paragraph etc. In that way no website related code should go into the analysis.

Then all the strings of text are cut into individual words called tokens in RM lingo (Tokenize (2)). Uppercase tokens are transformed to lowercase characters (Transform Cases (3)). Stop words (such as the, is, at, which, and on) are filtered off (Filter Stopwords English (4)). Since there are also some German webpages in our analysis, also German stop words are filtered (Filter Stopwords German (5)).

Then the tokens are filtered by their length (Filter Tokens by Length (6)), so that only tokens equal or above three characters are included. Finally, n-grams are created (Generate n-Grams (7)) for the tokens that appear in the same order more than seven times, since seven times is the lowest frequency specific tokens must have in order to be included in the list, a setting that can be chosen as a preference.

(iii) Word (1-gram) and n-gram frequencies

Figure 3 shows the thirty most frequently used single words – or 1-grams - in all of the analyzed websites as well as within how many different documents they occur. "Synthetic" and "biology" are the most frequently used words in all the webpages, which is not surprising due to the fact that it is part of the name of the field researched in this work i.e. "synthetic biology". Whenever a website mentions it as a reference, it occurs. Also "synthetic" has been used frequently in the search queries, often combined with other words. Thus, in the displayed word frequencies we have not filtered out (removed) the approximately 60 search words used to identify the appropriate websites. We experimented with a variety of filters, but they all have disadvantages and finally decided to use the non-filtered word data.
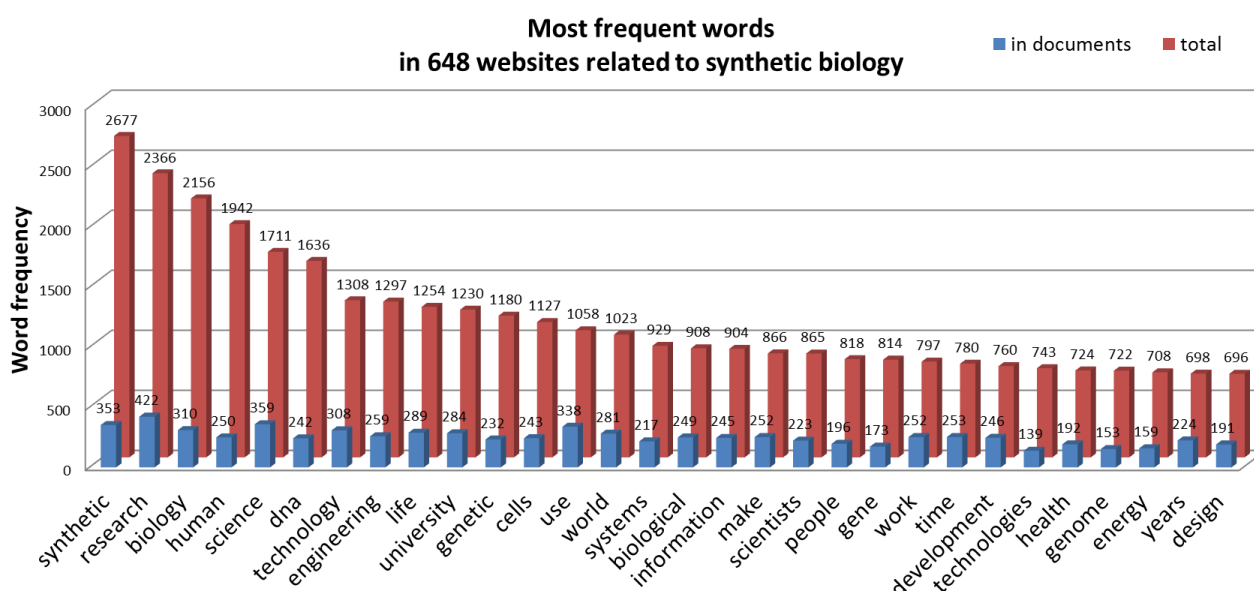
Figure 3 shows the 30 most frequently used words in all of the 648 analyzed website texts as well as in how many different documents (websites) they occur. For discussion see text.

It is interesting to note that just after "synthetic, biology, research, human, science and DNA", the words "technology" and "engineering" occurs, which indicates that SynBio indeed is an emerging field composed in part by biology and in of part by technology and engineering. It is also interesting to note that "university" is high on the list while words as "company", "patent" or "business" didn't even make the top-30 list. Thus, one can deduce that SynBio is still prevailingly an academic activity if we should only rely on these texts. It should also be noticed that e.g. "biology" and "biological" count for separately, while they probably should be pooled and the same could be said about "technology" and "technologies". To join nouns and adjectives we would need a different (and more complex) text preprocessing.

This simple analysis does not either tell whether the SynBio context is related to "human" or if it is the exact opposite "non-human", i.e. whether "human" is a frame-of-reference, or the opposite "non-human" is the frame reference. Such a distinction could have been made if we had kept

negating stop words in front of nouns and adjectives, which means a different (and more complex) pre-processing of the text.
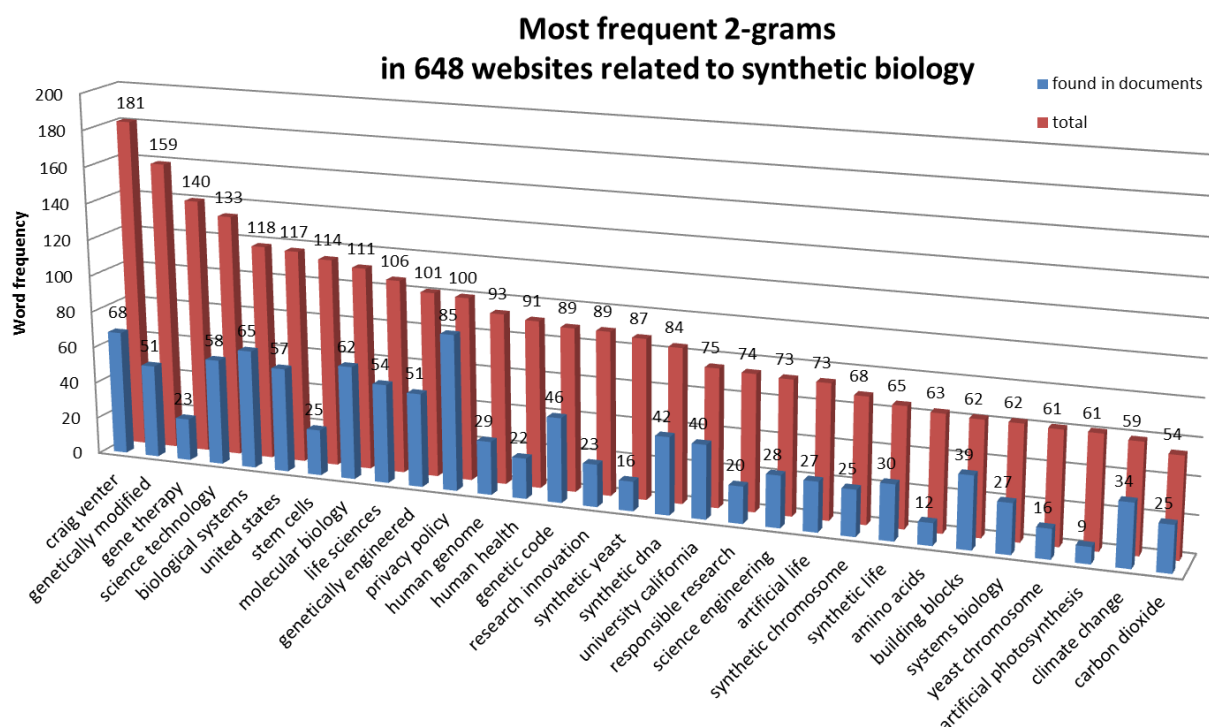
Most frequent 2-grams in 648 websites related to synthetic biology

Figure 4, shows the top-30 2-grams without "synthetic biology" and "genetic engineering" as they are outliers. For discussion see text.

The frequencies of double words, or 2-grams, are shown in Figure 4, where "synthetic biology" (SB) and "genetic engineering" (GE) and omitted to not obscure the structure of the following frequencies. SB and GE are significantly more frequent that any other 2-gram 1368 (in 209 text) and 345 (in 82 texts) respectively.

As "Craig Venter" is at the top in the 2-gram frequencies, we can deduce that many of the texts must be written by journalists and other SynBio non-experts. Craig Venter is definitely a critical player in the SynBio field, but so are George Church and Drew Andy just to mention two other famous top-down SynBio scientists, and none of them even made the top-30 list for the 2-grams. Craig Venter made major media headlines in 2010, where he announced that he had created the first synthetic organism, which the press ran with, and which was later denounced by the scientific community, including by Craig Venter himself. However, Craig Venter's team did make the first organism with an artificially synthesized full genome, which is a significant both scientific and engineering accomplishment.

It should be noticed that even if we filter (subtract) the 2-gram "Craig Venter" from the total number of 2-grams just as many times as we have used Craig Venter as a search 2-gram (same for the other 2-grams used as search words), Craig Venter is still the most frequently found 2-gram in these 628 texts as he is found in 68 of them.

Thus, we can deduce that many of these texts are very person-centric - and probably rather sensation seeking.

The top 2-grams also tells that many texts discuss SynBio applications e.g. "gene therapy", "stem cells", "human health", "artificial photosynthesis", "climate change" and "carbon dioxide". 2-grams

as "responsible research" and "research innovation" seem to indicate that societal and ethical issues are also included in the text discussions.

And geography matters for SynBio which can be seen from the 2-grams "united states" and "university (of) california", which indicate that the US is the leader in the SynBio research, which is indeed true.

Finally a technical issue should be noticed: the 2-grams start to pick up generic text from the websites as e.g. "privacy policy", which have nothing to do with the content of SynBio related texts.
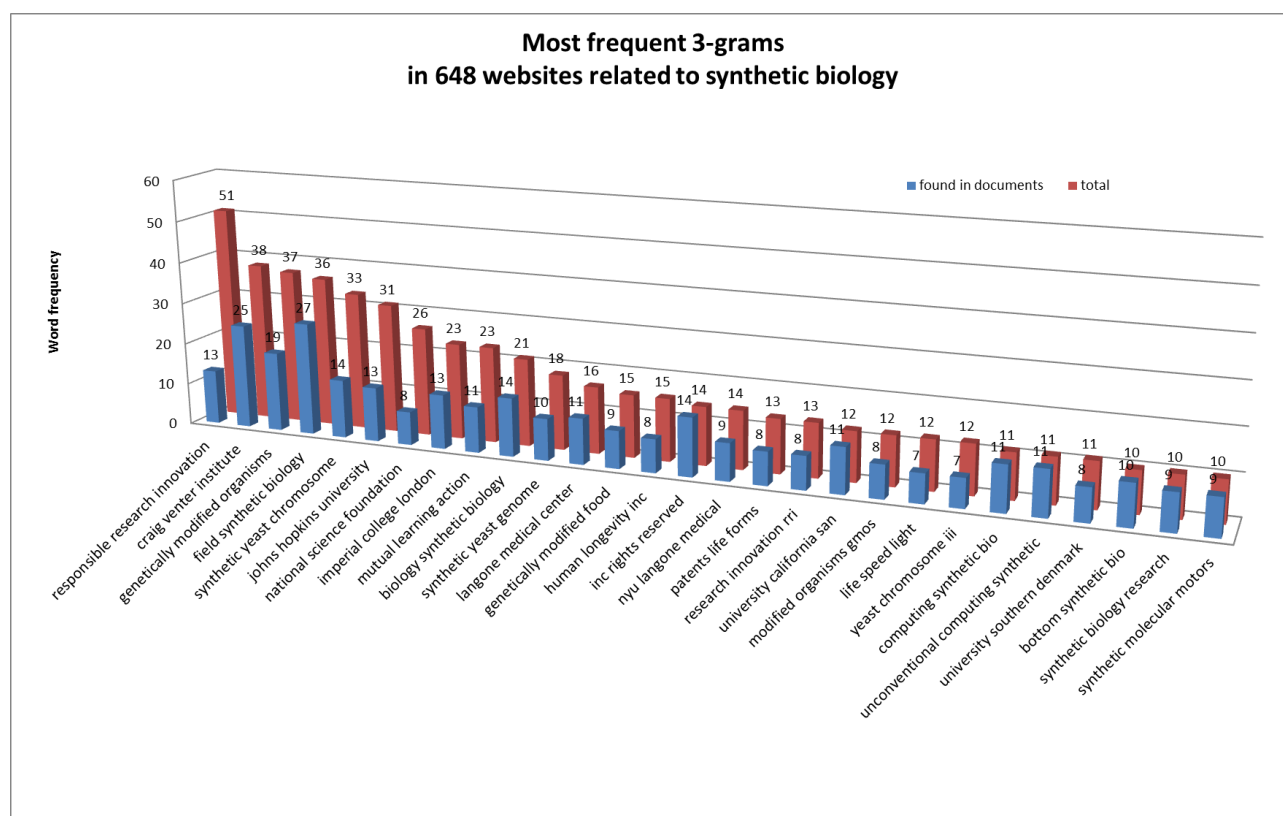
Figure 5 shows the top-30 3-grams from the texts. For discussion see text.

The 3-grams further support the findings from the 2-grams about many of the SynBio texts discussing "responsible research innovation" and "research innovation rri" as well as "patents life forms".

However, the most significant feature for these 3-grams is the emergence of the multiple SynBio locations and organizations. Such organizations (and locations) include: "craig venter institute" (US), "johns hopkins university"(US), "national science foundation" (US), "imperial college london"(EU), "langone medical center" + "nyu langone medical" (US), "university california san" (US), and "university (of) southern denmark"(EU).

Also a variety of SynBio applications are discussed in these texts as can be seen from: "genetically modified food", "human longevity inc", "modified organisms gmos" and probably "synthetic molecular motors".

It is in the 3-grams the clear bottom up SynBio activities as well as the SynBio underpinning information and communication technology (ICT) related activities are picked up. 3-grams include: "computing synthetic bio", "unconventional computing synthetic" and "bottom (up) synthetic bio".

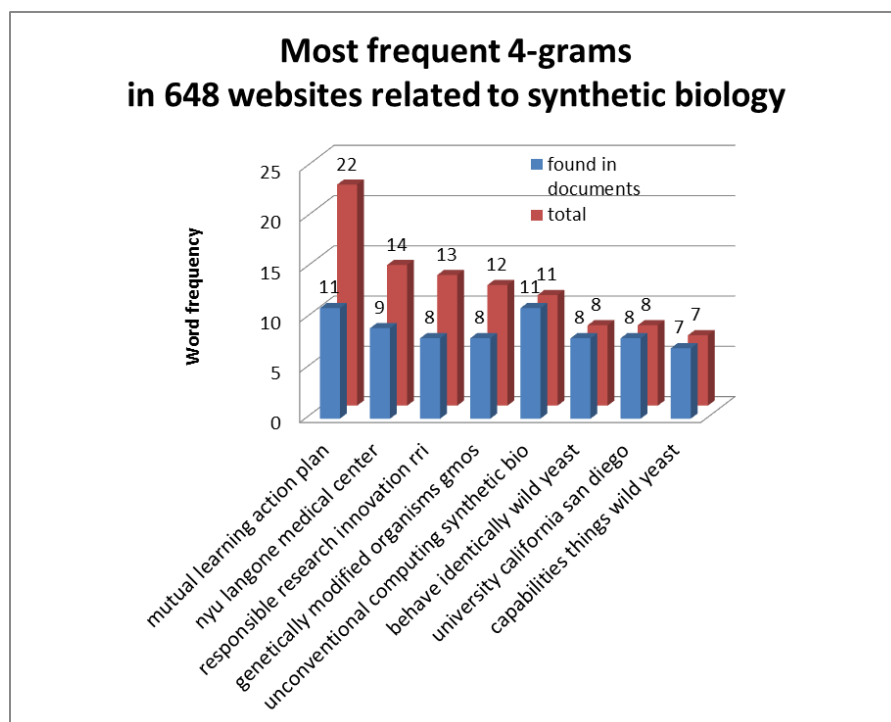Most frequent 4-grams
in 648 websites related to synthetic biology

Figure 6 shows the top-8 4-grams from the texts. For discussion see text.

We learned that the value of the n-grams decreases once n>3. There are two reasons for that. In part it is because we require that all n-grams occur at least seven (7) times and with this restriction we only obtain 14 4-grams (due to the word combinatorics any given 4-word combination sequence drops dramatically). The usefulness also decreases because we have to filter (subtract) an increasing number of high frequency irrelevant n-grams from our analysis. From the 14 4-grams, only eight (8) are left with direct relevance to the text content. The rest of the 4-garms pick up generic website verbiage as "enable javascript view comments", "please enable javascript view" or they are close to combinatorial permutations of the already given 4-grams, e.g. "behave identically wild yeast" and "identically wild yeast cells" are assumed to stem from the same text as they both had exactly seven (7) occurrences.

"Mutual learning action plans" is the top 4-gram which also appeared in the 3-garms as "mutual learning action".

For more details (raw data and code) please see: http://flint.sdu.dk/index.php?page=data-mining

4.2 Sentiment analysis

4.2.1 Feasibility study

We conducted a *feasibility study* of using a more sophisticated automated analysis of the online synbio text repository. We conclude that a sentiment analysis could be used for a further automated analysis of the SynBio texts.
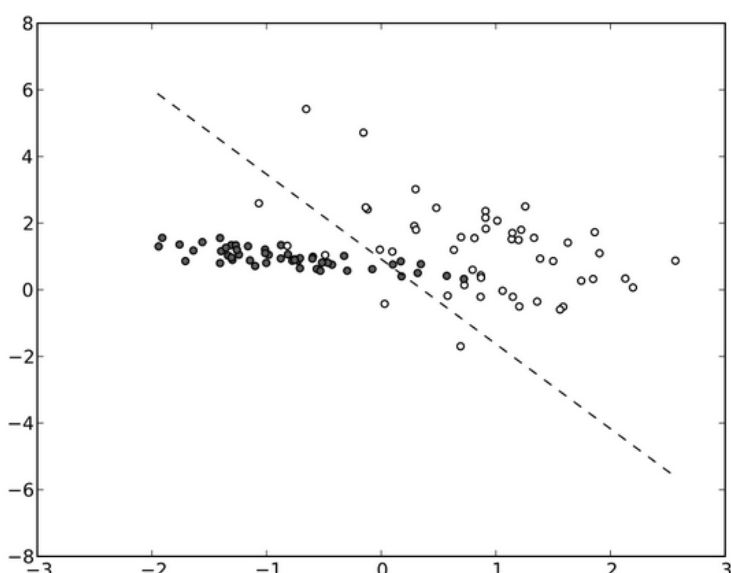
The discussion and presentation of the sentiment analysis is split into two steps for the sake of simplicity: Model creation and model application. Again, it should be noticed that the sentiment analysis tools we developed were not applied on the SynBio datasets as the scale of this

undertaking is outside the scope of this SYNEMERGENE deliverable. However, we have included a discussion of the automated sentiment analysis method, as we believe it could be useful for future applications (with more person month resources) perhaps even within SYNENERGENE project.

Model creation (step 1)

The model is created through machine leaning. Essentially taking sets of already classified data, and training a pre-selected computer algorithm to predict the sentiment as accurate as possible, based on these already known sets of data. This is done from a selected algorithm (model structure) which parameters are adjusted during the training process.

The method we use is based on the Support Vector Machine (SVM), e.g. see http://en.wikipedia.org/wiki/Support_vector_machine for more details. A graphical representation is given in the diagram below (also taken from the Wikipedia reference). In essence the method estimates whether a data point belongs to one of two populations, as seen in the diagram belwo (black dots pop1 and white dots pop2). More precisely each text is represented by a vector in a space with as many dimensions as selected words in the text (all words in the text minus the filtered stopwords). The frequency of these selected words (the number of occurrences) determines the coordinate in each dimension. Such a construction implies that the vector from two closely related texts will have very similar vectors, and the similarity can easily be quantified.

In this demonstration analysis the training data we use is not sentiments about SynBio issues, but sentiments about movies. The data is provided from a publicly available data set derived from movie reviews. http://www.cs.cornell.edu/People/pabo/movie-review-data/

Thus, the data set provides two classes of documents: one set that gives good reviews for a set of different movies and one set that gives bad review for a set of movies.

There is admittedly a difference between the style of language used in semi scientific websites related to synthetic biology, compared to that of movie reviews. However, the assumption is that the difference would not be too big for a "simple" sentiment polarity analysis and that it will have more similarities than differences.
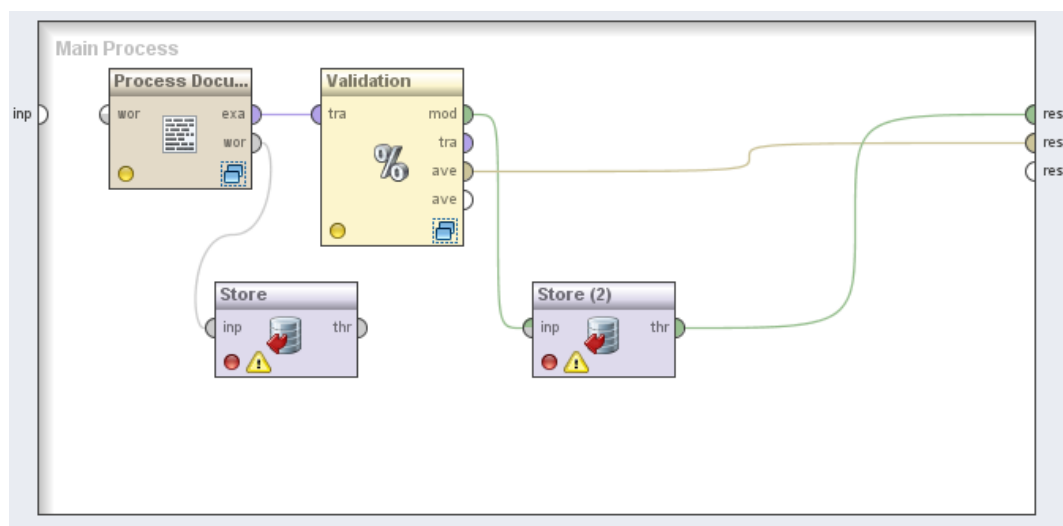
Figure 7 shows the overall process of model generation. See text for discussion.

The pre classified data (two datasets: one with positive reviews and one with negative reviews) is put into two categories in the Process Documents operator, specifying which directory contains positive or negative movie review documents, although this is not shown in the figure. The output is an exampleset (exa) and a wordlist (wor). The wordlist is stored for future retrieval (Store), and the exampleset is connected to the training (abbr: tra) sink of the "Validation" operator, which is a nested process, see next subsection. The validation operator's output is the model (mod) which is stored (Store2), as well as a performance average (ave). Both are routed to the result sinks for display, when the process has completed (res and res).

The latter type of WordList can also be called a word vector, which just means that a word has a certain positive and negative score (also called weight). The word vector is used in the final model.

In the following a short explanation of the two nested operators are discussed: Process documents and Validation.
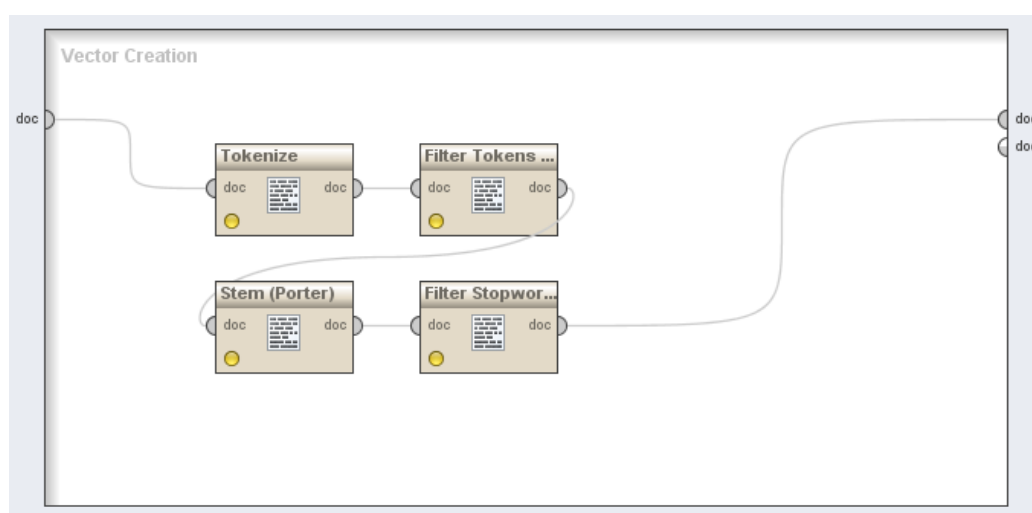
Process document operator

Figure 8. The movie reviews are processed as shown here. For details see text.

First, all the strings of text (sentences) are cut into words called tokens in RM lingo (Tokenize). Then the tokens are filtered by their length (Filter Tokens), so that only tokens equal or above two

characters are included. This value can be used to clean off certain types of words, not relevant to the model. One and two character words seldom have a sentiment value, but they are relatively frequent, thus creating more noise. Filtering them also reduces the amount of data to be processed.

After filtering, the tokens are stemmed (Stem). Stemming means to reduce the length of the word as much as possible while still retaining its meaning, or collapsing two very similar words into one. This is done by the porter algorithm. Finally remaining stop words (such as the, is, at, which, and on) are filtered off (Filter Stopwords).

Validation operator

The figure below roughly shows the internal working of the validation operator. Besides the integrated operations nested into the validation operator, it does a tenfold cross validation using stratified sampling, to estimate the statistical performance of the model.
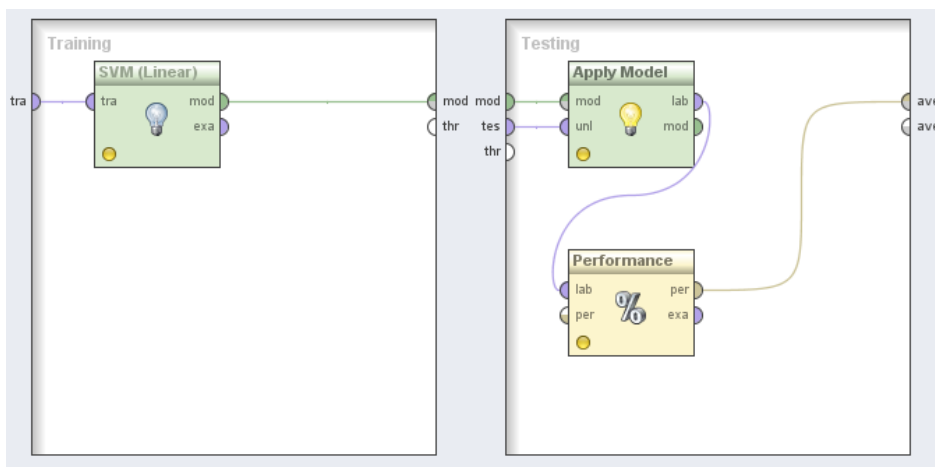

Figure 9 shows the internal working of the validation operator, which is introduced in Figure 7. For details see text.

The validation operator takes the Word Vector and the pre classified data as input, and uses a linear support vector machine "SVM process" for learning. The resulting model is then tested by the "Apply Model" operator and the performance is measured by the "Performance" operator. Finally the performance results are routed through to the results display sink (ave), as seen in the figure of the overall process of model generation.
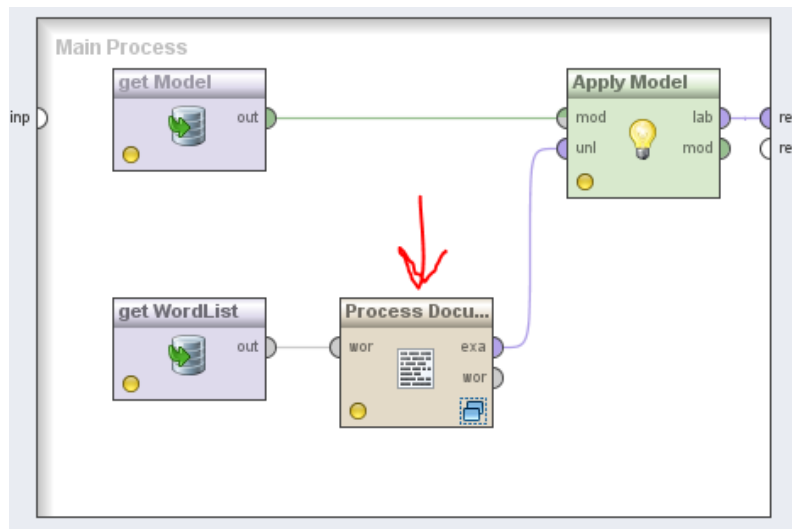
Model application (step 2)

Figure 10 shows the main data flow for the model usage. New data enters Process Document (red arrow).

The two "get" operators retrieves the model (get Model), and the wordlist (get Wordlist). The model is directly connected to "Apply Model" which just means that the previously generated SVM model is used. The wordlist that contains the word vectors of all the positive and negative words is connected to a "Process Documents" operator via (out). In this case it combines the unlabled data (abbr:unl), the data to be analyzed, with the wordList's word vectors. The output of the model is wired to results view sink.

4.2.2   Results of feasibility study

The created model resulted in an average accuracy of 83.6% ±3.81% as seen in the figure below, where details of the results, the predicted movie reviews, shows the prediction vs. the true classification.

accuracy: 83.60% +/- 3.81% (mikro: 83.60%)	true negative	true positive	class precision
pred. negative	814	142	85.15%
pred. positive	186	858	82.18%
class recall	81.40%	85.80%	

Notably the positive predictions are more precise than the negative.

Besides the testing of stratified samples from the pre classified data, we did a little test to see if the model could handle a new set of movie review data, really to see if it worked as well as it claimed.

Five reviews of the "The Dark Knight" representing the full range of imdb.com stars (1-10 where 10 is the best and 1 is the worst) were analyzed with the model and the results are shown in the following table.

Row No.	metadata_file	confidence(negative)	confidence(positive) ▽	prediction(label)
2	10 of 10.txt	0.324	0.676	positive
5	8 of 10.txt	0.372	0.628	positive
3	3 of 10.txt	0.393	0.607	positive
4	5 of 10.txt	0.397	0.603	positive
1	1 of 10.txt	0.596	0.404	negative

The table shows the model's prediction and the confidence in its decision. The table is sorted in descending confidence. The "metadata_file" column shows the classification made by the original review authors.

As the validation told us, the model seems to predict better the positive end of the range (above 5 stars), than the negative range (below 5 stars). The model correctly predicted the 10 out of 10 star review and the 1 out of 10 star review, but the confidence for a negative prediction is lower than that of the positive. The 3 of 10 review have a higher positive confidence that that of the 5 of 10 review. Also the negative confidence of the 3 of 10 review is lower than that of the 5 of 10 review, though it should have been the bigger.

Even though the general prediction trend is correct, the system got at least one out of five wrong. This test also has a very small sample with only five reviews.

Although the application of sentiment analysis to the original data from the SYNENERGENE web analysis is outside the scope of this investigation (it is too time consuming and too complex), we could not help but try to apply such a more sophisticated machine learning (artificial intelligence) method besides the very simple n-gram frequency analysis.

For more details (raw data and code) please see: http://flint.sdu.dk/index.php?page=data-mining

5   Concluding thoughts

Mission accomplished.

We have assembled and organized a significant online database repository (648 separate website text) about the online SynBio conversations. This may be the first online database of its kind. Further, we have analyzed the online conversation in a variety of ways including: web-address, front page content, website type, title, actor type, country, purpose, closeness to synthetic biology as well as automated content analysis.

Other partners of the consortium are invited to use the database in any way they like, especially for the various work packages in the SYNENERGENE project. Jn

The SYNENERGENE platform SYNENERGENE.eu should be visited more by the community and more content regarding the dissemination of and discourse about synthetic biology should be added to SYNENERGENE.eu. It is everyone's task in the consortium to partake in these actions. We believe the new online database repository is a step in this direction.

5.1 Possibility for developing a living database of synthetic biology (SynBio) websites

All stakeholders could benefit from the development of an online database of publicly available websites where synthetic biology (SynBio) issues are discussed. An initial database is now provided and can be found here:

https://app.smartsheet.com/b/home?mt=48&lx=LKsGoxaUVMX384SwoqTR1bsDXekyrd8V818ZsQ hQJ80&wx=QXz8CoNpV-a6yUoqIeRff1lZ1hK7Dhe1T2C0-ZLJfU0

Since such a one-stop international web resource is not yet available. SYNENERGENE could be the first to provide an international service for anybody who is interested in the public discourse of SynBio. Such a database could provide valuable information for the scientific community, for NGOs, the government, the press as well as the interested public.

There is a strong history from the scientific community showing that a well maintained and well documented web resource can shape the course of a field, e.g. as did Paul Ginspang with his e-print archives on Physics, Mathematics, Computer Science, Quantitative Biology, Quantitative Finance and Statistics. It started in 1991 http://arxiv.org and it changed preprint distribution globally. Betty Kober's HIV sequence database, which stared a few years later, changed the way HIV related global research was shared and conducted: http://www.hiv.lanl.gov/content/sequence/HIV/NextGenArchive/

SYNENERGENE could define its ambition to have a major say in shaping of the international public discourse of SynBio. Developing a central living database service might enable SYNENERGE to do just that. If the living database provides sufficient value for the community it could live many years beyond the conclusion of the SYNENERGENE project.

6 Appendix

The table with all stakeholders found during the web analysis can be looked up in the PDF attached. Furthermore, an online version of the table will be made available on the synenergene.eu platform.

Distribution of types of actors and online-spaces

// engaged in synthetic biology		
research institution	29	38%
project	9	12%
event	8	10%
company	8	10%
other institution	5	6%
website	5	6%

network	4	5%
gov. institution	3	4%
media	3	4%
blog	2	3%
education	1	1%

// engaged in neighbouring fields		
research institution	79	33%
company	34	14%
blog	23	10%
media	21	9%
other institution	19	8%
event	14	6%
project	12	5%
education	10	4%
website	9	4%
network	8	3%
gov. institution	5	2%
forum	5	2%
youtube channel	1	0%

// Science and Technology		
research institution	21	17%
project	16	13%
gov. institution	15	12%
other institution	14	12%

website	10	8%
education	10	8%
network	9	7%
media	8	7%
company	7	6%
blog	7	6%
event	3	2%
forum	1	1%
youtube channel	0	0%

// Multipliers		
media	200	75%
blog	25	9%
other institution	9	3%
website	8	3%
network	5	2%
education	5	2%
forum	5	2%
company	4	2%
project	3	1%
youtube channel	1	0%
research institution	0	0%
event	0	0%
gov. institution	0	0%

Search request used during the automated search (online-tool: brandwatch)

"Synthetic biology"

OR synbio*

OR (synthet* NEAR/3 bio*)

OR (Synthet* NEAR/3 life*)

OR (Synthet* NEAR/3 organism*)

OR (Synthet* NEAR/3 cell*)

OR (Synthet* NEAR/3 chromosom*)

OR (Synthe* NEAR/3 DNA*)

OR (Synthet* NEAR/5 (creating* NEAR/2 life*))

OR (Synthet* NEAR/3 genes*)

OR ((minimal* OR artificial*) NEAR/2 cell*)

OR (Genetic* NEAR/3 engineering*)

OR (Artificial* NEAR/2 (organism* OR life* OR photosynthesis*))

OR (DNA* NEAR/3 manipulat*)

OR ((Genome* OR genetic*) NEAR/3 manipulat*)

OR (Manmade NEAR/3 (synthetic* NEAR/2 bio*))

OR (Craig NEAR/1 Venter)

OR ((Play* NEAR/2 god*) NEAR/3 synthetic*)

OR Biohack*

OR (BioBricks)

OR protocell*

OR "cell free expression system"

OR bionanoscience*

OR (("biochemical information") NEAR/10 "communication technology")

OR "living technology"

OR "bio-info-nano-cogno"

OR (("unconventional computing") NEAR/10 (synthetic* NEAR/2 bio*))

OR (biocomputing* NEAR/10 (synthetic*))

OR "DNA computing"

OR (microfluidic* NEAR/10 (synthetic* NEAR/2 bio*))

OR (printing* NEAR/10 (synthetic* NEAR/2 bio*))

OR (nanoscience* NEAR/10 (synthetic* NEAR/2 bio*))

OR ("bottom up" NEAR/10 (synthetic* NEAR/2 bio*))

OR ("top down" NEAR/10 (synthetic* NEAR/2 bio*))

OR ("metabolic engineering" NEAR/10 (synthetic*))

OR ("regulatory circuits" NEAR/10 (synthetic*))

OR ("orthogonal biosystems" NEAR/10 (synthetic*))

OR ("protein engineering" NEAR/10 (synthetic*))

OR ("molecular motors" NEAR/10 (synthetic*))

OR ("biomineratization" NEAR/10 (synthetic* NEAR/2 bio*))

OR ("cell factories" NEAR/10 (synthetic*))

OR ("minimal genomes" NEAR/10 (synthetic*))

OR ("synthetic pathways" NEAR/10 (bio*))

OR ("gene therapy" NEAR/10 (synthetic*))

OR (pharmaceutical* NEAR/10 (synthetic* NEAR/5 bio*))

OR (vaccin* NEAR/10 (synthetic* NEAR/5 bio*))

OR (Xenobio* NEAR/10 (synthetic*))

OR (("Xeno Nucleic Acid" OR XNA) NEAR/10 (synthetic*))

OR ("genetic alphabet" NEAR/10 (synthetic*))

OR ("unnatural amino acid" NEAR/10 (synthetic*))

OR ("non-canonical amino acid" NEAR/10 (synthetic*))

OR ("biobased chemicals" NEAR/10 (synthetic*))

OR ("green chemicals" NEAR/10 (synthetic*))

OR ("live vaccines" NEAR/10 (synthetic*))

OR ("biodiversity" NEAR/10 (synthetic* NEAR/5 bio*))

OR ("do-it-yourself" NEAR/10 (synthetic* NEAR/5 bio*))

OR ("DIY" NEAR/10 (synthetic* NEAR/5 bio*))

OR ("open source" NEAR/10 (synthetic* NEAR/5 bio*))

OR ("biomass" NEAR/10 (synthetic* NEAR/5 bio*))

OR biosafe*

OR biosecur*

OR bioeconom*

OR igem*

OR biofuel*

OR biopatent*

OR "patents of life"

OR bioethic*

OR biopolitic*

NEIGHBOURS

((bio* NEAR/3 technolo*) AND scienc*)

OR ((bio* NEAR/3 enginee*) AND scienc*)

OR ((genetic* NEAR/3 enginee*) AND scienc*)

OR ((genetic* NEAR/3 bio*) AND scienc*)

SCIENCE AND TECHNOLOGY

"responsible research and innovation"

OR ("responsible research")

OR ("responsible research" NEAR/3 innovation)

OR MMLAP

OR "Mutual Learning Action Plan"

OR (scienc* NEAR/3 ethic*)

OR (bio* NEAR/3 ethic*)

List of events found during the web analysis

http://www.synbio-symposium.de/sb2013/	International symposium "Synthetic Biology - from understanding to application"	**Germany**	The international symposium "Synthetic Biology - from understanding to application" is a joint event of the community of synthetic biologists in Germany and covers a diversity of synthetic biology topics ranging from fundamental research to applications in health research and biotechnology. Apart from an exciting scientific program with internationally renowned scientists, we expect the 2013 winning iGEM Teams complemented by an art & science exhibition. The symposium is organized by the Helmholtz Initiative on Synthetic Biology in cooperation with Berlin-Brandenburgische Akademie der Wissenschaften, BIOSS - Centre for biological signalling studies, DECHEMA, HEiKA - Heidelberg-Karlsruhe Research Partnership, NSB Upper-Rhine network in synthetic

			biology and SYNMIKRO.
http://www.synbioconference.org/	The Synthetic Biology: Engineering, Evolution & Design (SEED)	**International**	The Synthetic Biology: Engineering, Evolution & Design (SEED) conference will be held annually and will rotate between cities. SEED2014 will focus on advances in the science and technology emerging from the field of synthetic biology. We broadly define this as technologies that accelerate the process of genetic engineering. It will highlight new tool development, as well as the application of these tools to diverse problems in biotechnology, including therapeutics, industrial chemicals and fuels, natural products, and agriculture. Systems will span from in vitro experiments and viruses, through diverse bacteria, to eukaryotes (yeast, mammalian cells, plants).
http://sb6.biobricks.org/	The BioBricks Foundation Synthetic Biology Conference Series	**International**	The BioBricks Foundation Synthetic Biology Conference Series (SBx.0 Conference) is the world's foremost professional meeting in the field of synthetic biology. The BioBricks Foundation is the proud organizer of the conference series.
http://blogs.cornell.edu/alife14nyc/	ALIFE	**International**	Since its inception in 1987, ALIFE has been the leading biyearly international conference in the field of Artificial Life — the highly interdisciplinary research area on artificially constructed living systems, including mathematical, computational, robotic, and biochemical ones. The understanding and application of such generalized forms of life, or "life-as-it-could-be", have been producing significant contributions to various fields of science and engineering.
http://isarob.org/symposium/	AROB symposium	**International**	This symposium was founded in 1996 under the support of Science and International Affairs Bureau, Ministry of Education, Culture, Sports, Science and Technology, Japanese Government. The objective of this symposium is to develop new technologies for artificial life and robotics and their applications in various fields listed in the Topics. Authors are invited to submit papers presenting original research and to

			discuss development of new technologies concerning artificial life and robotics based on computer simulations and hardware designs of state-of-the-art technologies.
http://vida.fundaciontelefonica.com/en/	VIDA Art and Artificial Life International Awards	**International**	The VIDA Art and Artificial Life International Awards was started in 1999 to support artistic investigation into artificial life and to promote production in this field. Its own particular framework, art and artificial life, forms part of that multidisciplinary territory where art, science and technology come together. VIDA is the first international contest dedicated to art and artificial life. The main aim of the contest is to recognise artists who are interested in the current discourse on life through the latest technologies and the most recent scientific advances.
http://www.nicso2013.org	VI International Workshop on Nature Inspired Cooperative Strategies for Optimization (NICSO 2013)	**International (UK)**	VI International Workshop on Nature Inspired Cooperative Strategies for Optimization (NICSO 2013) NICSO 2013 is the sixth edition of the International Workshop on Nature Inspired Cooperative Strategies for Optimization (previous ones were Granada 2006, Acireale 2007, Puerto de la Cruz 2008, Granada 2010, and Cluj-Napoca 2011), and its aims are to give a deeper investigation and a vigorous exchange of ideas about emerging research areas in cooperative problem solving strategies. Biological and natural processes have always been a source of inspiration for computer science and information technology in many real-world applications. Its well known that biological entities, from single cell organisms - like bacteria - to humans, often engage on a rich repertoire of social interaction that could range from altruistic cooperation through open conflict. One specific kind of social interaction is cooperative problem solving (CPS), where a group of autonomous entities work together to achieve certain goal. - See more at: http://www.nicso2013.org/index.html#

			sthash.qaDYmdQq.dpuf
http://dna20.molecular-robotics.org/	20th International Conference on DNA Computing and Molecular Programming	**International**	Research in DNA computing and molecular programming draws together many disciplines (including mathematics, computer science, physics, chemistry, material science and biology) to address the analysis, design, and synthesis of information-based molecular systems. This annual meeting is the premier forum where scientists with diverse backgrounds come together with the common purpose of applying principles and tools of computer science, physics, chemistry and mathematics to advance molecular-scale computation and nanoengineering. Continuing this tradition, the 20th International Conference on DNA Computing and Molecular Programming (DNA20), organized under the auspices of the International Society for Nanoscale Science, Computation and Engineering (ISNSCE), will focus on important recent experimental and theoretical results.
http://q-bio.org/wiki/The_q-bio_Summer_School_and_Conference	q-bio	**USA**	q-bio is a series of conferences and affiliated summer schools, which aim at advancing predictive modeling of cellular regulation, decision making, formation of response, and other information processing phenomena. The emphasis is on deep theoretical understanding, detailed modeling, and quantitative experimentation directed at understanding the behavior of particular regulatory systems and/or elucidating general principles of cellular information processing. Unlike many biological conferences, which focus on specific model systems, q-bio focuses on understanding of phenomena, which manifest themselves in many biological systems. The q-bio Conference is not affiliated with arXiv.q-bio, but symbiotically coordinates with it.
http://www.plluisi.org/	Pier Luigi Luisi Synthetic Biology Lab	**Italy**	The two main current projects – the Never Born Proteins and the Minimal Cell – can generally be ascribed to the domain of Synthetic Biology.

			In addition, supporting research themes on the biophysics of surfactant aggregates form an integer part of the group's activity.
http://www.birmingham.ac.uk/index.aspx	University of Birmingham	**UK**	Dr Anna Peacock is presenting an invited lecture at the Bottom-Up Synthetic Biology: Towards Molecular Assembly of Biomimetic Functional Materials.
http://www.globalengage.co.uk/synthetic-biology.html	Synthetic Biology Congress	**UK**	Global Engage is pleased to announce as part of their successful Genomic series of events the Synthetic Biology Congress, which will be held on October 20-21 in London, UK and will be co-located with our 2nd Annual qPCR and Digital PCR Congress. This event will attract over 150 industry & academic experts working in areas such as synthetic biology, bioengineering, biochemical / metabolic / chemical / genetic engineering, systems biology, microbiology, computational / molecular biology, chemistry, mathematics, computing, biochemistry, drug discovery and plant science. This will examine the latest strategies, developments and case studies using synthetic biology to further research in healthcare and the agriculture sectors. The congress will also have a dedicated section focusing on finance, aimed at those looking for investment opportunities and those seeking funding to exploit their research.
http://biosafety.icid.com/en/	Canadian Biosafety Symposium	**Canada**	The Canadian Biosafety Symposium will feature presentations on an array of biosafety topics, including emergency management for labs, building a biosafety culture, biosafety and public health, emerging and re-emerging diseases, laboratory acquired infections, ergonomics and safety, biowaste management and disinfection, regulations, airflow, ventilation, design and biosafety, animal issues, audits and inspections, occupational health and surveillance. It will be a unique opportunity for the biosafety community to learn and

			share knowledge with colleagues from across Canada and other countries.
https://www.regonline.co.uk/	Euroscicon Small Conference - Applications for Synthetic Biology in Industrial Biotechnology	**UK**	In this meeting a series of metabolic engineering programs representing each of the differing strategies for natural product biosynthesis will be presented and the potential merits of plant Vs microbial industrial biotechnology discussed, along with projections as to how each might benefit from synthetic biology based approaches. In addition to reviewing the latest development in plant natural product biochemistry and molecular biology, the meeting will be formative in shaping thinking as to how and where new approaches like synthetic biology can be best applied in industrial biotechnology in the coming years. This meeting will also include a meeting of the High Value Chemicals from Plants Network. With their provenance as an excellent source of pharmaceutical, neutraceutical and health promoting chemistries, plant natural products are an attractive target for biotechnological development for industrialization so as to make them more widely available. To realize this potential, two strategies are currently being employed whereby the associated metabolic pathways are engineered in planta, or are ectopically expressed in microbial hosts and produced through fermentation. In both cases it is clear that recent developments in genetics, and our understanding of metabolism are providing us with unprecedented tools to fast-track these ambitions. In addition, the advent of synthetic biology, where approaches more commonly employed in engineering are applied to design and optimize bioprocesses has much to offer industrial biotechnology in the future.
http://www.biomin2013.de/	12th International Symposium on Biomineralization	**Germany**	The BIOMIN'12 international symposium aims at bringing together scientists from different backgrounds all interested in understanding the principles of biomineralization and demineralization. Discovering these

			natural principles leads to direct, practical applications in biological materials science, biomedicine and technology. Scientific topics shall include the following: evolutionary aspects of biomineralization, molecular and genetic regulation of Calcifcation and Silicifcation from bacteria to vertebrates, pathological biomineralization and biomineral formation under extreme environmental conditions and modern analytical methods and biomimetics.
http://www.imvacs.com/	ImVacS, The Immunotherapies and Vaccine Summit	**International**	ImVacS, The Immunotherapies and Vaccine Summit, brings together a global audience of vaccine researchers and developers of cancer immunotherapies for five focused meetings that explore the frontiers of immunology as the basis for patient treatment. 250+ researchers from around the world gather to discuss new data, new approaches and novel science from industry, academia, regulatory, and research institutes in a collegial atmosphere that encourages interaction and information sharing.
http://sbl.riken.jp/fujihara-seminar/	The 65th Fujihara Seminar	**International**	The 65th Fujihara Seminar International Symposium on Synthetic Biology of Unnatural Base Pairs and Amino Acids
http://chemicalwatch.com/	Chemical Watch	**USA**	Following the major success of the 2013 Bio-based Chemicals Summit, this year's 5th Annual Next Generation Bio-Based Chemicals Summit will provide a detailed overview of the critical developments the industry is currently facing, including innovative feedstocks, end-user applications and perspectives, and progress of established and new chemical production platforms and applications. The Summit will provide technology start-ups, global chemical majors and high-profile brand owners with the opportunity to network and build partnerships across the bio-based value chain during this year's not to be missed, Speed Networking Reception. The event will incorporate spotlight sessions on policy updates,

			financing commercialization, sustainability drivers and will assess the international bio-based chemicals partnering landscape.
http://www.cbd.int/	The Convention on Biological Diversity (CBD)	**International**	The Convention on Biological Diversity (CBD) entered into force on 29 December 1993. It has 3 main objectives: The conservation of biological diversity The sustainable use of the components of biological diversity The fair and equitable sharing of the benefits arising out of the utilization of genetic resources
http://www.iwbdaconf.org/2014/	6th International Workshop on Bio-Design Automation	**International**	The Sixth International Workshop on Bio-Design Automation (IWBDA) will bring together researchers from the synthetic biology, systems biology, and design automation communities to discuss concepts, methodologies and software tools for the computational analysis and synthesis of biological systems. The field of synthetic biology, still in its early stages, has largely been driven by experimental expertise, and much of its success can be attributed to the skill of the researchers in specific domains of biology. There has been a concerted effort to assemble repositories of standardized components; however, creating and integrating synthetic components remains an ad hoc process. Inspired by these challenges, the field has seen a proliferation of efforts to create computer-aided design tools addressing synthetic biology's specific design needs, many drawing on prior expertise from the electronic design automation (EDA) community. The IWBDA offers a forum for crss-disciplinary discussion, with the aim of seeding and fostering collaboration between the biological and the design automation research communities.
http://www.berkeleybioeconomy.com	Berkeley Bioeconomy Conference	**USA**	The Bioeconomy Conference will highlight economic and policy issues related to biofuel and various biotechnologies in agriculture. Sessions will address biofuel policies

			and their implications, in particular, the future of biofuel policies (e.g., the renewable fuel standards in the United States), the economics of alternative forms of biofuel, and the role of biofuel within a more diverse renewable energy portfolio (e.g., the relationship between biofuel and alternative forms of solar energy). We will emphasize the impacts of biofuel and biofuel policies on the environment and on the poor and feature sessions on the political economy of biofuel policies and biofuel in Brazil. In the area of biotechnology, we will present results on the economic and environmental impacts of biotechnology and biofuel regulation as well as results on the political economy of biotechnology. We will emphasize the adoption and future of biofuel and biotechnology in Africa and the impacts of technology transfer and intellectual-technology arrangements on the dynamics of both technologies.
http://bioethicsmexico.mx/	12th World Bioethics Congress	**Global**	The objectives of the Congress include the following: Interact with the most important experts in the global field of bioethics. Exchange experiences and establish links for the future. Identify innovative trends in the field of bioethics, including original knowledge and its development and application. Strengthen actions that promote the solid presence of bioethics in the Latin American Region, both in the academic fields and in research, teaching, and practical performance. Promote the social transcendence of bioethics and its impact in the daily life of citizens, in the drafting of public policies, as well as in the international recognition of Mexico. Promote bioethical knowledge as an expression of culture and as an instrument for personal and collective development, for the care of health, protection of life in all of its

			expressions, and the preservation of the environment. Discuss and reflect on diverse bioethical considerations pertaining to human rights, equality, intercultural processes, and the prevention of discrimination.
http://bioethicsummit.mx/en/	10th Global Summit of National Ethics/Bioethics Committees.	**Mexico**	From June 22-24, 2014, Mexico City will have the honor of receiving official representatives from various nations as the host of the 10th Global Summit of National Ethics/Bioethics Committees. This achievement was based on the tireless labor of the Mexican National Bioethics Commission and the Permanent Secretariat of the World Health Organization, through its Department of Knowledge, Ethics and Research. The Global Summit is a forum for those attending to exchange opinions, information and experiences, while producing agreements and consensus on leading issues in ethics and bioethics in health that demand analysis at the local, regional and global levels.
http://philevents.org/	Upcoming Events in Philosophy	**Italy**	Conferences, CFPs, and seminars in philosophy
www.biohackathon.org/	BioHackathon	**Japan**	National Bioscience Database Center (NBDC) and Database Center for Life Science (DBCLS) have been organizing annual BioHackathon since 2008, mainly focusing on standardization and interoperability of bioinformatics data and web services for improving integration, preservation and utilization of databases in life sciences.