



Statistical Analysis and Related Visualization

**Gerhard Fischer
Intellectual Property Dept
Information Research**

WIPO Regional Workshop on Patent Analytics, Rio de Janeiro, August 26 to 28, 2013

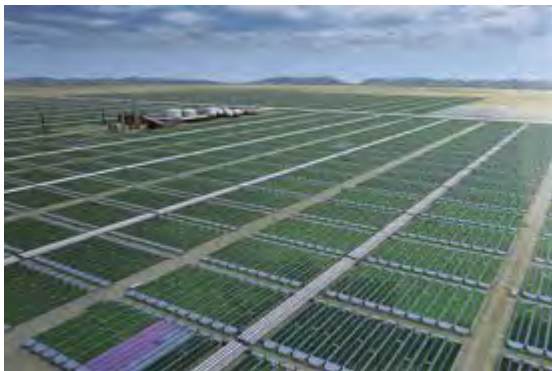
Classification: PUBLIC

Contents

- Algae Biofuel
- Search strategies & Retrieval
- Charts, Matrices, Classifications, Cluster maps, Citation analysis
 - Priority and Application Dates
 - Assignees
 - Inventors
 - Priority/Patent Country
 - Technology: Classification
 - Technology: Cluster Maps
 - Citation Analysis

Algae biofuel

- Algaculture (farming algae) for making vegetable oil, biodiesel, bioethanol, biogasoline, biomethanol, biobutanol and other biofuels
 - using land that is not suitable for agriculture
- Estimates suggests that the per unit area yield of oil from algae is between 4'700 to 18'000 m³/km²/year, this is 7 to 30 times greater than the next best crop, Chinese tallow (650 m³/km²/year)*



* Source: Wikipedia, Igenol Biofuels, Press Release March 6, 2013, see at http://en.wikipedia.org/wiki/Algae_fuel

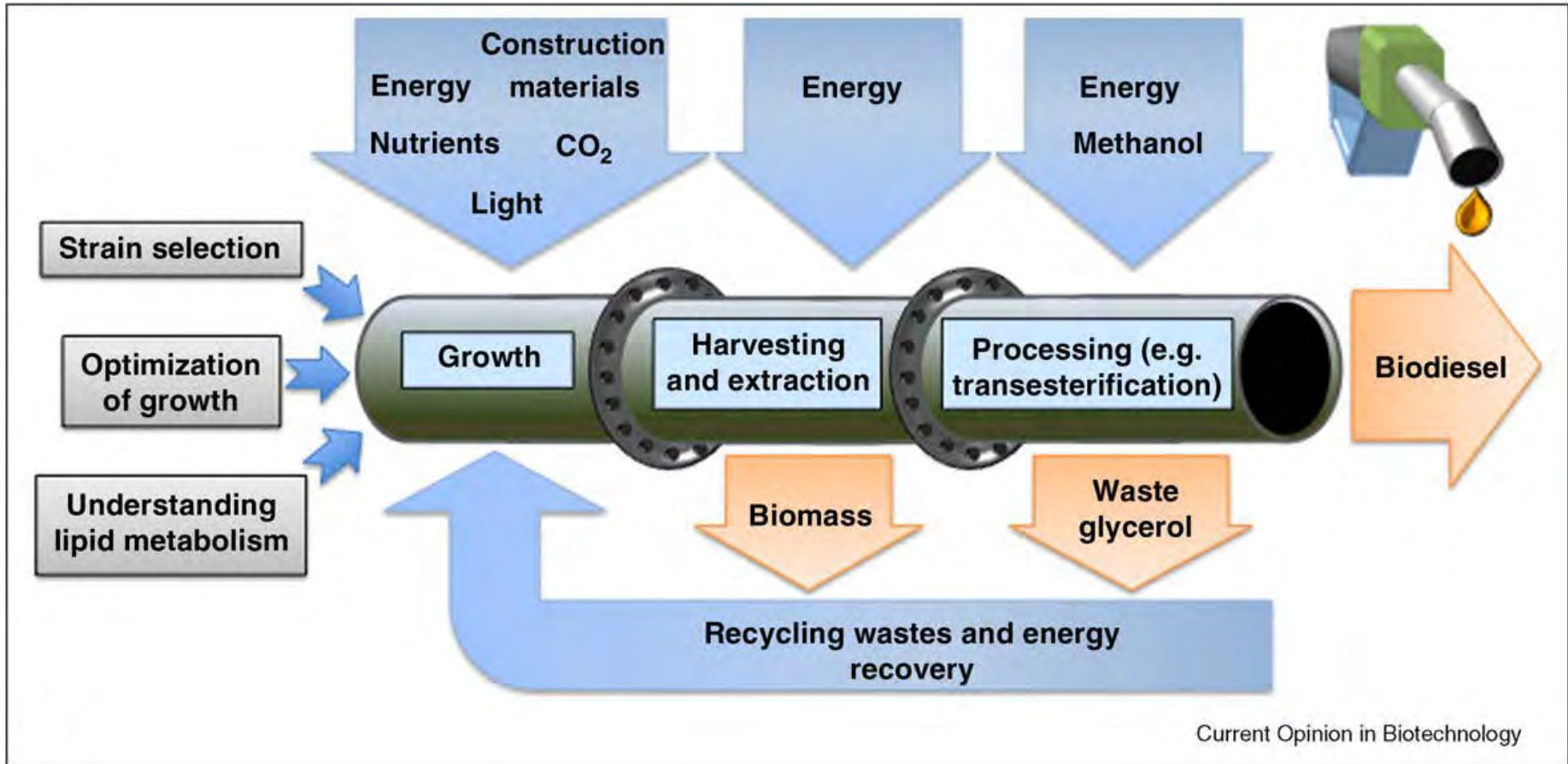
Ethanol from algae

- The company Algenol claims a process that can produce 8'450 m³ ethanol/km²/year*
 - growing corn and fermenting it produces 350 m³ ethanol/km²/year
 - sugar cane yields 830 m³ ethanol/km²/year



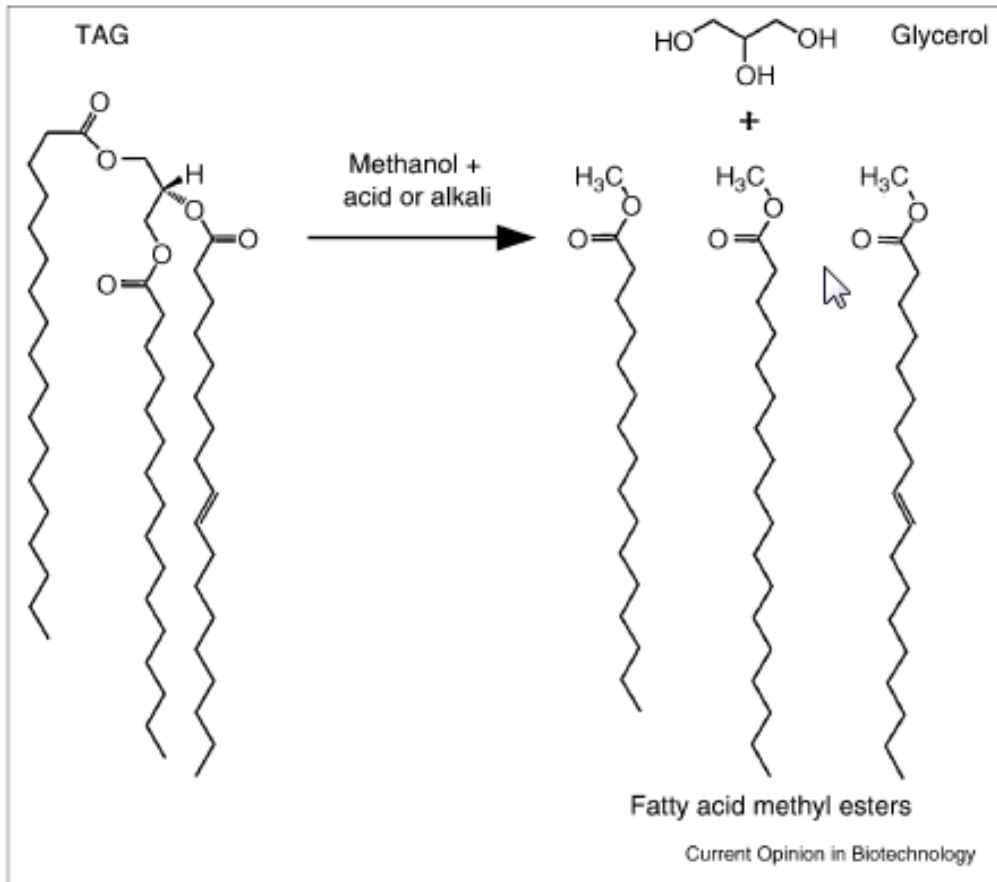
* Algenol Biofuels, Press Release March 6, 2013, see at <http://www.algenolbiofuels.com/media/press-releases>

The algae biofuel pipeline



Source: Current Opinion in Biotechnology 21, 277 (2010), see Figure 1

Biodiesel



Transesterification of triacylglycerides (TAG) extracted from algal oil to yield fatty acid methyl ester (biodiesel)

Source: Current Opinion in Biotechnology 21, 277 (2010), see Figure 2

Major technology aspects

- Growth of algae
 - closed (photobioreactors) or open bioreactors (open ponds)
 - nutrients and CO₂ supply
- Importance of light
 - delivery
 - capture
- Maximizing the triacylglycerides (TAG) content in algae
 - engineering of lipid production pathways
- Downstream processing
 - extraction of oil from algae
 - waste biomass conversion

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Search strategies: Algae (1)

- Keywords for various algae species, groups, classes, genus
 - *Pediastrum boryanum*,
 - Chlorophyta or Charophyta
 - Bryopsidophyceae or Chlorophyceae
 - Spirogyra or Cladophora
- General keywords
 - Algae or Alga or Algal or Algaculture or Microalgae or microalga or Microphytes or Microscopic algae or Microscopic alga or Seaweed or sea weed or phytoplankton or Marine microorganism or marine micro organism
 - Aquatic organism

Search strategies: Algae (2)

- IPC and US patent classifications
 - (A01H0013 or C12N0001-12 or C12R0001-89)/IPC
 - A01G0033/IPC
 - (435257001 or 4352570002 or 047001004 or 435946000 or 800296000)/incl,ncl
 - C04-F08/MC
 - D05-H08/MC
- Derwent Manual codes
 - C04-F08/MC
 - D05-H08/MC

Search strategies: Biofuel (1)

- **Keywords**

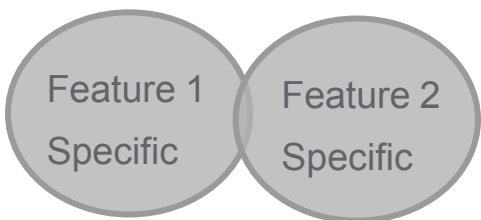
- ((Bio or biological) (w) (diesel or energ? or fuel or gasoline or gas or oil or methanol or ethanol or glycerol or butanol))
- ((alternative or substitute) (w) (fuel or diesel or energ? or gasoline or oil or gas))
- (biodiesel or bioenerg? or biofuel or biogasoline or biogas or biooil or biomethanol or bioethanol or bioglycerol or biobutanol or biomethanol or biologicaldiesel or biologicalenerg? or biologicalfuel or biologicalgasoline or biologicalgas or biologicalmethanol)
- (biologicaethanol or biologicalglycerol or biologicalbutanol or gasohol or alcoholfuel or alcohol fuel)....
- (starch or cellulos? or sugar or hemicellulos? or hemi(w)cellulos or lignin or lignocellulos? or ligno(w)cellulos?)(s)(hydrolyz? or hydrolys? or ferment?)
-etc.

Search strategies: Biofuel (2)

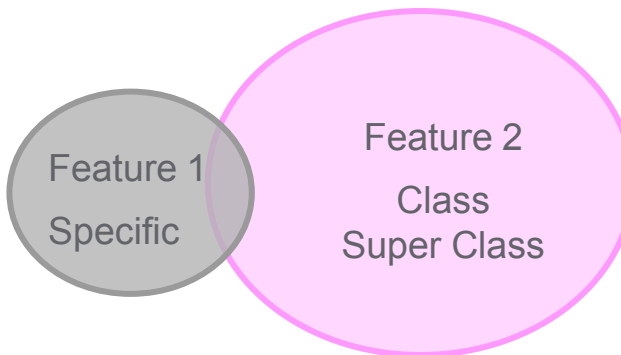
- **Patent Classifications and Derwent Manual Codes**

- (C12P0007-08 or C12P0007-10 or C12P0007-06 or C12P0007-16 or C12P0007-20 or C12P0007-12 or C12P0007-14 or C10L0005-44 or C10L0005-46 or C10L0005-48)/IPC
- (435159000 or 435160000 or 435162000 or 435163000 or 435164000 or 435165000)/incl
- (C12P0005 or C12N0001 or C12P0007-64 or C10L0001 or C10G0002 or C10G0003 or C10L0001 or C11C0003 or C07C0067 or C12N0015-82)/IPC
- (H06-B04 or H06-A04 or H06-B05)/mc
- (127001000 or 127037000 or 435134000 or 435135000 or 435161000 or 554169000 or 554174000)/incl

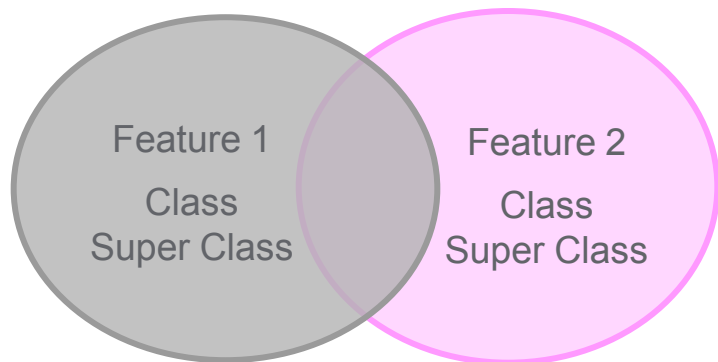
High quality data sets: Keeping control in retrieval



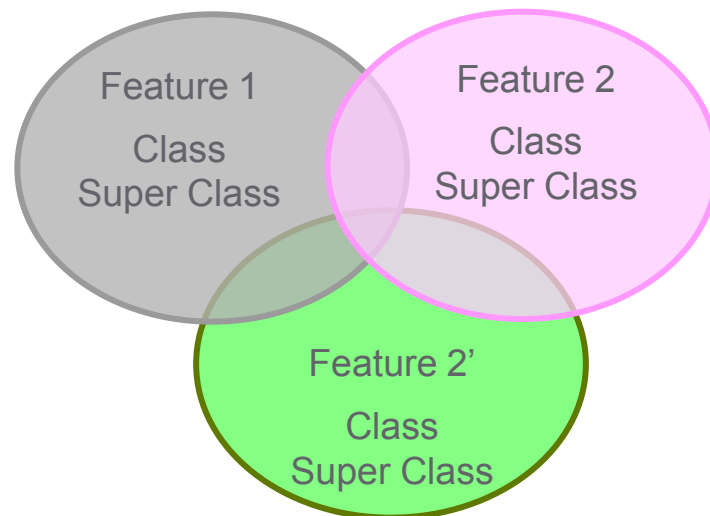
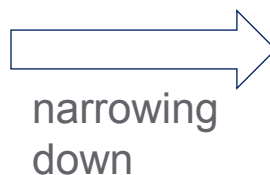
low recall and high precision



medium recall and precision



high recall and low precision

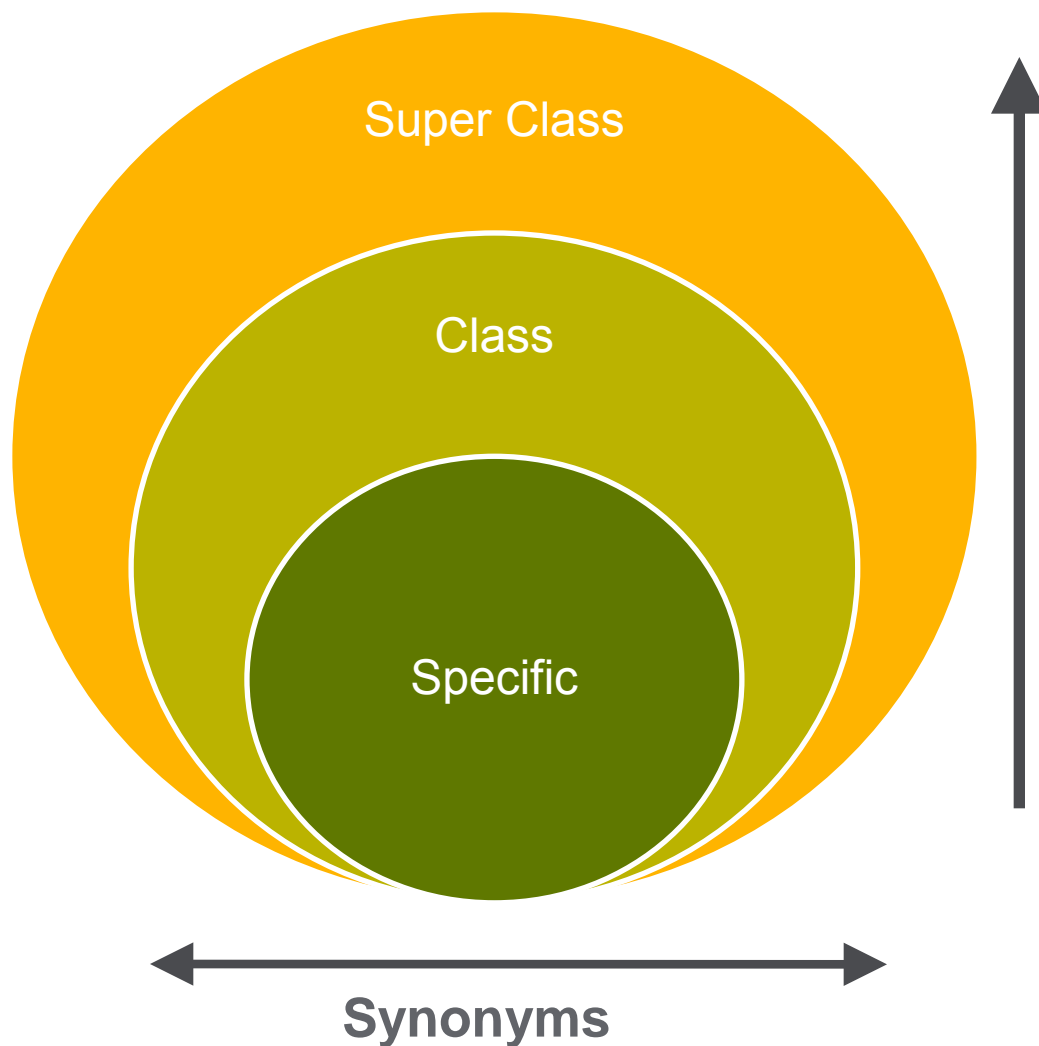


Generic feature expansion: an example

- Anti-Inflammatory agents
- Analgesics

- Hydroxybenzoic acids
- Salicylic acids

- Aspirin
- Acetylsalicylic acid
- CAS RN 50-78-2



“AND” combination of Algae and Biofuel search strategies

- 60+ different search strategies in STN World Patents Index (WPINDEX) database
- Each answer set randomly checked for relevance on low-cost data format
- 20 answer sets selected as good quality and 10 answer sets cleaned and added



2'700 patent families (WPI)

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Data typically available for Patent Analytics (1)

- Organizations/Assignees
- Inventors
- Publication Dates
- Priority/Application Dates
- Patent Countries
- Patent Country Kind Codes
- Patent Classifications
- Database Classifications and Codes

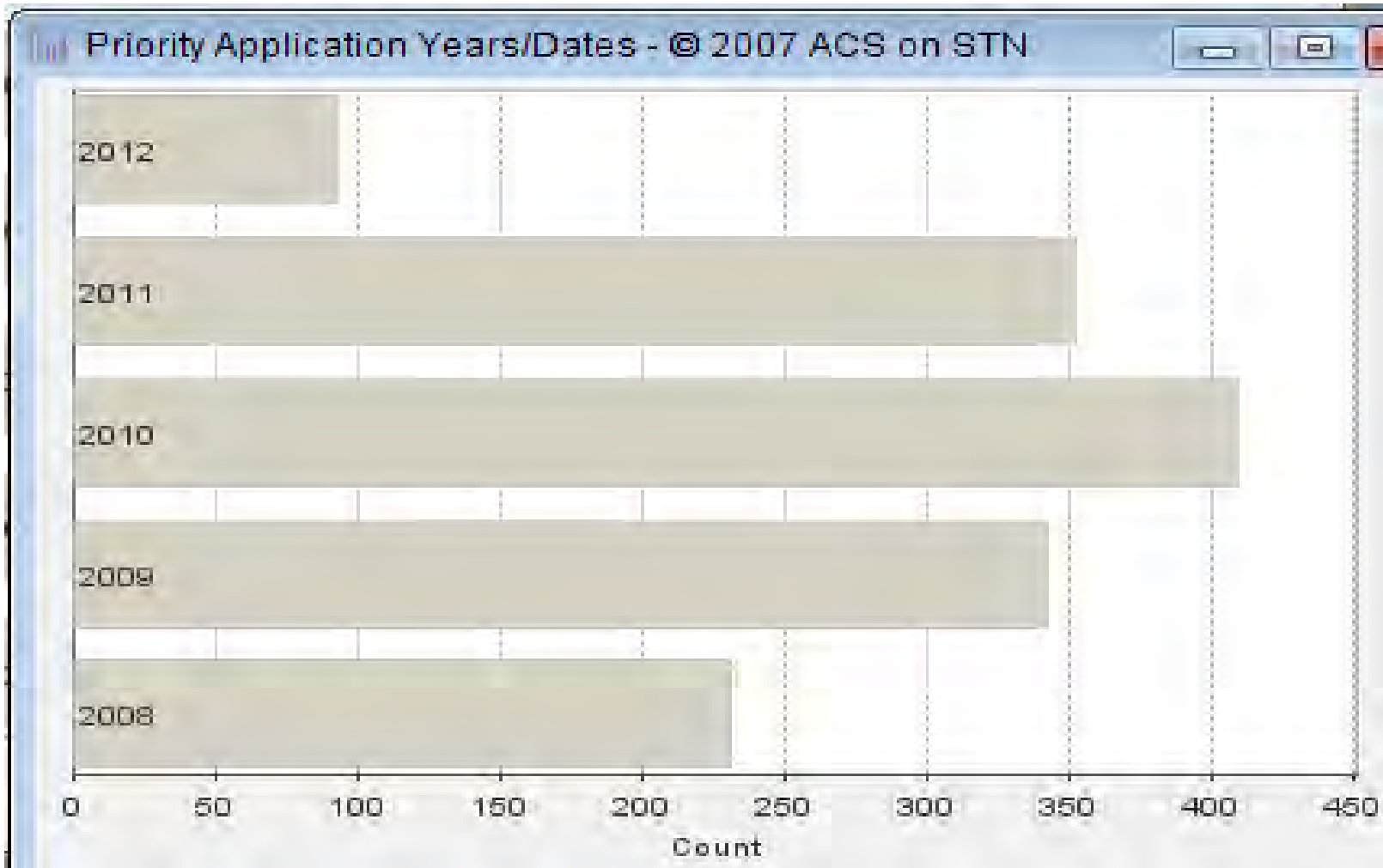
Data typically available for Patent Analytics (2)

- Text from documents
 - Titles (First page or man-made abstracts)
 - Abstracts (First page or man-made abstracts)
 - Claims
 - Description
- Legal Status

Contents

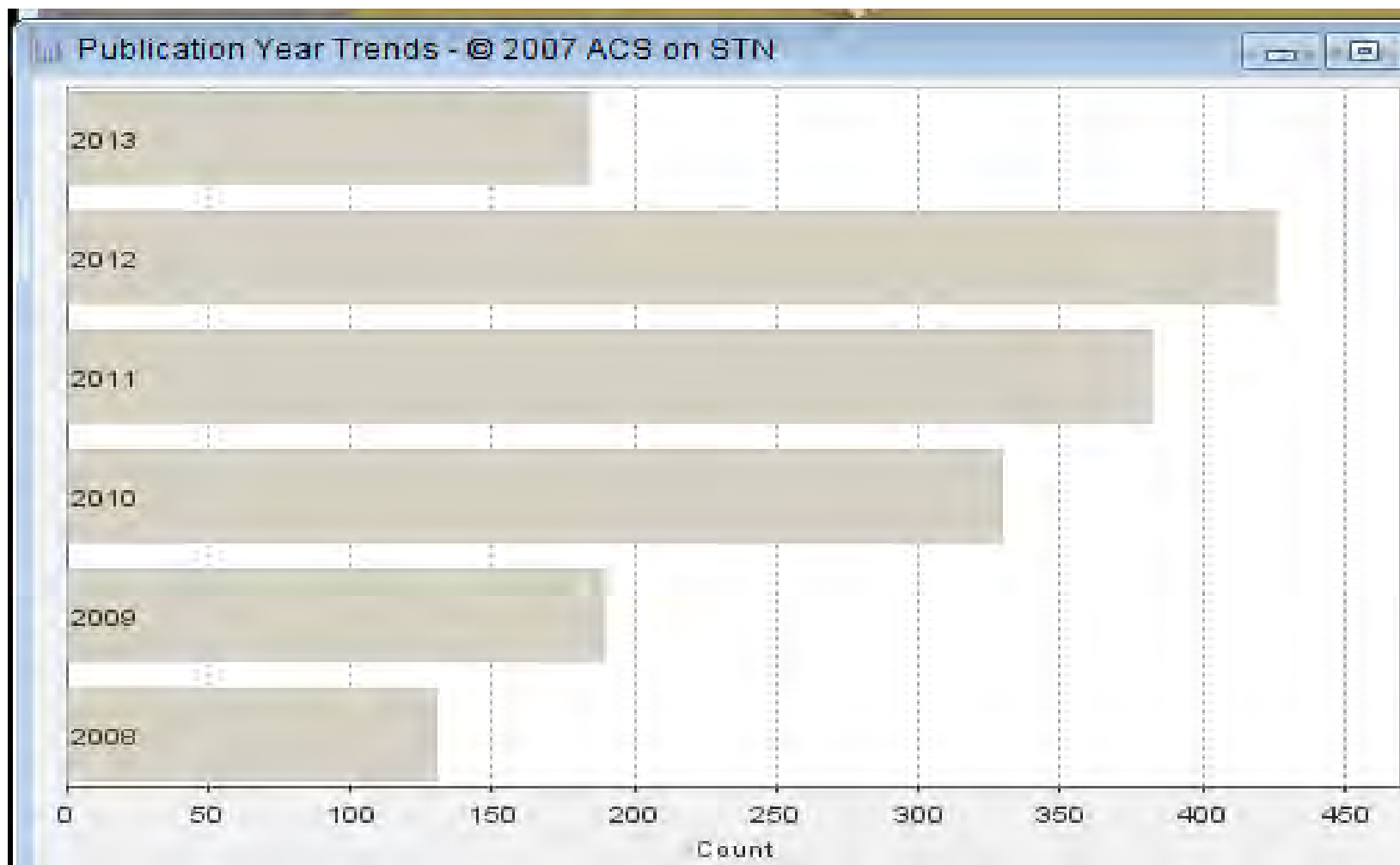
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Priority Application Years



STN AnaVist on WPI data

Publication Year Trends



STN AnaVist on WPI data

Key Assignees by Patent Documents

Key Organizations/Assignees by Document Distribution - © 200	
	Patent
HELIAE DEV LLC	49
Mitsubishi Heavy Industries...	48
ZH CHIKYU KANKYO SAN...	39
CHINESE ACAD SCI OCE...	34
SOLAZYME INC	29
XINAO SCI&TECHNOLOG...	28
JFE Holdings, Inc.	28
SAPPHIRE ENERGY	26
IHI Corporation	17
Tokyo Electric Power Co., ...	16

STN AnaVist on WPI data

Key Assignees by Publication Year on WPI data (STN AnaVist) – by co-occurency frequency

Key Organizations/Assignees by Publication Year Trends - © 2007 AC

	2012	2009	1995	2011	2010
HELIAE DEV LLC	34			10	
CHINESE ACAD SCI OCE...	12			9	5
XINAO SCI&TECHNOLOG...	6	11		2	7
JFE Holdings, Inc.			11		
Mitsubishi Heavy Industries...			9		
SAPPHIRE ENERGY	3	3		5	9
IHI Corporation	9				
LIVEFUELS INC	3			1	9
ZH CHIKYU KANKYO SAN...			8		
SOLAZYME INC	6	2		3	7
China Petroleum and Che...	7			2	1
UNIV SOUTH CHINA TEC...		1		7	1
Tokyo Electric Power Co., ...	6		1	3	

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Key Assignees by Publication Year

Key Organizations/Assignees by Publication Year Trends - © 2007 ACS on STN

	2013	2012	2011	2010	2009	2008
HELIAE DEV LLC	5	34	10			
Mitsubishi Heavy Industries...	1					
ZH CHIKYU KANKYO SAN...						
CHINESE ACAD SCI OCE...	3	12	9	5		1
SOLAZYME INC	6	6	3	7	2	1
XINAO SCI&TECHNOLOG...	2	6	2	7	11	
JFE Holdings, Inc.						
SAPPHIRE ENERGY	4	3	5	9	3	2
IHI Corporation	5	9				
Tokyo Electric Power Co., ...		6	3			
KAIYO BIOTECHNOLOGY...						
Japan, Ministry of Internati...						
UNIV QINGHUA		1		4	3	1
UNIV CHINA OCEAN		1	6	3	2	2

STN AnaVist on WPI data

360° Report Assignees

#	Assignee	Total No. of Records	Filing Trend (Cumulative)	No. of Filings in last 5 yrs vs Average of Top 20 Assignees	Filing Year Range
1	MITSUBISHI CHEM IND LTD (MITU)	55 (2%)			1975-2011
2	HELIAE DEV LLC (HELI-N)	49 (1.8%)			2011-2012
3	ZH CHIKYU KANKYO SANGYO GIJITSU KENKYU (CHIK-N)	39 (1.4%)			1992-2000
4	SOLAZYME INC. (SOLA-N)	29 (1.1%)			2005-2012

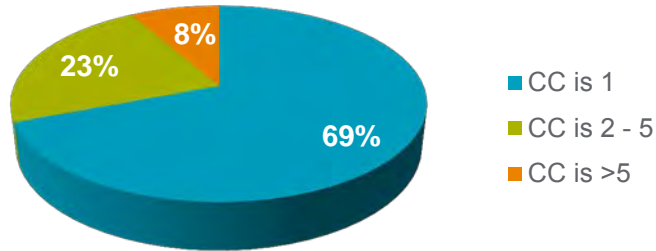
Top Assignees vs Priority Country

Priority_Country	Total	CN	JP	US	WO
Assignee_Name					
Total	261	27	125	108	1
HELIAE DEV LLC	48			48	
MITSUBISHI CHEM	45		45		
ZH CHIKYU	34		34		
XINAO	27	27			
SOLAZYME INC	25			25	
KAWASAKI STEEL	21		21		
SAPPHIRE ENERGY	19			19	
UNIV ARIZONA	18			17	1
ISHIKAWAJIMA	17		17		
TOKYO ELECTRIC	15		15		

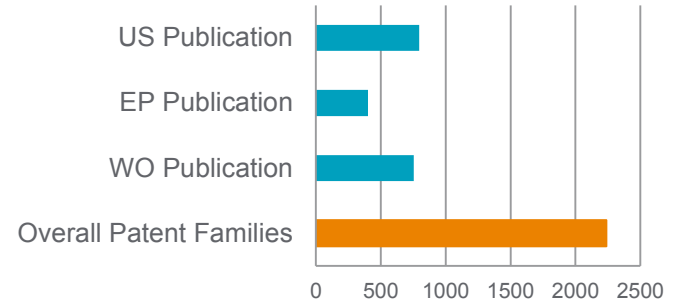
STN AnaVist on WPI data

Technology Coverage in Global Markets

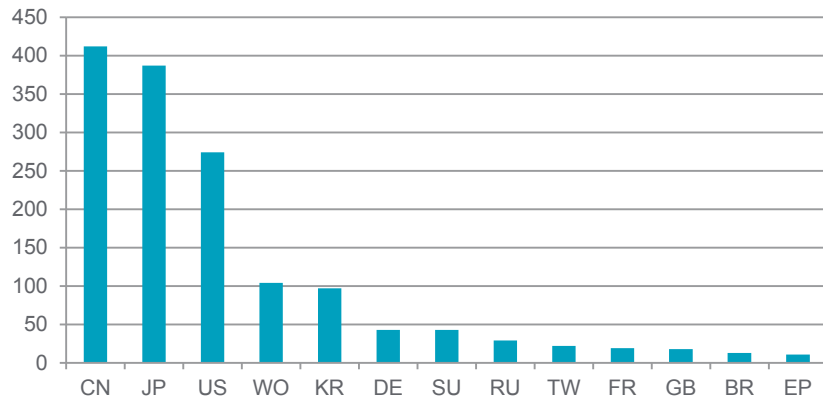
One Country Only Publication vs broad Country Coverage



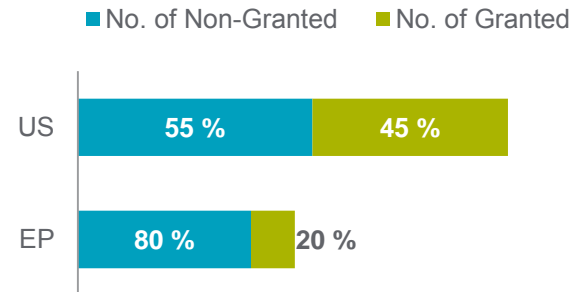
Patent Family with WO, EP or US Publication vs All Families



Patent Families with Single Country Publication



Percentage of Granted EP or US



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Key Researchers by Documents

Key Researchers by Document Distribution - © 200	
	Patent
Kale A	52
Zhang Y	26
Li Y	26
Li X	26
Chen Y	26
Zhang J	24
Liu M	23
Zhang W	22
Takeuchi D	22
Wang Y	21

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Key Assignees by Key Researchers

Key Organizations/Assignees by Key Researchers - © 2007 ACS on STN

	Kale A	Takeuchi D	Iizuka T	Ueda R	Uehara K	Somanchi A	Franklin S	Liu M
HELIAE DEV LLC	47							
JFE Holdings, Inc.		22	21		20			
Mitsubishi Heavy Industries...				20				
SOLAZYME INC						16	16	
XINAO SCI&TECHNOLOG...								15
HAZLEBECK D A								
LIVEFUELS INC								
IHI Corporation								
Arizona Board of Regents	4							

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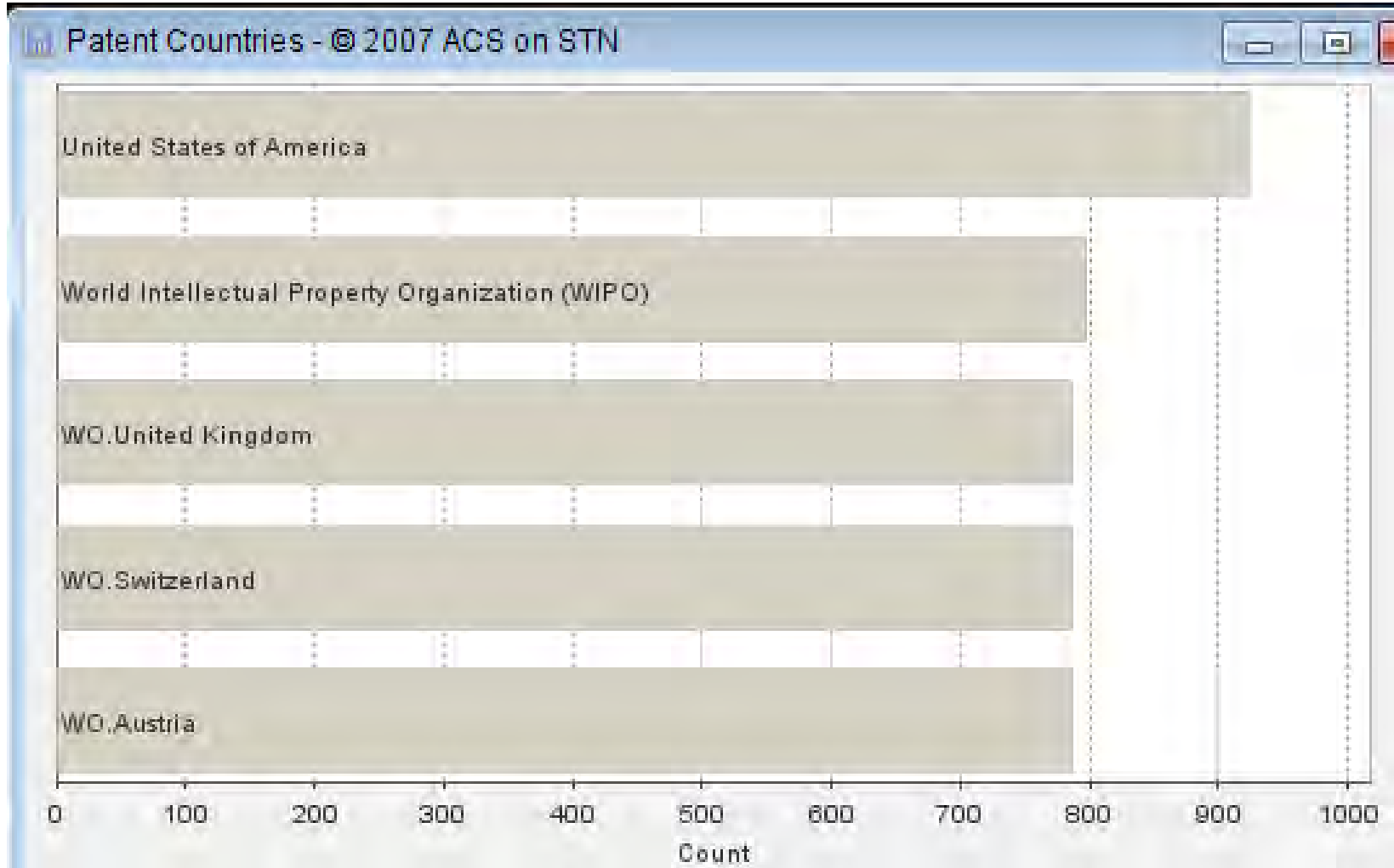
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XINAO	27	27			
SOLAZYME INC	25			25	
KAWASAKI STEEL	21		21		
SAPPHIRE ENERGY	19			19	
UNIV ARIZONA	18			17	1
ISHIKAWAJIMA	17		17		
TOKYO ELECTRIC	15		15		

STN AnaVist on WPI data

Patent Countries

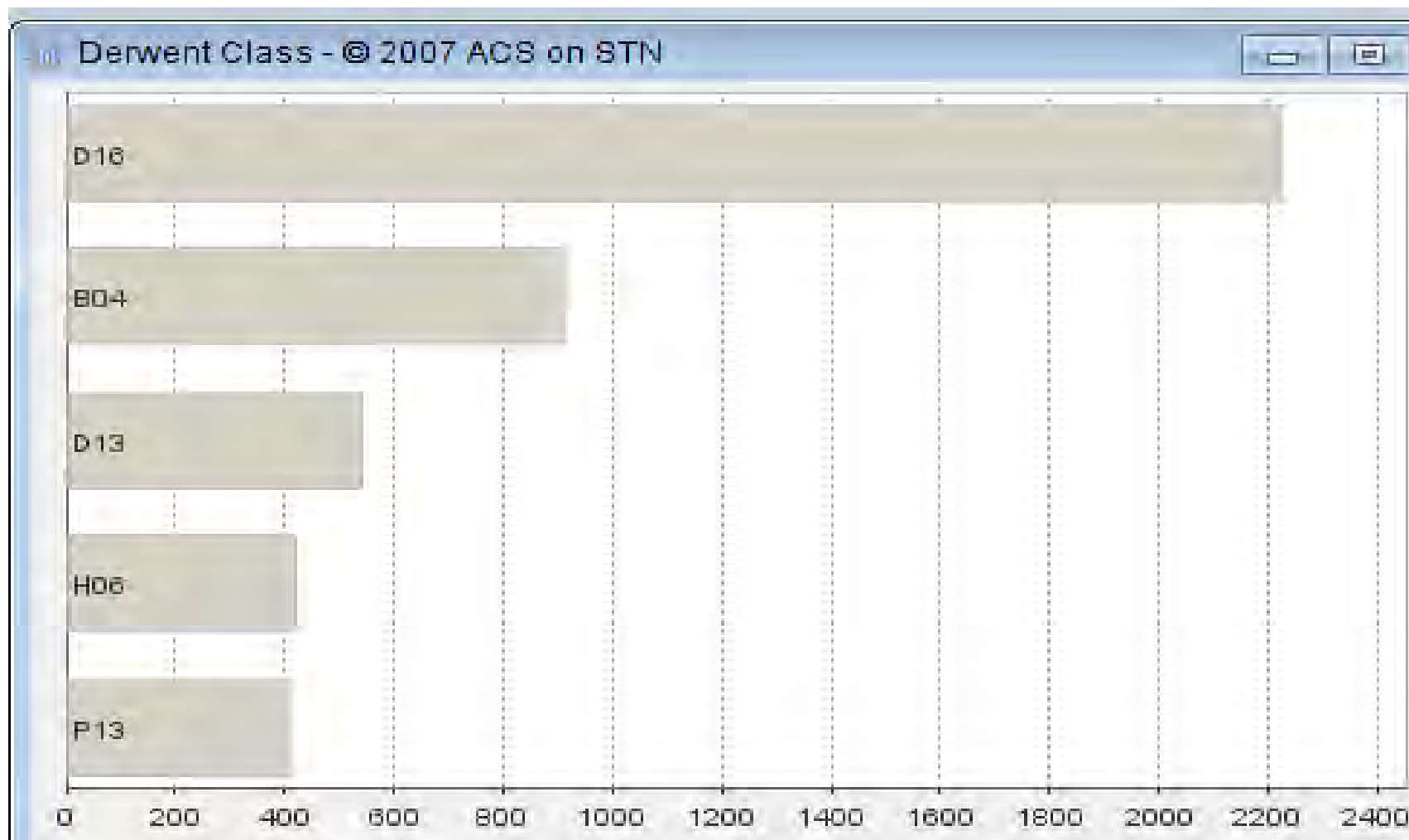


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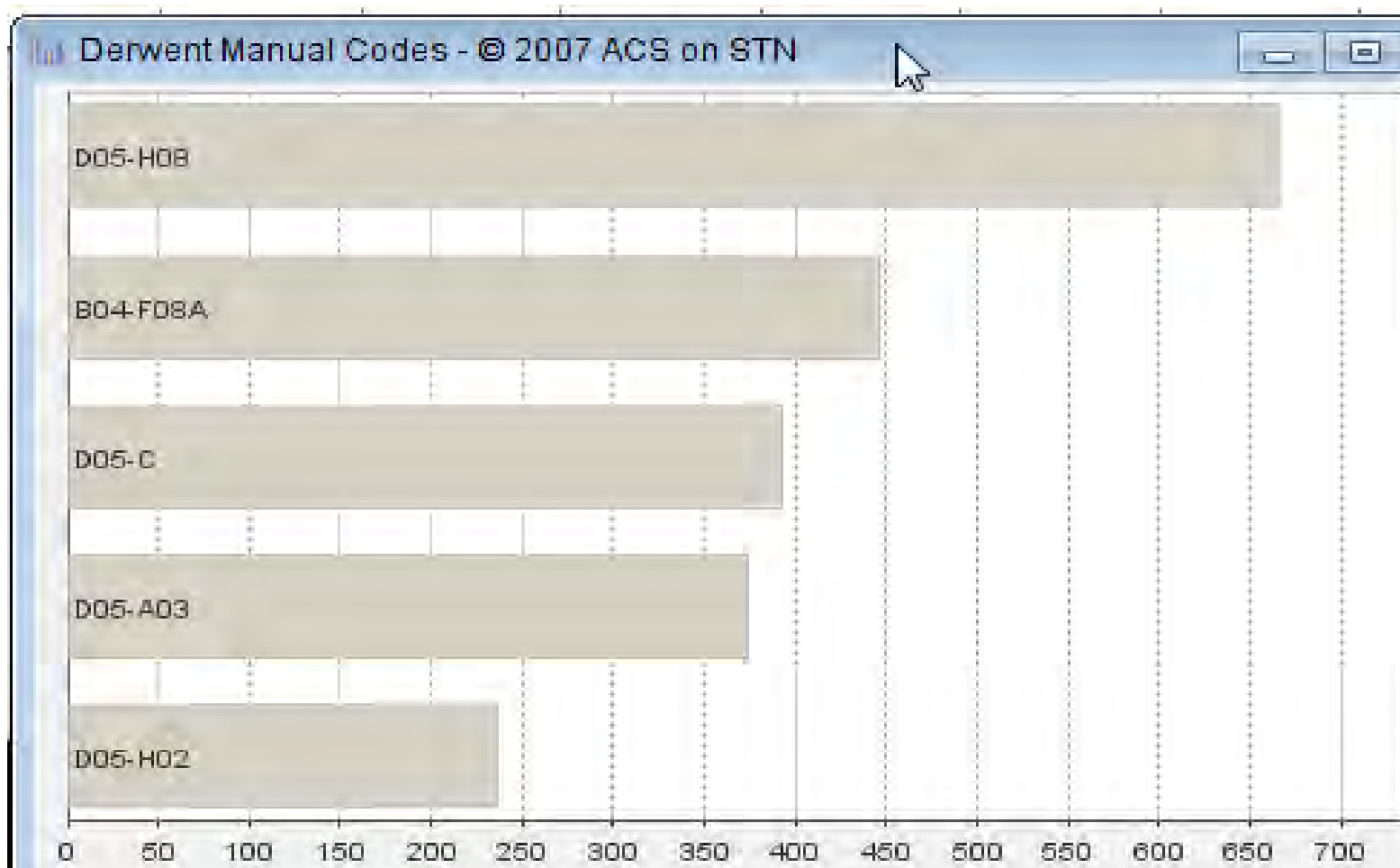
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Derwent Classes

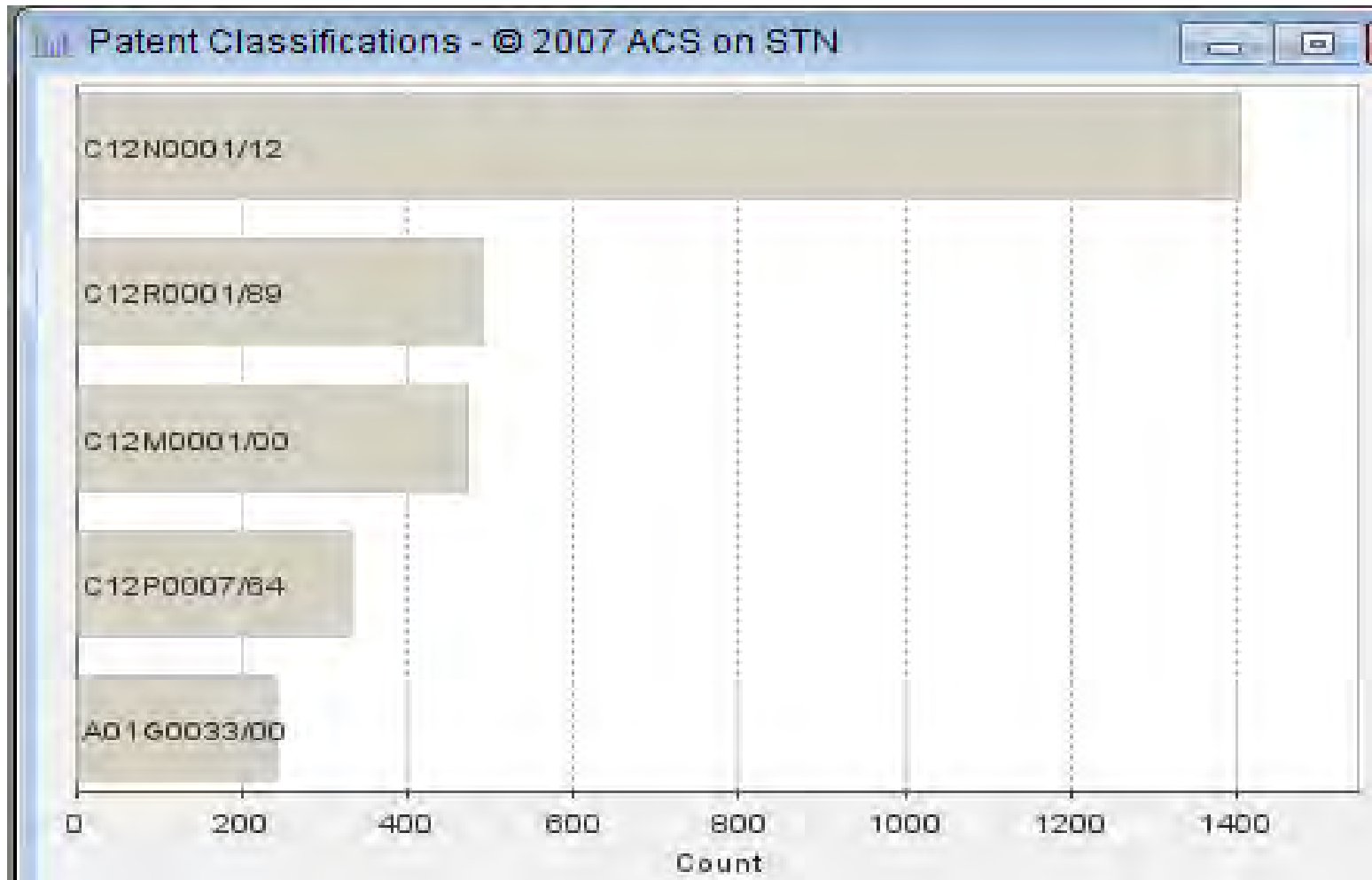


Derwent Manual Classes on WPI data (STN AnaVist)



STN AnaVist on WPI data

Patent Classifications

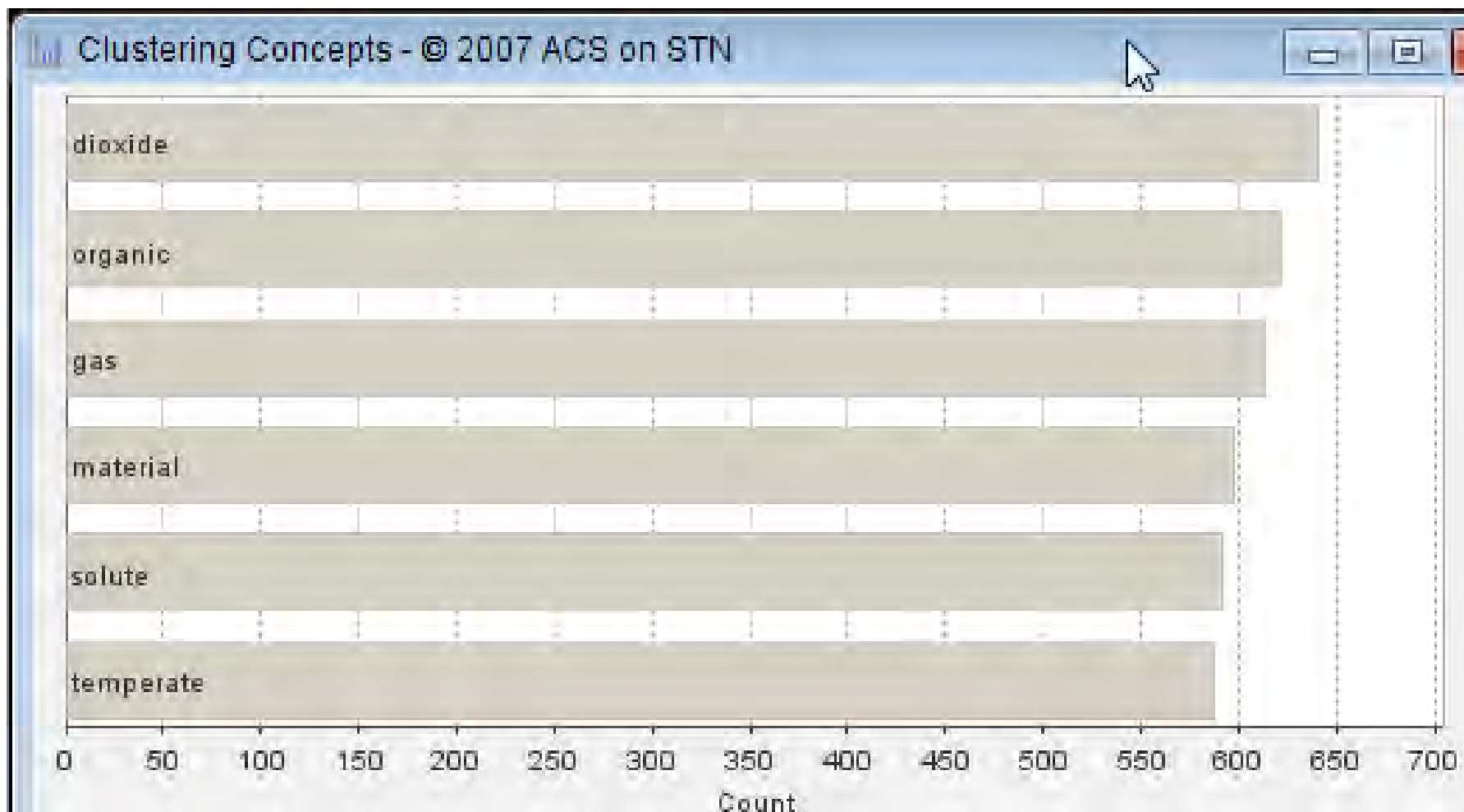


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Clustering Concepts



STN AnaVist on WPI data

Document Distribution by Clustering Concepts

	dioxide	organic	gas	material	solute	temperate	biotechnology	acid	remove	react	oil
Patent	640	622	613	597	591	587	586	567	524	523	509

STN AnaVist on WPI data

TOP Assignees vs Technology

UDC_Category	Total	Importance of light	Growth of algae	Max TAG	Downstream processing
Assignee_Name					
Total	261	53	116	70	130
HELIAE DEV LLC	48	10	4	22	44
MITSUBISHI CHEM	45	12	30	4	9
ZH CHIKYU	34	15	24	1	5
XINAO	27	7	16	1	10
SOLAZYME INC	25	3	1	17	22
KAWASAKI STEEL	21		17	6	4
SAPPHIRE ENERGY	19	1	2	3	14
UNIV ARIZONA	18	3	6	9	11
ISHIKAWAJIMA	17	1	13	3	7
TOKYO ELECTRIC	15	3	9	4	6

STN AnaVist on WPI data

Text Clustering on Titles and Abstracts

On WPI data

Text Clustering (2707)

- algal,biomass,lipid (259)
- microalgae,culture,method (205)
- sequence,gene,expression (194)
- carbon,dioxide,carbon dioxide (191)
- light,photobioreactor,photosynthetic (172)
- acid,fatty,fatty acid (167)
- pipe,tube,fluid (163)
- tank,solution,apparatus (150)
- contg,soln,aq (130)
- sodium,culture,culture medium (111)
- water,fish,pond (108)
- seaweed,sea,methane-fermentation (100)





First Page Data

Text Clustering (2707)

- microalgae,culture,method (246)
- algal,biomass,lipid (228)
- light,device,tank (195)
- acid,fatty,marine (193)
- culture,medium,cultivation (177)
- system,alga,organism (175)
- carbon,dioxide,carbon dioxide (172)
- gene,expression,protein (145)
- hydrogen,ethanol,fermentation (141)
- water,bacterium,body (115)
- microorganism,photosynthetic,photosyn (115)
- strain,chlorella,microalga (92)

Thomson Innovation Analyst

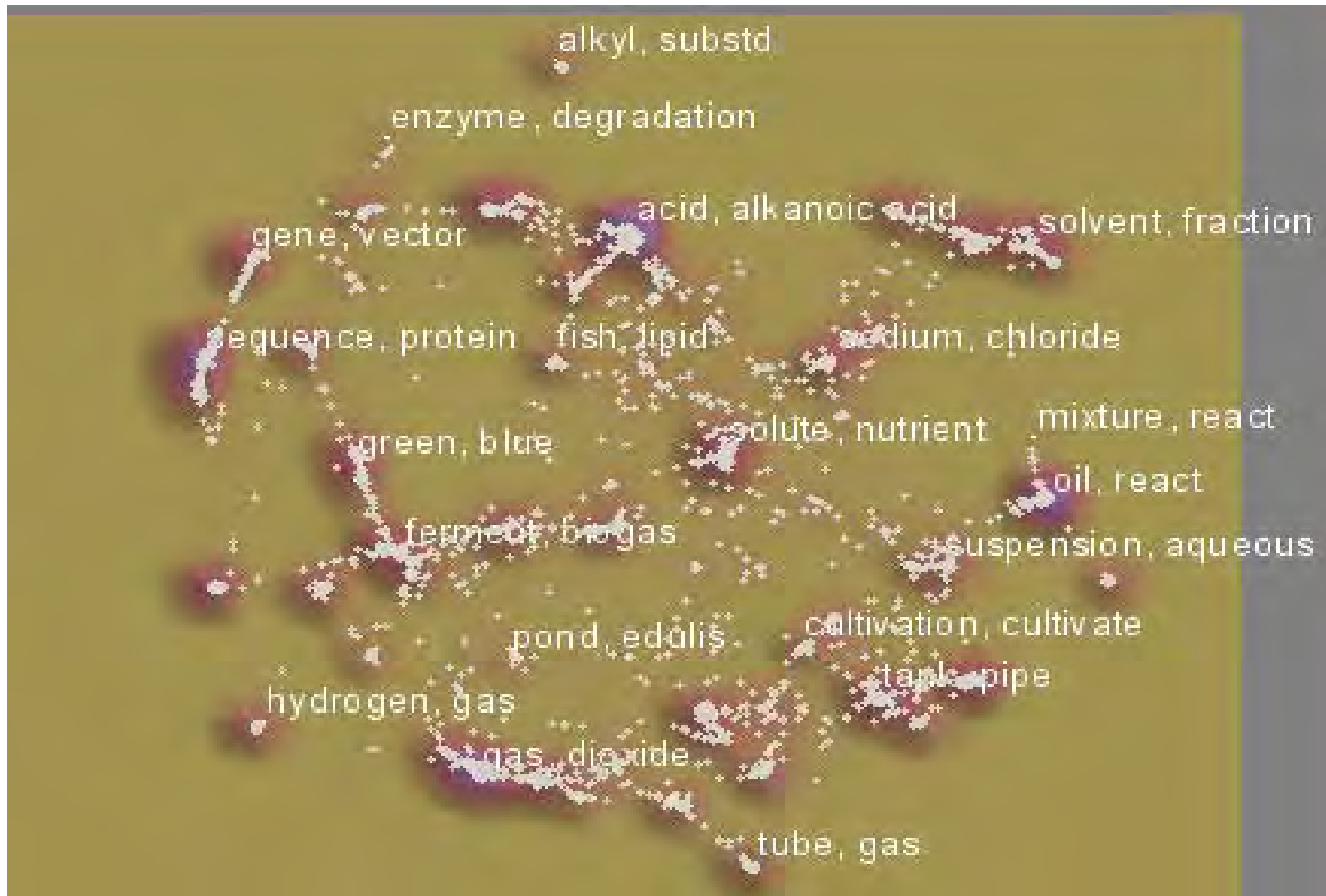
360° Report on Technologies

#	UDC	Total No. of Records	Filing Trend (Cumulative)	Filing Year Range	Top 5 Assignees	Top 5 Inventors
1	Growth of algae	1249 (46.2%)		1967-2013	MITSUBISHI CHEM IND LTD (MITU)(30) ZH CHIKYU KANKYO SANGYO GIJITSU KENKYU (CHIK-N)(24) KAWASAKI STEEL CORP HELIAE DEV LLC (HELI-N)(44) SOLAZYME INC (SOLA-N)(22) SAPPHIRE ENERGY(14) UNIV ARIZONA(11) UNIV QINGHUA(10)	Zhang Y(16) Takeuchi D(16) Liu M(16) Li Y(15) Iizuka T(15)
2	Downstream processing	969 (35.8%)		1965-2013	HELIAE DEV LLC (HELI-N)(44) SOLAZYME INC (SOLA-N)(22) SAPPHIRE ENERGY(14) UNIV ARIZONA(11) UNIV QINGHUA(10)	Kale A(49) Franklin S(16) Somanchi A(13) Rakitsky W(12) Rudenko G(12)
3	Max TAG	515 (19%)		1970-2013	HELIAE DEV LLC (HELI-N)(22) SOLAZYME INC (SOLA-N)(17) LIVE FUELS INC (LIVE-N)(10) UNIV ARIZONA(9) KAWASAKI STEEL CORP	Kale A(26) Franklin S(12) Somanchi A(11) Rudenko G(10) Rakitsky W(9)
4	Importance of light	477 (17.6%)		1970-2013	ZH CHIKYU KANKYO SANGYO GIJITSU KENKYU (CHIK-N)(15) MITSUBISHI CHEM IND LTD (MITU)(12) HELIAE DEV LLC (HELI-N)(10)	Kale A(9) Tanaka Y(7) Mori K(6) Li Y(6) Li X(5)

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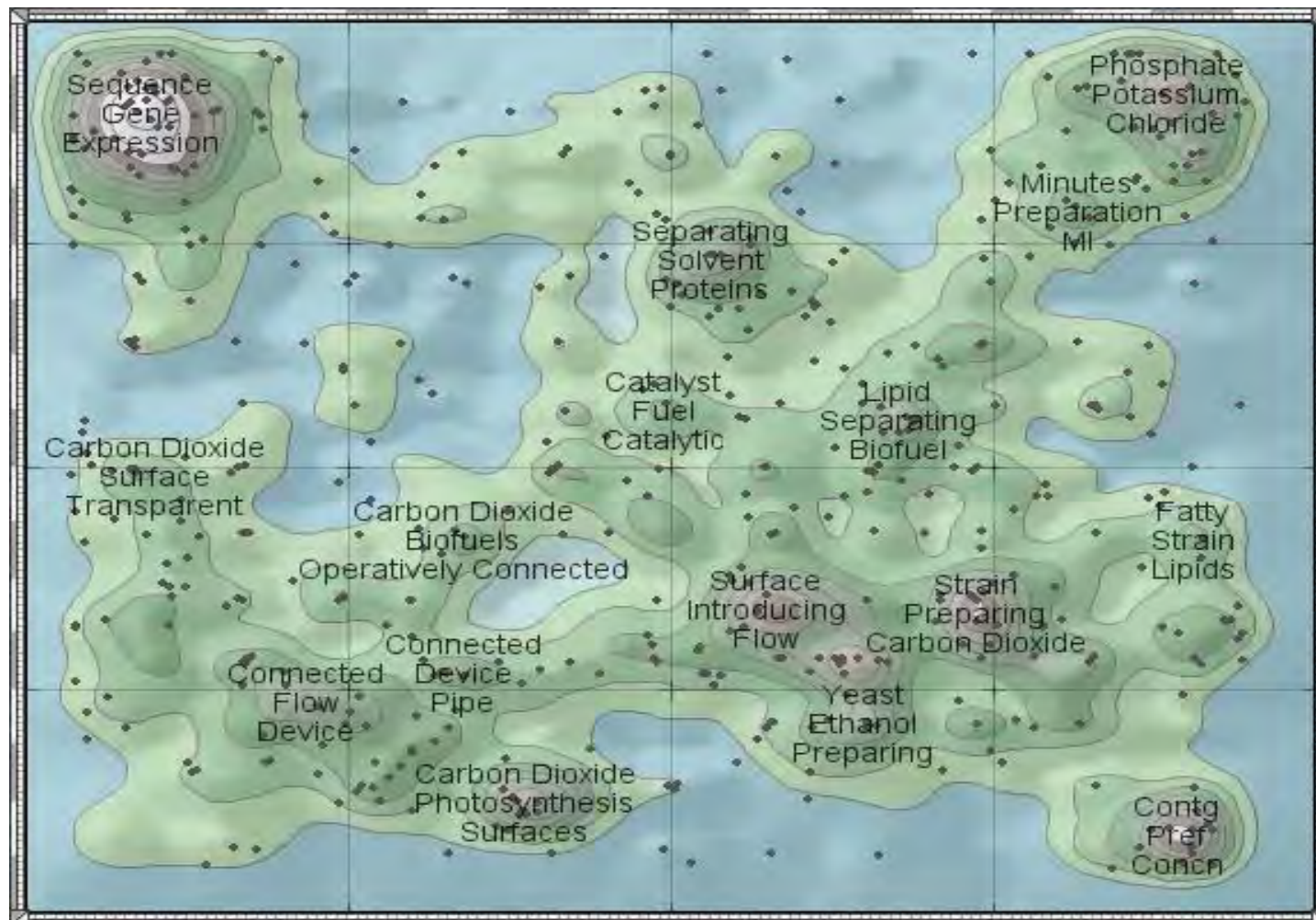
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Concept map based on WPI titles and abstracts



STN AnaVist on WPI data

Concept map based on *WPI* titles and abstracts



Thomson Innovation Analyst Themescape

Concept map based on *First Page* titles and abstracts



Thomson Innovation Analyst Themescape

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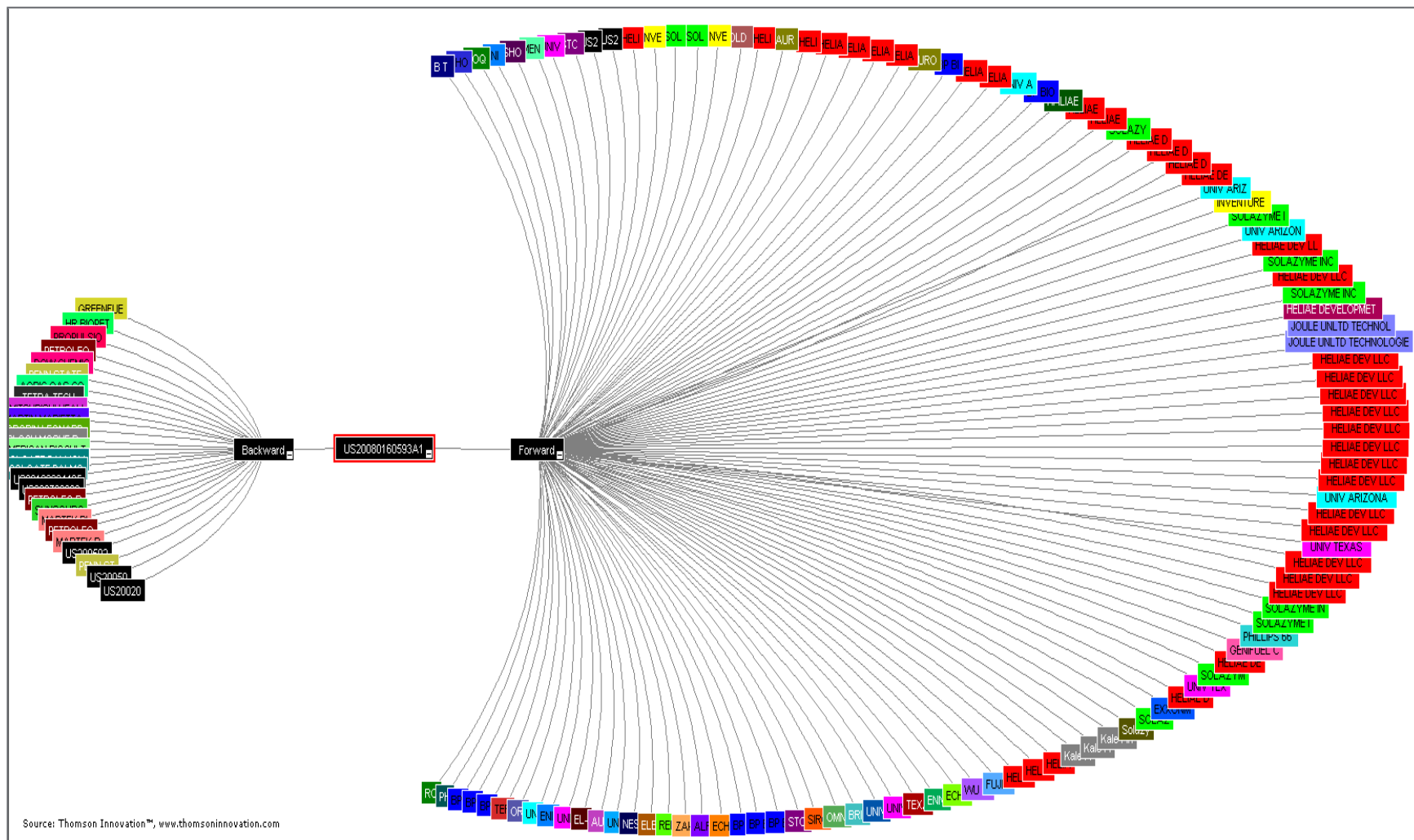
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Top Cited Patent Publications¹

Patent Number	Patent Assignee	Category	Citing Patent Count	Family Member Country Count
US20080160593	GENIFUEL CORP (GENI-N)	Downstream Processing;	113	1
US4267038	THOMPSON W J (THOM-I)	Downstream Processing; Importance of Light;	92	1
US20070048848	SUNSOURCE IND (SUNS-N)	Growth of Algae; Importance of Light;	92	1
US20090029445	ECKELBERRY N (ECKE-I),ECKELBERRY T R (ECKE-I)	Downstream Processing; Importance of Light;	81	2
US4333263	SMITHSONIAN INST (SMIT-N)	Downstream Processing; Growth of Algae; Importance of Light; Maximization of TAG;	76	1
US20100233761	SRS ENERGY (SRSE-N)	Downstream Processing;	58	8
US20050064577	BERZIN I (BERZ-I)	Downstream Processing; Growth of Algae; Importance of Light;	54	1
WO08151149	SOLAZYME INC (SOLA-N)	Downstream Processing; Maximization of TAG;	54	15
US4253271	BATTELLE MEMORIAL INST	Growth of Algae; Importance of Light; Maximization of TAG;	53	1
WO9111918	MARTEK BIOSCIENCES CORP (MTKB),MARTEX CORP (MART-N)	Downstream Processing; Growth of Algae; Maximization of TAG;	53	12
WO9737032	DSM,GIST-BROCADES (KONN)	Downstream Processing; Maximization of TAG;	51	12
US5661017	DUNAHAY T G (DUNA-I),JARVIS E E (JARV-I),ROESSLER P G (ROES-I)	Maximization of TAG;	50	1
WO08144583	PETROALGAE,UNIV ARIZONA	Downstream Processing; Growth of Algae; Maximization of TAG;	50	3
US20100261922	AURORA ALGAE INC (AURO-N)	Downstream Processing; Maximization of TAG;	50	3

¹ Patent Publications cited more than 50 times are listed.

Forward and Backward Citation Map of Most Cited Patent



Thomson Innovation Analyst Citation Mapping

Bringing plant potential to life