INCUBATOR

UCSD

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In this Issue:

Computers See Through Faked Expressions of Pain Better Than People

A joint study by researchers at the University of California, San Diego and the University of Toronto has found that a computer system spots real or faked expressions of pain more accurately than people can.

The work, titled "Automatic Decoding of Deceptive Pain Expressions," is published in the latest issue of Current Biology.

"The computer system managed to detect distinctive dynamic features of facial expressions that people missed," said Marian Bartlett, research professor at UC San Diego's Institute for Neural Computation and lead author of the study. "Human observers just aren't very good at telling real from faked expressions of pain."

Senior author Kang Lee, professor at the Dr. Eric Jackman Institute of Child Study at the University of Toronto, said "humans can simulate facial expressions and fake emotions well enough to deceive most observers. The computer's pattern-recognition abilities prove better at telling whether pain is real or faked."

(cont on page 2)

Which expression do you think shows real pain? Attempts to fake expressions of pain typically involve the same facial muscles that are contracted during real pain. There is no telltale facial muscle whose presence or absence would indicate real or faked pain. The difference is in the dynamics. The real expression of pain is image B on the right.

Facial Expression, cont from page 1

The research team found that humans could not discriminate real from faked expressions of pain better than random chance – and, even after training, only improved accuracy to a modest 55 percent. The computer system attains an 85 percent accuracy.

"In highly social species such as humans," said Lee, "faces have evolved to convey rich information, including expressions of emotion and pain. And, because of the way our brains are built, people can simulate emotions they're not actually experiencing – so successfully that they fool other people. The computer is much better at spotting the subtle differences between involuntary and voluntary facial movements."

"By revealing the dynamics of facial action through machine vision systems," said Bartlett, "our approach has the potential to elucidate 'behavioral fingerprints' of the neural-control systems involved in emotional signaling."

The single most predictive feature of falsified expressions, the study shows, is the mouth, and how and when it opens. Fakers' mouths open with less variation and too regularly.

"Further investigations," said the researchers, "will explore whether over-regularity is a general feature of fake expressions."

In addition to detecting pain malingering, the computer-vision system might be used to detect other real-world deceptive actions in the realms of homeland security, psychopathology, job screening, medicine, and law, said Bartlett.

UC San Diego researcher Marian Bartlett in her lab.

"As with causes of pain, these scenarios also generate strong emotions, along with attempts to minimize, mask, and fake such emotions, which may involve 'dual control' of the face," she said. "In addition, our computer-vision system can be applied to detect states in which the human face may provide important clues as to health, physiology, emotion, or thought, such as drivers' expressions of sleepiness, students' expressions of attention and comprehension of lectures, or responses to treatment of affective disorders."

The above story is reprinted from materials provided by UCSD News Center.

The original article was written by Paul K. Mueller.

"Our approach has the potential to elucidate 'behavioral fingerprints' of the neural-control systems involved in emotional signaling."

— Marian Bartlett

UC San Diego Start-Up Emotient Shows the Face of New Technology

The start-up Emotient is a prime example of how industry, academia, and venture capital can combine to create a groundbreaking business.

The basic technology arose in UC San Diego's Machine Perception Laboratory, led by Javier R. Movellan, a research scientist in the Institute of Neural Computation. Movellan and his colleague Marian Bartlett pioneered the automation of facial coding using computer vision and machine learning.

Supported by entrepreneur Ken Denman and investor Seth Neiman of Crosspoint Venture Partners, the Emotient team led by Movellan has created the Emotient API, a sophisticated facial-recognition technology with applications in the health care, retail, and entertainment industries.

In retail, the Emotient API technology allows store owners to assess customer service and quickly enhance their customers' experience. In health care, the technology provides an opportunity for physicians to better engage patients through online video calls, and may help in diagnosing depression and other mental disorders. In video games, the Emotient API allows awareness of gamers' emotional and physical responses, so the content and pace of games can be changed to generate unique and personalized enhancements.

"Seth Neiman pointed me to the UC San Diego team," said Denman, now Emotient's chief executive officer. "He told me they were the most published, the most experienced, the most enthusiastic researchers doing this work."

Movellan credits the university for the smooth and efficient start-up process.

"There was a genuine will to help Emotient innovate," he said. "UC San Diego is amazing at working on interdisciplinary science. They were really innovative in helping computer scientists, psychologists, and entrepreneurs collaborate."

Denman also credits the university's Technical Transfer Office (TTO) and its associate director William Decker.

"I worked with William Decker, and I was very impressed with his knowledge, skill, and ability to get things done and to keep his commitments and be reasonable in his negotiations overall," Denman said. "I was very pleasantly surprised."

Emotient now joins the long list of start-ups – currently more than 180 -- that the TTO has helped to establish, Decker said.

"Ken Denman is an innovator, and a pleasure to work with. We hope he considers other technologies now under way at UC San Diego."

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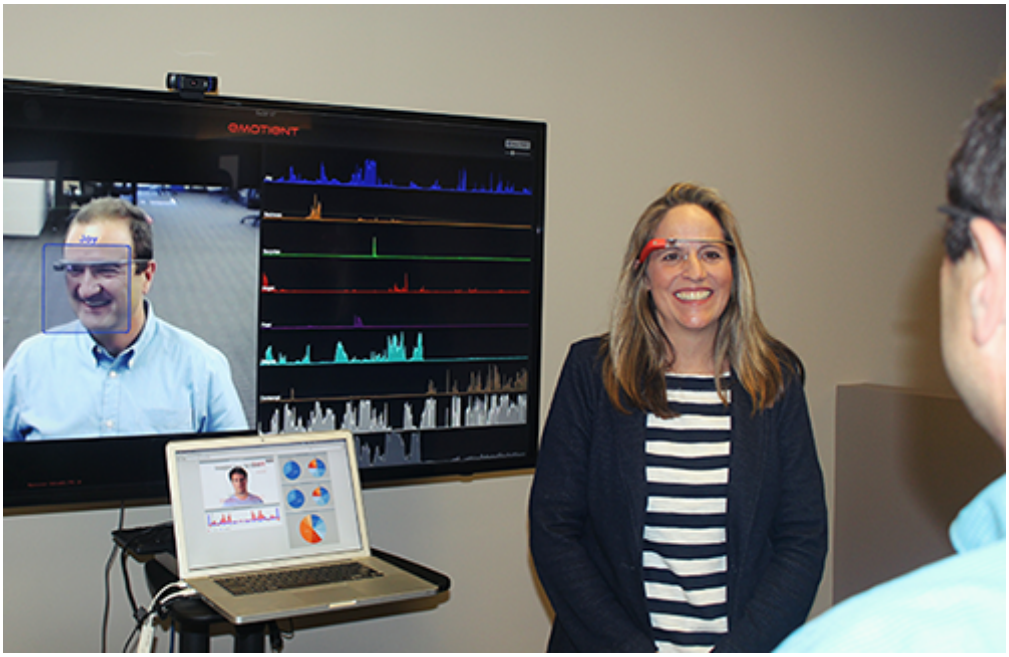


Emotient makes software that can pinpoint seven emotions based on facial expressions. It has developed a beta app for Google Glass,which will be available to select customers and partners.

Innovator Talks About Getting University Work Into Business

By U-T San Diego Jan. 27, 2014

TTO: Those letters often strike fear into the hearts of scientists and venture capitalists. They stand for Tech Transfer Office, the place you have to negotiate if you want to commercialize technology developed at a university or research institute.

San Diego's future success in the innovation economy depends in part on mining these new technologies. So let's meet Marian Bartlett, co-founder and lead researcher for Emotient, winner of Connect's 2013 Most Innovative New Products Award in the software category for FACET, which translates facial expressions into actionable information, enabling companies to create new levels of customer engagement.

Q: Did you start out to be a scientist?

A: I had some preconceived notions that women and girls didn't like math. Then in college I realized that I was good at it and became a math major. After college, I wanted to use my math skills with something human oriented so I contacted everyone in Boston in the visual perception field, and I was hired as a research assistant at MIT. Then I came to UCSD, where I earned a Ph.D. in cognitive science and psychology in 1998. (Her thesis became the basis of Emotient.)

Q: When did you first learn about business?

A: At UCSD, I was fortunate that one of my professors was Robert Hecht-Nielsen, the co-founder of HNC Software (HNC developed software used by the credit card and insurance industries to detect fraud and was purchased by Fair, Isaac and Co. in 2002.). Robert bridged academia and the business world, and he taught that in his classes. He had us write SBIR (Small Business Innovation Research) proposals as part of our class on neural networks. Also, my graduate adviser, Terry Sejnowksi, had previously started a business, Softmax, with some of his former postdocs that was later purchased by Qualcomm. So I was able to see firsthand how novel research can transform into a successful business.

Q: Were other women in the program?

A: In experimental psychology just under half (of the) students were women. When I moved over to the neural network machine-learning lab at Salk, I was the only one. It was aggressive, exciting and motivating.

Q: What was it like being one of a few women?

A: On rare occasions I thought that some people perceived my male graduate peers as being smarter or more capable, but I also benefited from being one of the few women in machine learning, so people remembered me.

Q: When did you start a company?

A: In 2008 with four colleagues, we started Machine Perception Technologies, which released a toolbox for the academic community called CERT — computer expression recognition toolbox. Silicon Valley venture capitalist Seth Neiman, a senior partner at Crosspoint Venture Partners, tried the demo on the website. In 2012, he became our lead investor, and we changed the company name to Emotient.

Q: Did you leave your research professor position at UCSD?

A: I wanted to remain part time at UCSD because I enjoy research, and I had commitments to students, I was the principal investigator on $3 million to $4 million in grants at the time and had $10 million total since 2001. UCSD's policies regarding intellectual property are interpreted very broadly and contain language often called the umbilical clause. If you are a faculty member, even if you do research on your own time and in separate facilities, UCSD will claim ownership. The result is to force out people who develop ideas. I was required by the investors to take a full leave or there would have been no company.

(Neil's note: I think it is sad that Bartlett had to leave UCSD. The whole issue of how a university tries to monetize intellectual property will be a topic for another column.)

Q: What's different between an academic setting and a startup?

A: At UCSD, the primary objective was to generate research papers that had the highest impact on our field. A complex research paper doesn't generate revenue. Pitching to venture capitalists and actually selling software were new skills for our team. We

needed to blend our science skills with the business skills of Seth Neiman and our CEO, Ken Denman.

Q: What advice would you give to other academics who want to commercialize their technology?
A: Team up with the right partners with deep experience in the business world unless you want to spend a lot of time writing SBIR proposals.

We love Bartlett's story. Clearly she is a determined individual passionate about her work, and she understands the importance of knowing what you don't know. We hope that universities and research institutes will revisit and revise their intellectual property policies so that inventive scientists like Bartlett can maintain a foothold in both academia and business.

Neil Senturia and Barbara Bry, serial entrepreneurs who invest in early-stage technology companies, take turns in writing this weekly column about entrepreneurship in San Diego. Please email ideas to Barbara at bbry@blackbirdv.com .

Chancellor Pradeep K. Khosla welcomed Senate Majority Leader Ellen Corbett and expressed his confidence in the potential of the program to revolutionize the way we understand the brain.

Member Spotlight - Kim Hutson de Belle

Sustainability of TDLC

Newsletter editor Tomoki Tsuchida has sat down with TDLC executive director Kim Hutson de Belle to talk about her continuing work on funding and sustaining TDLC.

- Can you briefly describe your background?

I am a geochemist by training. I studied hydrology of the Grand Canyon, particularly the aquifer system of the South Rim. I then lived in Nevada for seventeen years, where I worked for water agencies and helped discover new water resources and invoke a conservation effort in Nevada for water use. In the course of doing that, I found myself more involved with their community outreach and planning for physical improvements in the system. I began to do more strategic planning and organizational development, and I established citizen roots that would help us manage the resources more effectively. Getting the stakeholder to buy in, as it were.

About seven years into the job, I realized I was no longer doing science anymore, but was facilitating the strategic processes for government agencies, nonprofits, and grassroots organizations instead. I've also worked for environmental engineering consulting farms that would do big public projects and pipelines – dams, water storage reservoirs, and flood control. A lot of facilitating and mediating were necessary when the development made many people in the community upset. So I would work with the community and the development proponent, and I helped them design and build the project together.

I moved to San Diego in December 2010 with my husband Stephen, who is a neuroscientist and the technical director for the TDLC. He was in Washington, D. C. with the NSF for three and a half years. When we were in D. C., I got a call from a friend who had a pharmaceutical company here. And he said: "come move to San Diego, and come work with me!" So we did. It was a very good timing. A year and a half later, Stephen was at a meeting in DC , and he ran into Andrea Chiba; they were on the panel for grant proposal review, and she said "we are losing our executive director, we need to hire a new one! Do you know anybody who we should talk to?" And he said yes, you should talk to my wife.

- What are some of your current roles here at INC?

One of the things I try to do with the amazing staff we have here is to tell our story. If you are going to be responsible for managing three to four million dollars annually, you need to share with the world all the good work that goes on at the center. The amazing collaboration that takes place at the individual investigator, laboratory and network levels is one of the strongest results

this science of learning center experiment yielded. We have collaborations across more institutions than any other science of learning centers: more than two hundred individuals in eighteen institutions across four different countries are doing research at any given time. This level of collaboration is very unusual, and to have so many people to work under the same leadership is quite remarkable. Even before I started working here, I heard many stories about the research and the training at this institution.

Young men and women are growing up in a culture that's much more collaborative and connected than my generation. The fact that this model is feeding into the younger generation's worldview and the way they work and think is very timely. There is a lot of synergy here, culturally, politically and scientifically. It provides an incredible value, and I would hate to see it stopped, simply because the federal government did not have the foresight to have a succession plan.

The federal government started out with six or seven Science of Learning Centers. Rumor has it that only one or two of them will have funding beyond 2016. For this reason, in the next two years, we need to become experts at telling our story in addition to meeting our science and training goals. We need to tell not only the larger story of the overall center, but also the individual research advances. We need to show how these are going to improve the quality of life for everyone, and how much of that research can actually help employment and become part of the economic engine.

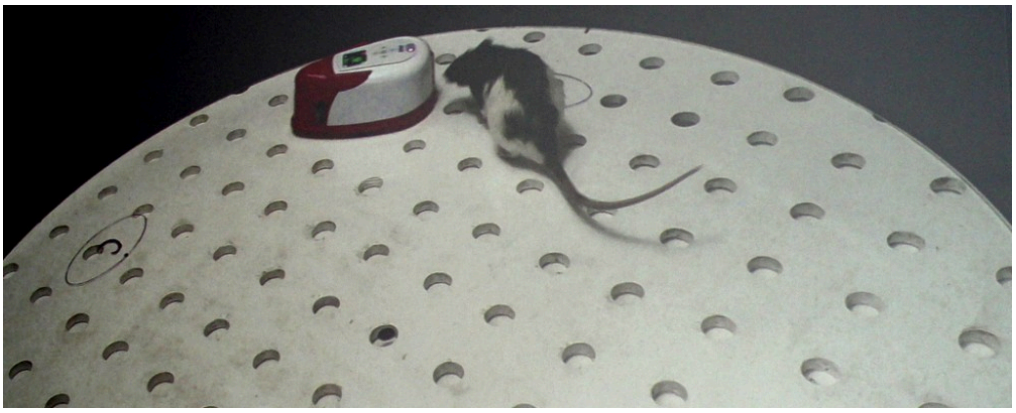
I also feel strongly about the mission to provide scientific underpinnings to the way we teach at K-12. I know it's a slippery slope: everyone has a different opinion about what's rigorous or scientific enough to propose a change to pedagogy and policy. But if anyone can do it, I would say it is the people here at TDLC. Despite the fact that most of the PIs are on the academic tenure track, they have teaching obligations. But many of them will tell you they have not taken a single education class, and they're not trained to be teachers. It's just a byproduct of what they have to do. But I think all of them respect that teaching is an important function in our society, and in our culture. If the rigorous scientific research conducted here can feed into appropriate enhancements for education, the teachers will be very much supportive of the change.

- Who do you work with most closely? Do you work with public or private sectors?

The fiscal portfolio for TDLC comprises mostly of the NSF. It's a dangerous situation, since it is very concentrated. So, my strategy is to diversify this portfolio by including funding from other sources – from other branches of the government and possibly private. The government is easier to deal with, because they expect little return: for every dollar, if you get a dollar back, that's great, but they don't demand it. Industry is more challenging, but because San Diego county and California are very supportive of new, innovative technology companies, we're in a good position to work with them too. So I'd like to see the rest of the funding come from both government and industry.

As an example of the industry funding, we signed a master research agreement in February. It's a multi-year, multi-million-dollar commitment to the TDLC. Every week, I try to go to pharmaceutical and biomedical meetings, conferences, cocktail parties to meet funders and companies that might not have the desire to build an entire research and development facility themselves. I believe the TDLC and many of our partners here on campus can act as a ready-made research and development division for companies that want to go to new directions.

The other aspect of my job is to help our principle investigators think about where in the industry sectors their work might become a basic research foundation. Of course, not everyone is interested in the commercial gain: many of the researchers believe in the open-source model that benefits the UC system's nonprofit status and the greater good, and we respect that. But there



Janet Wiles' iRat robots were used to probe the empathic capabilities of real rats.

(Credit: Minh McCloy.)

are also PIs who are interested in developing intellectual property and new inventions. So we're trying to build a model that respects our ability to work trans-disciplinarily, one that values training opportunities from the high school to post-docs and beyond. But we will need to have industry money, because everyone is aware that the federal dollars are drying up, and the competition is so fierce. I think finding a balance for the TDLC will be much easier, because we have a history of collaboration and respect in the community. That's what will allow us to build a kind of second-tier model. UCSD has many experiences across many departments in doing industry-academic collaborations, too.

- There are start-up companies, such as Emotient, that were nurtured by TDLC researchers. Are there other examples of such start-up companies?

I'll be happy to tell you about our Australian collaborator, Janet Wiles at the University of Queensland. She has been collaborating with the Andrea Chiba lab in the iRat project. When we had our annual all-hands meeting in early February, Janet came over with four iRat robots and started a series of experiments with them. The iRats were interacting with the real rats, and they were looking at empathy capacities and responses of the rats. It was exciting, because they found the rats have more capacity for empathy than people ever imagined. With the right algorithms, perhaps they can build the capacity for empathy in the iRat, not to mention discovering the limit of empathy within rats. Empathy is one of the key characteristics by which you could propose a living being to have the self-awareness and awareness of others. It is very interesting.

There are two immediate commercial possibilities from this project. The first one is that every lab in the world that wants to test out computational models can purchase iRat robots. Janet has talked to me a bit about doing commercial partners for that particular purpose.

The second one is to use the iRat as a pet or an education tool. There are lots of things you can teach children and adults with an iRat that's programmed in specific ways. And interestingly enough, the hardware and electronics within the iRat has about the same life as an average rat. So you could make something like Tamagocchi – little electronic toys where you have to feed and take care of the virtual pet – with an iRat. Since the iRat can record voices, you could use them in the classroom to record information. There are lots of possibilities. Janet's coming back in June, and I'll be introducing her to a company who would be interested in commercializing it as a lab tool, and the another company interested in commercializing it as life-enhancement technology. Janet is a PI who may not want to engage with industry, but if that can be facilitated through TDLC, then we'd be happy to have that happen.

The ultimate goal is for the PIs to have the opportunity to benefit from their discoveries, if they're interested. It reinforces the importance of staying within a "play group", as Andrea likes to call it. It's called the "play group", because they're in the basic science research, and their technology development is expedited thanks to

the collaboration and data sharing. Our primary sustainability goal is to keep that aspect intact while feeding the bottom line fiscally. I would also like to see much greater fiscal allocation for training opportunities. We have very nice programs for undergraduates to graduate students and postdocs. But there should be more collaborative cross training for the trainees, in the same ways PIs.

Here's an example: one of Viriginia de Sa's undergraduates developed a neuro-gaming system. It's an arm-wrestling game – it's literally a plastic arm – and you put on a headgear that records your brain waves. As you concentrate, you and your opponent could move the arm this way and that, depending on which one has the concentration and sending the waves the right way. So the arm moves back and forth, and you arm-wrestle with your mind. The game could be possibly commercialized as a training tool in schools, or it could be used for the entertainment purposes.

The game would be presented at a neuro-gaming conference in San Francisco in May, so I sent the notice out to a number of PIs whose labs or networks I know are interested in the neuro-gaming research. By the end of the day, there were fifteen people who wrote me back and said showed interest. So we're all going; we will be strategic about who attends which sessions, or meet with which companies. I'd like to build an awareness not only for what we do already day-to-day for our research and training, but also for the opportunities for collaboration with the industry. There're trainees who don't normally meet during the year, but do meet at these conferences. So I'd like to see us doing dinner together and talk about who we met today, or which dataset we might have and who to share it with. The iterative nature of this collaboration is an important part of the sustainability as well.

Here's another example. I met with Sheldon Brown, who is a director of the Arthur C. Clarke Center for Human Imagination that just launched in May of 2013. I met with him last week at the suggestion of Sandy Brown. She thought there might be some synergy, and as it turns out, 45 minutes before I arrived at our meeting, Sheldon had sent on a research proposal. He knew it would not get funded, because he couldn't answer the questions about the theories of learning applied to the visual arts. He said he had been looking for people on campus who study the theory of learning. If only I'd met with him two weeks ago, we could've collaborated on a grant. He recognized that he had a lot of technology and the capacity to help us answer some of the questions we're trying to answer. So, by collaborating, both his and our work would improve. We're getting together with him again in two weeks with a number of our PIs and trainees. He's going to show us some of his technologies and systems he's building, and he'll ask questions he wants answers for. Then we're going to talk about collaboration. I think that's another important part of sustainability of TDLC.

We have to have more connections with innovative centers and departments at UCSD. We have launched a new relationship with the UCSD music department as well. Some of our researchers look at sensorimotor elements in terms of timing and learning, and of course, music is full of sensorimotor and rhythmic elements. We have many researchers who're looking specifically at perception of time and attention, and we're finding synchrony in many instances can improve both. This has implications for autism, ADHD, and maybe even for some basic sensorimotor disorders like Parkison's disease. We are having our first symposium on music and the brain. We're brining in people from the UC system by and large, and we will have unique discussions among artists, educators, ethnomusicologists, cognitive psychologists, and neuroscientists.

"Our primary sustainability goal is to keep the basic science research intact while feeding the bottom line fiscally."

— Kim Hutson de Belle

That's another example where TDLC and another department go after the funding together, so that we bring added value to funders and to each other. I have just enough neuroscience and larger center experiences in organizational development to help them grow and live beyond 2016.

The final thing I will tell you is that the NSF does not have a formal process to fund the Science of Learning Centers beyond 2016. It was a 10-year experiment. But it's been quite clear globally that this experiment works, and we've seen that in Australia, their government committed to funding their Science of Learning Center. The directors of the Science of Learning Centers here in the US just came back from the United Nations congress, where they discussed education and science of learning. The Chinese government invited them to hold the meeting there, because they're very interested in re-vamping their education system. And they see that this collaboration is probably the way of the future.

There's a push by Soo-Siang Lim, who is the program director for the Science of Learning Centers at NSF. Every month, she's out on other countries promoting science of learning to UNESCO, OECD, and every other large international organization that has to do with education and the brain. She asked me last June if TDLC would consider helping lead an advocacy campaign over the next two years in Washington, D. C. to secure the funding for some of the Science of Learning Centers beyond. So some of our program directors are going to Washington, D. C. in May, and we'll start meeting with the department of education, the white house, and the NSF directorates. We will discuss how we can best use the time next two years, and how many people we can enroll across the six centers to launch a campaign. We need to fund this experiment.

We just received the news last week that NSF's budget request to congress featured TDLC. We were so excited about that. So we think that means we're in a pretty good stead. They featured us out of hundreds of millions of dollars they fund every year. So we're trying to build our reputations from this kind of publicity, one at a time.

INCEVENTS

CHALK TALKS

01/16/14	**Tony Bell**	Learning and energetics in dynamical systems
01/30/14	**Katja Lindenberg**	Non-equilibrium thermodynamics
02/20/14	**Alexander Terekhov**	Constructing space: how a naive agent can learn spatial relationships by observing sensorimotor contingencies
02/27/14	**Nima Bigdely Shamlo**	Integration of EEG source dynamics in and across studies
03/13/14	**Paul Sadja**	Your eyes give you away: pupillary responses, EEG dynamics and applications for BCI

More information: *http://inc.uscd.edu/events.html*

For more information on current events,
please contact **Kristen Michener** kmichener@ucsd.edu

INC at a glance

Institute for Neural Computation (INC)
http://www.inc.ucsd.edu
Terrence Sejnowski and Gert Cauwenberghs, Co-Directors
Carol Hudson, Management Service Officer

Swartz Center for Computational Neuroscience at INC
http://www.sccn.ucsd.edu
Scott Makeig and Tzyy-Ping Jung, Co-Directors

Machine Perception Laboratory at INC
http://mplab.ucsd.edu/
Javier Movellan, Marian Stewart Bartlett, and Glen Littlewort, Principal Investigators

Temporal Dynamics of Learning Center (TDLC) Motion Capture/Brain Dynamics Facility at INC
http://inc.ucsd.edu/~poizner/motioncapture.html
Howard Poizner and Scott Makeig, Co-Directors

Office of Naval Research (ONR) Multidisciplinary University Initiative (MURI) Center
http://inc.ucsd.edu/~poizner/onr_muri/
Howard Poizner, UCSD (PI); Gary Lynch, UCI (Co-PI); Terrence Sejnowski, Salk Institute/UCSD (Co-PI)

Mobile Brain Imaging Laboratory (MoBI) at INC
Scott Makeig, Principal Investigator

Poizner Laboratry at INC
http://inc2.ucsd.edu/poizner/
Howard Poizner, Principal Investigator

Dynamics of Motor Behavior Laboratory at INC
http://pelican.ucsd.edu/~peter/
Peter Rowat, Principal Investigator

Data-Intensive Cyber Environments (DICE) Group at INC
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