COSMOS cluster 9 got off to a rousing start with dazzling displays of technology and artistry. In the first three days, cluster 9 students were exposed to a variety of musical and technological tools. Dr. Oliveira gave an overview of the nature of soundwaves and introduced students to a sound recording and analysis software package called Audacity. Audacity generates sounds or takes sound inputs and allows the user to analyze these. Audacity also serves as a simple mixing system with which musicians can overlay multiple recording tracks. An even more challenging software package, called Pure Data that was developed at UCSD, was taught to the cluster on Wednesday by Teaching Assistant Kevin Haywood. Pure Data is a drag and drop sound synthesis system that allows students to create increasing complex sound synthesizing and processing combinations. Teaching Assistant Colin Zyskowski gave an overview of Arduinos, Raspberry Pi, and other microcontrollers that cluster 9 students will use in creating their capstone projects. During the Tuesday session, Teacher Fellow Jeff Mellinger led students through a few Audacity projects. During the Wednesday session students were instructed in the art of concert conducting by Dr. Dubnov. The session was highlighted by a group improvisation performance. Among those leading the improvisation were Nick P. and Mark E. on guitar, Sam L. and Emily K. on violin, Rochelle T. on Clarinet, Ryan W. on Trumpet, Saachi K. on the cajon box, and Ike T. on keyboard. In addition, a number of students experimented with instruments from Dr. Oliveira’s homeland, Brazil.
The watchword for Cluster 9 at the end of week one was VICTORY! The "Niners" finished the week in triumph by winning the COSMOS Olympics. The cream rose to the top as the musical and choreographic talent of the cluster members, under the leadership of RA’s Kevork and Sabira, carried the day. The performers included John G. (violin), Rochelle T. (clarinet), Elena C. (cello), Sam L. (violin), Ryan W. (trumpet), Maria V. (viola), Laryn Q. (drums), Emily K. (violin), Kaylee T. (vocals), Ashley C. (flute), Nick P. (guitar), and Saachi K. (cajon). The after-hours fun took place only at the conclusion of challenging days filled with fast-paced learning in the lab and the music hall. The team had the opportunity to rehearse its Olympics act in the Conrad Prebys Music Hall recording studio. The session featured a guitar and violin serenade by Nick and Sam of Piazzolla’s Libertango and a complex Bach fugue played by Ike Tamanaha. The students learned not one but two microcontroller systems that will be used to control their upcoming musical projects. In addition, they were served a rapid fire lecture in the basics of Python programming. Toward the end of Monday’s session the group learned that not all music comes from dedicated musical instruments; in fact, virtually any instrument that can vibrate the air can fulfill a musical purpose. The highlight of the afternoon was instruction in the art of playing a saw with a fiddle bow. Week three promises to be a bustle of activity as the cluster members form groups and embark on their capstone projects.
This week saw lectures and essays give way to brainstorming, creativity, and collaboration as the Cluster 9 team members formed groups of three and began work on their capstone projects. Essays explored an ethical issue related to sound, related technology, or the music industry. The essays submitted by the Cluster 9 students were of high quality. A number of essays were forwarded to the COSMOS administrators to be considered for COSMOS awards that will be presented at the closing ceremony. Teacher Fellow, Jeff Mellinger, selected the three for intramural awards. The first, second, and third place awards went to Tejal A., Emily K., and Rochelle T., respectively.

Among the most popular technologies used by Cluster 9 students are Pure Data, Arduinos, and the Python computer language. Pure Data is a visual programming language that provides users with the capability to create wide array of musical sounds and general sound effects. As one of the first systems presented to the cluster, several of the groups are using this program extensively in their projects. Of the microcontroller systems available, the most readily comprehensible is the Arduino. While an Arduino does not have digital signal processing capability useful in producing audio sound it has many uses as a general-purpose control of automated functions. The functionality of Arduinos is enhanced when it is connected to external circuitry. Python, though a relatively new computer language is rapidly gaining popularity for its ease of use.

The projects being developed at this point include a system that uses artificial intelligence to produce a melody for an input sequence of chords (Ryan, Ike, Bhargav); software that uses a piezoelectric stimulus to produce a percussion sound (Tejal, Emily, Mariamma); an instrument tuner and synthesizer activated by voice recognition (Nick, Sam, Jun); a system that compares a performed piece of music against its corresponding sheet music (Sihyun, Elena, Ashley); the use of neural networks to apply style transfer in synthesizing sound (John, Eric, Mark); a glove with internal sensors to produce different percussion sound based on the motion of the hand (Derek, Johnny, Laryn); The computer-generated creation of a harmony to accompany a user input melody (Saachi, Rochelle, Kaylee).

Students will be devoting some extra hours over the next week to complete their projects for the August 5 presentation.
UCSD COSMOS is in the home stretch and students in cluster 9 have been immersed in their capstone projects for the past ten days. Professors Oliveira and Dubnov along with grad students Colin and Kevin have been providing technical expertise with a 5-to-1 student to instructor ratio. Much of the learning, however, has been autodidactic with students scouring the internet for resources and information to aid them in their work.

Project in progress are:

**Saachi, Rochelle, and Kaylee**: Creation of a musical harmony based on a user provided input melody using Pure Data audio software and Python.

**Laryn, Johnny, and Derek**: Creation of a glove that produces percussion sounds based on the position of the hand using accelerometers and pressure sensors connected to an Arduino.

**John, Mark and Eric**: Use of neural networks in applying style transfer used for images to the synthesis of sound using Python and Pure Data.

**Ashley, Sihyun, and Elena**: Comparison of the accuracy of a musical performance against sheet music with dynamic time warping using MuseScore and the Python Music21 library.

**Bhargav, Ryan, Ike**: AI melody creation using probabilities based on input chord changes using Pure Data, Python, and Arduino.

**Sam, Jun, and Nick**: Instrument tuner and synthesizer activated by voice recognition using Google voice recognition API and Python speech analysis.

**Tejal, Emily, Maria**: Software that receives a musical input and uses piezoelectric sensors to produce a percussion sound.

The cluster took an afternoon off last week to visit the Museum of Making Music in Carlsbad. The Museum is sponsored by the National Association of Music Manufacturers, a trade organization that promotes the sale of musical instruments. The group spent several hours viewing and playing several unique and antique instruments. The tour guide Barbara led the group through a history of twentieth century American music. NAMM president Joe Lamond spoke with group for half an hour and spent another half hour answering questions.

The past four weeks have been a whirlwind of information. Students have gained exposure, and in many cases proficiency, in hardware such as Raspberry Pi, Arduino, electronic circuits, and sensors, as well as software systems including the Python computer language and music dedicated software such as Pure Data, MuseScore, and Music21. Cluster 9 members are looking forward to concluding their projects and presenting to parents this Saturday.