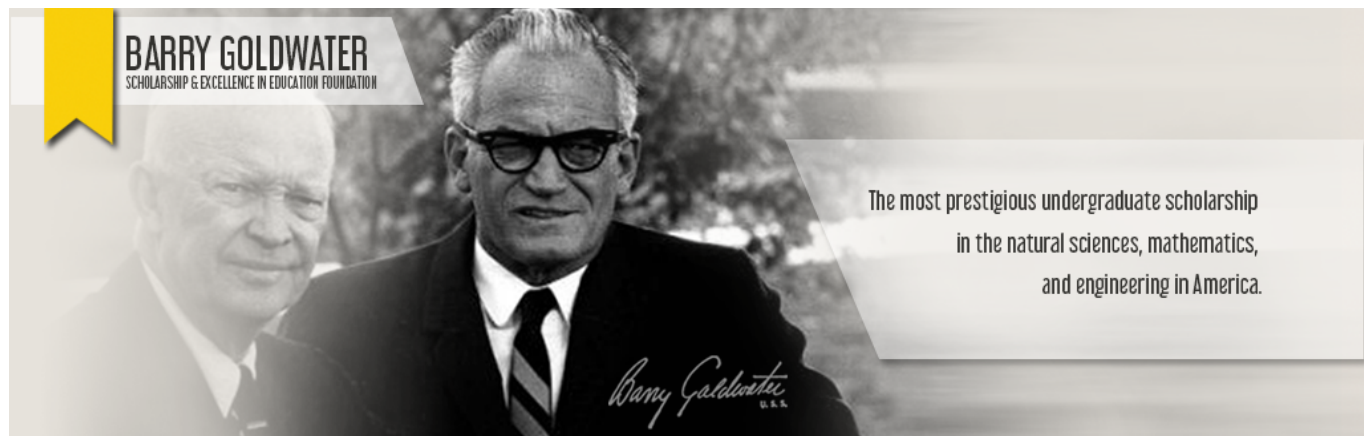


Registration ID 1274807

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The Barry Goldwater Scholarship and Excellence in Education Foundation

Application Review

Registration
ID 1274807

Registration ID 1274807

Your session will automatically time out at **5:23:03pm** Central Time if no action is taken. Any action (saving information or choosing a new page) will reset this timer.

Your application data has been submitted. No changes to your application can be made, however, you can update profile information at any time from the Student Overview screen.

Recommenders

Recommenders

Actions	Name *	Email *	Action Date	Buttons
	A. Ravi P. Rau	arau@phys.lsu.edu	01/19/2022 08:48am	
	Frank Neubrandner	neubrand@math.lsu.edu	01/19/2022 08:48am	
	Jeffery Chancellor	jeff@spartanphysics.com	01/19/2022 08:48am	

The recommender's list is currently locked. The submission window is closed.

This application requires 3 recommendations.

Making a change to the list of recommenders: Student applicants cannot make changes to the list of recommenders. Changes to the list must be made by the Campus Representative. For guidance on how to remove and replace a recommender, please see FAQ questions "[How is a letter writer replaced?](#)"

Application Questions & Answers

Legal Residence Information

Question	Answer
* Citizenship	U.S. Citizen
* Legal Residence Address Address (line 2)	3598 S Lincoln St.
* City	Siloam Springs
* State	Arkansas
* Zip Code	72761
* Your U.S. Congressional House District	3rd

Career Goals/Professional Aspirations

Question	Answer
* What is the highest degree you plan to obtain?	Ph.D.
* In one or two sentences, describe your career goals and professional aspirations (see example below). This statement will be used in publications if you are selected as a scholar.	<p>I'm planning on a Ph.D. in physics, with the goal of becoming a research faculty member at a university, with an interdisciplinary theoretical emphasis.</p> <p>The best research happens at the intersection of fields. Specialization, while essential, tends to ossify a scientist's rational toolkit and blind researchers to relevant strides made elsewhere. Progress is often restricted to infinitesimal variations of knowledge's boundary, and accomplished through heavier labor rather than more radical insight. When disciplines collide, their members graft together decades of isolated research to produce unimaginable breakthroughs. I hope to be a part of such change, and so have focused my academic efforts on attaining the skills likely to help catalyze that interdisciplinary transfer.</p> <p>Mathematics is at the core of physics, and is the most common vector through which its advancements from elsewhere are drawn. These days, the transfer can even be bidirectional, with problems in the purest of mathematics solved by physical means. Hoping to learn to interpret modern mathematics like a native, I've focused my education along mathematical headings as well as physical: in addition to my in-progress physics major, I've completed the necessary courses for an undergraduate degree in math. I've taken a couple of graduate-level classes in the subject already, and hope to meet the coursework requirement for a masters degree by the time I finish the physics program. Outside of formal education, I've made a habit of browsing through the QA section in the university library, gaining familiarity with the totality of mathematical research by looking at titles, flipping through introductions, and skimming familiarity with the contents, taking particularly interesting or useful works home for deeper study. This has given me a rough grasp of topics like Sobolev spaces, Riemannian geometry, and category theory far earlier than if I had waited until my classes had made those topics accessible.</p> <p>Just as essential to physics is computer science, providing ways to test theoretical predictions and generating new ones where exact analytical methods fail. I've had a long history of more hands-on education in the subject, working with GNU/Linux sporadically since middle school and now using Gentoo and Emacs for nearly all my computer-based workflows. I started reading programming books around the same time, and have experience with a myriad of languages and modern frameworks, particularly enjoying the functional family. I've watched many an online theoretical computer science lecture to improve the quality and my understanding of the code I write, and am familiar with quite a few modern libraries and frameworks.</p> <p>I intend to advance my capabilities in these secondary areas as I continue in physics, applying to physical</p>

* Describe an activity or experience that has been important in helping shape or reinforce your desire to pursue a research career in science, mathematics or engineering.

* In what way did COVID-19 or other hardships over the past couple of years affect your research career plans and did those events alter your ability to pursue those plans? If you have had to make changes, in what way(s) did you adapt to the situation? If COVID-19 did not influence your plans, simply state that there was no impact. Please note that your application will not be looked at less favorably in any way if you have not been significantly impacted.

(Optional question, answering the question below will depend on your personal experience.)

Goldwater Scholars will be representative of the diverse economic, ethnic and occupational backgrounds of families in the United States. Describe any social and/or economic impacts you have encountered that influenced your education - either positively or negatively - and how you have dealt with them.

problems tools fascinating in their own right, like FPGA computation or generalized functions, exploring the wonderfully turbulent regions between established bodies of knowledge, with the hope of discoveries thereby made sparking progress in them all.

As long as I can remember, I've read fanatically. Fiction proved a welcome respite from the utter monotony of elementary school, and I spent almost all of the time teachers spent talking immersed in pages penned by the likes of Card, Colfer, and C.S. Lewis. The peak of the obsession was 8th grade, wherein I checked out and read 94 books from the school library, not counting the entire Wheel of Time series and others obtained by different means—every one fantasy. If there's any common thread among those texts that so captivated me, it's this: their characters are transformed by gaining deeper knowledge of the fundamental workings of their worlds. It's not terribly surprising, then, that I should aspire to understand the fundamental workings of ours. Emulating those hero's journeys inscribed between thousands of now-tattered paperback covers, I have for the last 14 years been fixated on the career that is magic in all but its lack of mysticism. There is awe in bouncing radio signals halfway around the world off meteor trails, in the properties of superconductors and superfluids, in the many consequent miracles of the transistor; this awe and that brought by masterful worldbuilding are of one kind. My forays through literary universes engendered a thirst for this awe that further expeditions don't quench. A thirst the path of a natural scientist does.

Lockdowns started halfway through the spring semester of my freshman year. My plans to produce something tangible from the functional analysis reading I had been doing the prior year were no longer easily possible, since closure of campus shut down any whiteboard-and-library-style work. I was able to secure a last-minute interview for a full-time data science internship at J.B. Hunt, a Fortune 500 intermodal logistics company headquartered a few minutes from my hometown. I was ultimately hired, and spent the whole summer improving and porting a maintenance prediction model from IBM SPSS Modeler to a Python-based Databricks workflow. COVID continued to affect the availability of in-person research opportunities the following semester, and so I concentrated on doing independent investigation into category theory and quantum computation, principally on work done by Selinger and Valiron, among others, on abstractly equating the structure of quantum computation to lambda calculi used in linear logic. When things began to open up, I used this knowledge to start conversations with Dr. Rau, a quantum information researcher here. The detector development work I did the subsequent, mostly-normal summer was obstructed from completion this fall by supply chain issues and Dr. Chancellor's severe illness due to a mistaken coronavirus diagnosis. We've been planning on drafting a manuscript and filing for a provisional patent since last September, but these circumstances have impeded it.

I was born in the rice country around Jonesboro, Arkansas to a parks director and an OBGYN. My mother, an M.D. and first-generation college student from five generations of rural Arkansan privation, and my father, the child of two educators, were intent on maximizing the educational opportunities for their kids. The city's majority-minority school system had recently implemented forcible integration measures in light of rampant de-facto segregation, coupled with the introduction of a libertarian magnet system. My very early education consequently suffered from a long commute and gained from the STEM-focused elementary I was able to attend. When I was around 8, we moved across the state to Siloam Springs so my father could take a chief executive position at a struggling Christian nonprofit summer camp. Representing a fulfilled dream for my parents, it came with the educational consequences of a municipal tax base one-sixth the size. Disgruntled with lethargic pacing and poor instruction despite skipping 7th grade, I made the decision to abandon friends and football to attend a public charter high school 45 minutes away. This was at tremendous financial cost to my parents, who took a large income cut in changing occupations anyway and now had to support 3 hours of daily driving's worth of gas and opportunity cost. That expense bought the proximal foundation of my research career, with 60 hours of advance credit enabling me to seek 2 degrees and do early undergraduate research.

Research Projects and Skills		
Question		Answer
Research Project #1		Weak ODE Solutions
Starting Month		08
Starting Year		2019
Ongoing		No
Ending Month		03
Ending Year		2020
Average Hours/Week (Academic Year)		10
Average Hours/Week (Summer)		0
Name of Project Mentor		Frank Neubrander
Position of Project Mentor		Professor of Mathematics
Affiliation of Project Mentor		Louisiana State University
Name of Project Mentor		
Position of Project Mentor		
Affiliation of Project Mentor		
Name of Project Mentor		
Position of Project Mentor		
Affiliation of Project Mentor		
Institution where this research was performed		Louisiana State University
Description of research, including your involvement in AND contribution to the project. A separate narrative box has been provided for you to describe the research skills you acquired while working on this project.		This was effectively selected readings in functional analysis. Dr. Neubrander is something of an authority on generalized functions, and I was directed to read about some of the basics of Lesbegue integration, function spaces, semigroup theory, divergent series, and asymptotic analysis. Specifically, Hardy's "Divergent Series," Yosida's "Operational Calculus: A Theory of Hyperfunctions," and Estrada's "A Distributional Approach to Asymptotics" were major points of focus, alongside smaller passages from other works and non-published, one-on-one instruction. Due to my lack of formal analysis education, none of the coverage of the above works was terribly complete, but it showed me the light at the end of the skull-crushingly monotonous tunnel that is undergraduate advanced calculus. This work was to culminate in a poster on weak ODE solutions, but plans were suspended due to COVID-induced cancellation of the poster session. The work has resumed this year.
Research Skills (Briefly describe any research skill(s) you developed while working on this project that will be important going forward in your research career.)		I learned quite a lot of library skills by constantly fetching the various texts with snippets relevant to the work. This catalyzed independent work afterwards. The substantive aspects are useful in their own right, e.g. in formalizing physicists' casual use of delta functions.
Do you have Papers/Publications associated with this research project?		No
Do you have Presentations associated with this research project?		No

Research Projects and Skills		
Question		Answer
Research Project #2		J.B. Hunt Data Science
Starting Month		05
Starting Year		2020
Ongoing		No
Ending Month		08
Ending Year		2020
Average Hours/Week (Academic Year)		0
Average Hours/Week (Summer)		40
Name of Project Mentor		Avinash Yalavarthi
Position of Project Mentor		Senior Data Scientist
Affiliation of Project Mentor		J.B. Hunt
Name of Project Mentor		
Position of Project Mentor		

Affiliation of Project Mentor	
Name of Project Mentor	
Position of Project Mentor	
Affiliation of Project Mentor	
Institution where this research was performed	
	The summer of my freshman year, I took a full-time data science internship at J.B. Hunt Transportation Services, a Fortune 500 logistics/intermodal freight company, wherein I developed a model that estimates the repair time of tractors from basic data (e.g. mileage, repair location) based on Yandex's CatBoost that, to my knowledge, is currently deployed. My work was two-faceted: port the old IBM DB2 query over to an Azure MySQL one, and to produce a better model of the resulting data. The first part was made difficult by decades of cruft in the data pipelines. The second allowed for greater experimentation and learning on my part, and I ran through logistic regression, random forest, neural net, and many other models, tuning associated hyperparameters for the last 2 months. In the end, the hybrid categorical-continuous nature of the data made it suited to a CatBoost model, estimating the length of repairs better than SPSS Modeler by a difference in mean absolute percent error of 10%.
Description of research, including your involvement in AND contribution to the project. A separate narrative box has been provided for you to describe the research skills you acquired while working on this project.	This generated significant skill with Python; ML packages such as scikit-learn, TensorFlow, and of course CatBoost; a variety of data handling and analysis tools like SQL and the Databricks analytics platform; and distributed computing through the Apache Foundation's Spark engine.
Research Skills Briefly describe any research skill(s) you developed while working on this project that will be important going forward in your research career.	
Do you have Papers/Publications associated with this research project?	No
Do you have Presentations associated with this research project?	No

Research Projects and Skills	
Question	Answer
Research Project #3	Categorical QM Reading
Starting Month	11
Starting Year	2020
Ongoing	No
Ending Month	05
Ending Year	2021
Average Hours/Week (Academic Year)	10
Average Hours/Week (Summer)	0
Name of Project Mentor	A. Ravi P. Rau
Position of Project Mentor	Professor of Physics
Affiliation of Project Mentor	Louisiana State University
Name of Project Mentor	
Position of Project Mentor	
Affiliation of Project Mentor	
Name of Project Mentor	
Position of Project Mentor	
Affiliation of Project Mentor	
Institution where this research was performed	Louisiana State University
	This began by reading in quantum information theory with the Chuang-Nielsen text. My engagement in a graduate topology course that semester naturally led to the mathematical field of category theory, and in my reading in this subject illuminated efforts to recast the foundations of quantum information in categorical terms started by Abramsky and Coecke. This was inherently interesting to me as it applies some of the most abstract mathematics to a pressing physical problem, and I began to read in the subject. Selinger and Valiron's development of quantum lambda calculi through the formalism held further interest given the connection to functional programming languages, and I contemplated writing a proof assistant for such calculi using Isabelle. The existence of the essentially equivalent Quantomatic software that does the same for the diagrammatic ZX-calculus killed that idea. In the spring, I began conversation with Dr. Rau and started reading the Sakurai quantum mechanics textbook.
Description of research, including your involvement in AND contribution to the project. A separate narrative box has been provided for you to describe the research skills you acquired while working on this project.	I gained experience independently investigating recent progress in a research field with tools like Web of Science, chasing citation trees and figuring out which papers are most relevant. Experience with quantum computation will be useful when the subject matures and is used in computation itself.
Research Skills Briefly describe any research skill(s) you developed while working on this project that will be important going forward in your research career.	
Do you have Papers/Publications associated with this research project?	No
Do you have Presentations associated with this research project?	No

Research Projects and Skills	
Question	Answer
Research Project #4	Spaceflight Radiation Detector Development
Starting Month	05
Starting Year	2021
Ongoing	Yes
Average Hours/Week (Academic Year)	20
Average Hours/Week (Summer)	50
Name of Project Mentor	Jeffrey Chancellor
Position of Project Mentor	Grant Principal Investigator
Affiliation of Project Mentor	Louisiana State University
Name of Project Mentor	
Position of Project Mentor	
Affiliation of Project Mentor	
Name of Project Mentor	
Position of Project Mentor	
Affiliation of Project Mentor	
Institution where this research was performed	Louisiana State University
	Understanding the radiation environment inside a spacecraft is essential for safe long-term human occupation of space. Currently, detectors capable of tracking the highly energetic, massive particles encountered in cosmic rays are designed for ground-based operation, and present data in ways optimized for analysis by researchers. This work, originally intended to fly on SpaceX's Inspiration 4 mission, is to develop an iOS-based interface for ADVACAM's MiniPIX detectors that allows for easy and user-friendly presentation of key information of medical interest, without compromising the quality of data gathered. My role in the project is the primary software developer among our team of four: for the working prototype we presented to SpaceX, I wrote 100% of the Swift application and the majority of the embedded C program that wraps the MiniPIX output for transmission by Apple's proprietary iAP2 protocol. COVID issues have obstructed further progress, but the software is nearly complete.
Description of research, including your involvement in AND contribution to the project. A separate narrative box has been provided for you to describe the research skills you acquired while working on this project.	I had zero prior experience with Swift, UI/UX development, and embedded C. That which I gained will allow me to produce software of similar kinds going forward. I also learned how to pull 100 hour weeks when the grant provider moves a deadline back by a third of the remaining time.
Research Skills Briefly describe any research skill(s) you developed while working on this project that will be important going forward in your research career.	
Do you have Papers/Publications associated with this research project?	No
Do you have Presentations associated with this research project?	Yes

If yes, how many presentations are associated with this work?	2
Citation	Wilkie D., Miller J., Taylor J., Chancellor J. Embedded development for spaceflight radiation detectors. Presented at: Louisiana Space Grant Consortium Council Meeting; 2021 October 29-30; Baton Rouge, LA.
Campus, Regional, National or International	Regional
Presentation type	Poster
How are you listed on the presentation?	Presenter
Citation	Wilkie D., Miller J., Taylor J., Chancellor J. Embedded development for spaceflight radiation detectors. Presented at: LSU College of Science Dean's "Spirits and Science" Fundraising Research Showcase; 2021 November 12; Baton Rouge, LA.
Campus, Regional, National or International	Campus
Presentation type	Poster
How are you listed on the presentation?	Presenter

Research Projects and Skills

Question	Answer
Research Project #5	PHITS Porcelain
Starting Month	10
Starting Year	2021
Ongoing	Yes
Average Hours/Week (Academic Year)	5
Average Hours/Week (Summer)	0
Name of Project Mentor	Jeffery Chancellor
Position of Project Mentor	Assistant Professor of Physics
Affiliation of Project Mentor	Louisiana State University
Name of Project Mentor	
Position of Project Mentor	
Affiliation of Project Mentor	
Name of Project Mentor	
Position of Project Mentor	
Affiliation of Project Mentor	
Institution where this research was performed	Louisiana State University
Description of research, including your involvement in AND contribution to the project. A separate narrative box has been provided for you to describe the research skills you acquired while working on this project.	At SpARTAN Physics group meetings last summer during my work on spaceflight radiation detection, I noticed that the Monte Carlo particle transport program several graduate students were using had a cumbersome interface. The Particle and Heavy Ion Transport code System (PHITS) requires specially-formatted files be written and read to use it. This makes difficult, for example, the use of machine learning, which requires incremental modification to input files in each step based on the results of previous computations. Python is the standard interface between the physicist and his thinking rock, and many comparable programs provide interfaces in the language (e.g. Geant's g4py), making numerical experiments of the form described above possible. I am developing a Python type system and set of functions that enable automatic creation of an input file and running of PHITS on that input file, allowing easy interface between the program and the myriad of tools available in Python.
Research Skills Briefly describe any research skill(s) you developed while working on this project that will be important going forward in your research career.	I've been writing the library in a functional style, using immutable record types and functions instead of classes and methods. This is a pleasant style to write in and use, and is one I plan to implement for future projects. I haven't written much for use by others, an invaluable skill to develop.
Do you have Papers/Publications associated with this research project?	No
Do you have Presentations associated with this research project?	No

Mentor Recognition Information

Question	Answer
Mentor Name Jeffery Chancellor	
Title Dr.	
Mentor Name A. Ravi P. Rau	
Title Dr.	
Mentor Name Frank Neubrandner	
Title Dr.	

Letter Writer Information

Question	Answer
* Name of Letter Writer	Jeffery Chancellor
* Letter Writer's Institution	Louisiana State University
* Title of Letter Writer	Assistant Professor of Physics
* Relation of the Letter Writer to the student	Mentored projects 4 & 5

Letter Writer Information

Question	Answer
* Name of Letter Writer	A. Ravi P. Rau
* Letter Writer's Institution	Louisiana State University
* Title of Letter Writer	Professor of Physics
* Relation of the Letter Writer to the student	Mentored project 3

Letter Writer Information

Question	Answer
* Name of Letter Writer	Frank Neubrandner
* Letter Writer's Institution	Louisiana State University
* Title of Letter Writer	Professor of Mathematics
* Relation of the Letter Writer to the student	Mentored project 1

Other Activities and Accomplishments

Question	Answer
Activity/Accomplishment	Informal Physics Tutoring
Organization (if applicable)	
Scope of Activity/Accomplishment	College/University

Role/Involvement	Many of my friends were struggling with freshman physics for majors. Due to my high school work, I had it fairly easy, and spent many hours in the physics library helping them with the material. After COVID, I set up a Discord server to continue it.		
Leadership Position			
Length of Involvement	More than one academic year		

Recognitions			
	Question		Answer
Recognition Type		LURA Other	
Award Description		The Louisiana Space Grant Consortium Undergraduate Research Assistantship is a statewide award for work done in accordance with NASA research priorities. I have been funded for the 2021-22 academic year through this program.	
Award Year		2021	

Recognitions			
	Question		Answer
Recognition Type		PFLR College/University	
Award Description		The President's Future Leaders in Research scholarship provided my research wages before I was funded through other means	
Award Year		2019	

Current College/University			
	Question		Answer
* Institution type:		4-year institution	
* I am currently enrolled		Full-time	
* Are you a transfer student (i.e., Did you transfer from another academic institution to the institution that is nominating you for a Goldwater scholarship?)		No	
* Field of study		Physics and Astronomy	
Physics and Astronomy areas of specialization		Theoretical Physics	
Period through the end of which you will be reporting your GPA		Fall 2021	
* Official cumulative unweighted GPA through the period reported above		3.68	
* How many credit hours does your school require for graduation?		120	
* How many credit hours will you achieve as of January 1, 2022?		133	
* How many credit hours do you plan to achieve for graduation?		179	
* Expected baccalaureate graduation month		05	
* Expected baccalaureate graduation year		2023	
* According to the definition provided above, indicate whether you are a sophomore or junior.		Junior	
* Matriculation status at the institution you will be attending during the 2022-2023 academic year		Currently Enrolled	
* Have you been involved in or do you plan to Study Abroad?		No	

Coursework			
	Question		Answer
Current Course 1		Electromagnetism and Electromagnetic Waves	
Course Level		Undergraduate	
Current Course 2		Thermodynamics and Statistical Mechanics	
Course Level		Undergraduate	
Current Course 3		Introduction to Solid State Physics	
Course Level		Undergraduate	
Current Course 4		Introduction to Quantum Mechanics	
Course Level		Undergraduate	
Current Course 5		Geometry and Physics	
Course Level		Graduate	
Current Course 6			
Course Level			
Future Course 1		Subatomic Physics	
Course Level		Undergraduate	
Future Course 2		Undergraduate Research	
Course Level		Undergraduate	
Future Course 3		Senior Thesis	
Course Level		Undergraduate	
Future Course 4		Quantum 2	
Course Level		Undergraduate	
Future Course 5		Atomic Physics	
Course Level		Undergraduate	
Future Course 6			
Course Level			
Course outside of Major 1		Real Analysis	
Course Level		Graduate	
Course outside of Major 2		Abstract Algebra I	
Course Level		Graduate	
Course outside of Major 3		Differential Geometry	
Course Level		Graduate	
Course outside of Major 4		Functional Analysis	
Course Level		Graduate	
Course outside of Major 5		Topology II	
Course Level		Graduate	
Course outside of Major 6		Ordinary Differential Equations	
Course Level		Graduate	

Previous Schools attended

Question	Answer
School Name	University of Arkansas
City	Fayetteville
State	AR
Institution type:	4-year institution
Dates attended	May 2018 to August 2019
Unweighted GPA on a 4.00 scale	4.00
Will you be providing a transcript from this school to your Goldwater Campus Representative?	No
Please explain why you will not be providing a transcript.	I took two summer mathematics classes (multivariable calculus and elementary differential equations) dual-enrollment during high school which are notated on my LSU transcript.

Future Academic plans

Question	Answer
* Is the institution you will be attending for the 2022-2023 academic year the same as your current academic institution?	Yes

Certification and Release

Question	Answer
* Applicant's Signature	Duncan Wilkie

Supporting Documentation

File Type / Description	Description
Essay	essay.pdf