

# The Importance of Algorithmic Explainability in Behavioral Health

---

Colin G. Walsh, MD, MA

Assistant Professor of Biomedical Informatics, Medicine & Psychiatry

Vanderbilt University Medical Center

July 11, 2019

@CWalshMD

[Colin.Walsh@vumc.org](mailto:Colin.Walsh@vumc.org)

No relevant disclosures, financial or otherwise

# Objectives

---

- To highlight the relevance of explainability to behavioral and mental health
- To provide examples of studies to bridge those gaps
- To suggest key topics in this area for discussion

# Background

---

- Today, 123 Americans will die from suicide
- Yearly, 1 in 40 Americans attempt suicide
- 1 in 20 contemplate suicide

## Active-Duty Military Suicides at Record Highs in 2018



Lt. Cmdr. Karen Downer writes a name on a Suicide Awareness Memorial Canvas in honor of Suicide Awareness Month at Naval Hospital Jacksonville, Sept. 10, 2018. (U.S. Navy/Jacob Sippel, Naval Hospital Jacksonville).

# Suicide Risk Stratification and Prediction

**N** NEWSWEEK MAGAZINE

## Machine-Learning Algorithms Can Predict Suicide Risk More Readily Than Clinicians, Study Finds

BY **MATTHEW HUTSON** ON 2/27/17 AT 11:42 AM



By finding useful patterns among dozens or hundreds of risk factors, machine learning algorithms could be better at predicting suicides than humans.

RICHARD WAREHAM FOTOGRAFIE/GETTY

## Predicting Risk of Suicide Attempts Over Time Through Machine Learning

Colin G. Walsh, Jessica D. Ribeiro, Joseph C. Franklin,

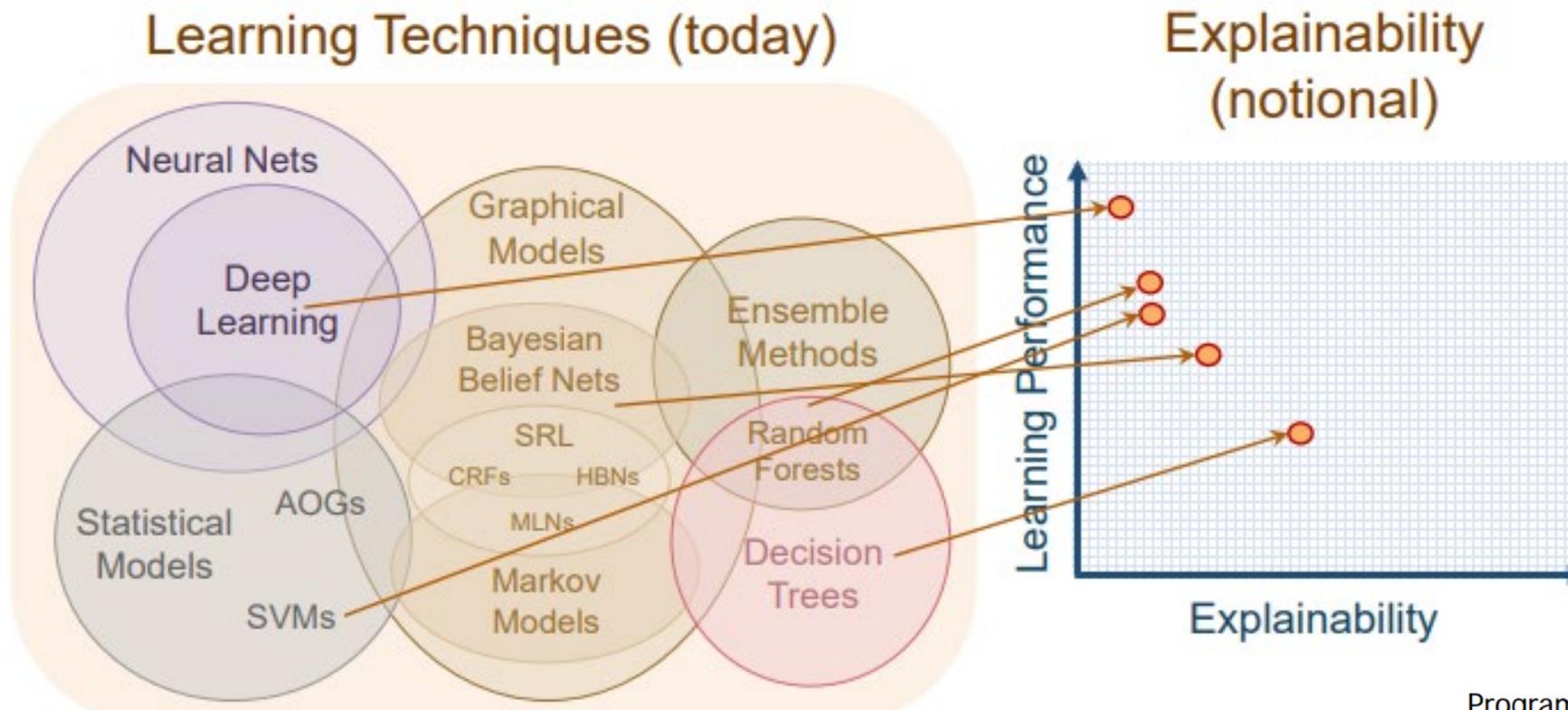
First Published April 11, 2017 | Research Article |

 Check for updates

<https://doi.org/10.1177/2167702617691560>

Machine Intelligence + Routine Healthcare Data

# Explainability and Accuracy



David Gunning  
DARPA/I2O  
Program Update November 2017



# Prediction != Prevention

ART OF INTELLIGENCE

QUARTZ

**Machines know when someone's about to attempt suicide. How should we use that information?**

By Olivia Goldhill • September 5, 2018

# The Why of Explainability

---

- All models are wrong, some are useful\*
- But in behavioral health, errors might lead to:
  - Harm or loss of life
  - Unnecessary treatment or threats to liberty interest
  - Stigma
  - Negative career impacts
  - Loss of trust for both patients and providers

# Predicting Risk of Suicide Attempts Over Time Through Machine Learning

Colin G. Walsh<sup>1,2,3</sup>, Jessica D. Ribeiro<sup>4</sup>, and Joseph C. Franklin<sup>4</sup>

<sup>1</sup>Department of Biomedical Informatics, Vanderbilt University Medical Center; <sup>2</sup>Department of Medicine, Vanderbilt University Medical Center; <sup>3</sup>Department of Psychiatry, Vanderbilt University Medical Center; and <sup>4</sup>Department of Psychology, Florida State University

Clinical Psychological Science  
1–12  
© The Author(s) 2017  
Reprints and permissions:  
sagepub.com/journalsPermissions.nav  
DOI: 10.1177/2167702617691560  
cpx.sagepub.com  


# Protecting Life While Preserving Liberty: Ethical Recommendations for Suicide Prevention With Artificial Intelligence

Lindsey C. McKernan<sup>1,2\*</sup>, Ellen W. Clayton<sup>3,4</sup> and Colin G. Walsh<sup>1,5,6</sup>



PERSPECTIVE  
published: 03 December 2018  
doi: 10.3389/fpsyg.2018.00850

## Arthritis Care & Research

AMERICAN COLLEGE  
of RHEUMATOLOGY  
*Empowering Rheumatology Professionals*

Original Article

## Outpatient Engagement Lowers Predicted Risk of Suicide Attempts in Fibromyalgia

Lindsey C McKernan✉, Matthew C Lenert, Leslie J Crofford, Colin G Walsh

First published: 07 September 2018 | <https://doi.org/10.1002/acr.23748> | Cited by: 1

## The Journal of Child Psychology and Psychiatry

*Journal of Child Psychology and Psychiatry* **59**:4 (2018), pp 661–668

ACAMH  
The Association  
for Child and Adolescent  
Mental Health

doi:10.1111/jcpp.12916

## Predicting suicide attempts in adolescents with longitudinal clinical data and machine learning

Colin G. Walsh,<sup>1</sup>  Jessica D. Ribeiro,<sup>2</sup> and Joseph C. Franklin<sup>2</sup>

<sup>1</sup>Vanderbilt University Medical Center, Nashville, TN; <sup>2</sup>Florida State University, Tallahassee, FL, USA



AMIA Annual Symposium Proceedings

## Balancing Performance and Interpretability: Selecting Features with Bootstrapped Ridge Regression

Matthew C. Lenert, BA and Colin G. Walsh, MD MA

Molecular Psychiatry  
<https://doi.org/10.1038/s41380-018-0326-8>

ARTICLE

## Significant shared heritability underlies suicide attempt and clinically predicted probability of attempting suicide

Douglas M. Ruderfer<sup>1,2</sup> · Colin G. Walsh<sup>2</sup> · Matthew W. Aguirre<sup>3</sup> · Yosuke Tanigawa<sup>3</sup> · Jessica D. Ribeiro<sup>4</sup> · Joseph C. Franklin<sup>4</sup> · Manuel A. Rivas<sup>3</sup>

Received: 4 June 2018 / Revised: 15 September 2018 / Accepted: 12 November 2018  
© The Author(s) 2019. This article is published with open access

# Predicting Risk of Suicide Attempts Over Time Through Machine Learning

Colin G. Walsh<sup>1,2,3</sup>, Jessica D. Ribeiro<sup>4</sup>, and Joseph C. Franklin<sup>4</sup>

<sup>1</sup>Department of Biomedical Informatics, Vanderbilt University Medical Center; <sup>2</sup>Department of Medicine, Vanderbilt University Medical Center; <sup>3</sup>Department of Psychiatry, Vanderbilt University Medical Center; and <sup>4</sup>Department of Psychology, Florida State University

Clinical Psychological Science  
1–12  
© The Author(s) 2017  
Reprints and permissions:  
sagepub.com/journalsPermissions.nav  
DOI: 10.1177/2167702617691560  
cpx.sagepub.com  


# Protecting Life While Preserving Liberty: Ethical Recommendations for Suicide Prevention With Artificial Intelligence

Lindsey C. McKernan<sup>1,2\*</sup>, Ellen W. Clayton<sup>3,4</sup> and Colin G. Walsh<sup>1,5,6</sup>



PERSPECTIVE  
published: 03 December 2018  
doi: 10.3389/fpsyg.2018.00850

## Arthritis Care & Research

AMERICAN COLLEGE  
of RHEUMATOLOGY  
*Empowering Rheumatology Professionals*

Original Article

### Outpatient Engagement Lowers Predicted Risk of Suicide Attempts in Fibromyalgia

Lindsey C McKernan ✉, Matthew C Lenert, Leslie J Crofford, Colin G Walsh

First published: 07 September 2018 | <https://doi.org/10.1002/acr.23748> | Cited by: 1

## The Journal of Child Psychology and Psychiatry

*Journal of Child Psychology and Psychiatry* **59**:4 (2018), pp 666–674

ACAMH  
The Association  
for Child and Adolescent  
Mental Health

doi:10.1111/jcpp.12916

### Predicting suicide attempts in adolescents with longitudinal clinical data and machine learning

Colin G. Walsh,<sup>1</sup> Jessica D. Ribeiro,<sup>2</sup> and Joseph C. Franklin<sup>2</sup>

<sup>1</sup>Vanderbilt University Medical Center, Nashville, TN; <sup>2</sup>Florida State University, Tallahassee, FL, USA



AMIA Annual Symposium Proceedings

### Balancing Performance and Interpretability: Selecting Features with Bootstrapped Ridge Regression

Matthew C. Lenert, BA and Colin G. Walsh, MD MA

Molecular Psychiatry  
<https://doi.org/10.1038/s41380-018-0326-8>

ARTICLE

### Significant shared heritability underlies suicide attempt and clinically predicted probability of attempting suicide

Douglas M. Ruderfer<sup>1,2</sup> · Colin G. Walsh<sup>2</sup> · Matthew W. Aguirre<sup>3</sup> · Yosuke Tanigawa<sup>3</sup> · Jessica D. Ribeiro<sup>4</sup> · Joseph C. Franklin<sup>4</sup> · Manuel A. Rivas<sup>3</sup>

Received: 4 June 2018 / Revised: 15 September 2018 / Accepted: 12 November 2018  
© The Author(s) 2019. This article is published with open access

# From Civilian Risk to Active Duty

---

**Aim 1:** Validate and Update our Models in the U.S. Navy Active Duty Servicemembers

**Aim 2:** Evaluate Clinical Routines and Workflows to Inform CDS

**Aim 3:** Pilot Decision Support and Study Uptake and Behaviors



# Can we see into the algorithm's black box?

---

- 14,000 Vanderbilt patients with Fibromyalgia
- Our predictive algorithms “work” in this group (aka external validation)
- But can we **explain** this performance and might it suggest intervention?

Arthritis Care & Research 

Original Article |  Full Access |

**Outpatient Engagement Lowers Predicted Risk of Suicide Attempts in Fibromyalgia**

Lindsey C McKernan , Matthew C Lenert, Leslie J Crofford, Colin G Walsh

First published: 07 September 2018 | <https://doi-org.proxy.library.vanderbilt.edu/10.1002/acr.23748>



# Can we see into the algorithm's black box?

- Protective Factors Driven by Outpatient Care and Medication Prescription
- Time-Based Utilization Analysis

<1 h

50 h

## Possible Intervention

Arthritis Care & Research 

Original Article | [Full Access](#)

**Outpatient Engagement Lowers Predicted Risk of Suicide Attempts in Fibromyalgia**

Lindsey C McKernan , Matthew C Lenert, Leslie J Crofford, Colin G Walsh

First published: 07 September 2018 | <https://doi-org.proxy.library.vanderbilt.edu/10.1002/acr.23748>



Theme	BoLASSO	mRMR	BoRIDGE	Factor Type
<b>Demographics</b>				
Race	X	X	X	Risk for Caucasians
Gender		X	X	Risk for Men
Age	X	X	X	Protective
Area Deprivation Index		X		Risk for Low-Income
<b>Behavioral Comorbidities</b>				
Substance Abuse		X	X	Risk
History of Mental Illness	X	X	X	Risk
Prior Poisoning	X	X	X	Risk
Absence of Prior Self-Inflicted Trauma		X		Protective
Absence of Behavioral Medication		X	X	Protective
Presence of Behavioral Medication		X		Risk
<b>Physical Comorbidities</b>				
Cardiac Conditions		X	X	Protective
Endocrinological Conditions			X	Protective
Hematologic Conditions			X	Protective
Vascular Conditions	X	X	X	Protective
<b>Healthcare Utilization</b>				
Inpatient Utilization	X	X	X	Risk
Emergency Room Utilization	X	X		Risk
Outpatient Utilization		X		Risk

## Balancing Performance and Interpretability: Selecting Features with Bootstrapped Ridge Regression

[Matthew C. Lenert](#), BA<sup>1</sup> and [Colin G. Walsh](#), MD MA (Primary Advisor)<sup>2</sup>

[AMIA Annu Symp Proc.](#) 2018; 2018: 1377–1386.

Published online 2018 Dec 5.

PMCID: PMC6371276

PMID: [30815182](#)



# Explainability and the “Five Rights”

---

- the right **information**,
- to the right **person**,
- in the right intervention **format**,
- through the right **channel**,
- at the right time in **workflow**.

# Open Questions and Gaps

---

- Explainable does not equal Actionable
- When does Explainability matter most? When might it not matter?
- Interpretability of an algorithm is not the same as insights about an individual
- Explainability is not causality

# Acknowledgements

---

## **Walsh Lab**

- Matthew Lenert, Michael Ripperger, Malia Latimer, Chris Puchi, Henning Ander, Lina Sulieman, Rachel Smith, Wilmer Comstock, Ioana Danciu

## **VUMC Collaborators and Mentors**

- Lindsey McKernan, Leslie Crofford, Laurie Novak, Christopher Simpson, Carrie Reale, Elliot Fielstein
- Stephan Heckers, Jameson Norton
- Bill Stead, Chris Lindsell, Kevin Johnson

## **FSU Collaborators**

- Joseph Franklin, Jessica Ribeiro

# Acknowledgements

---

## **Funding Sources**

W81XWH-10-2-0181

Evelyn Selby Stead Center for Innovation Fund

R01 LM010685-09S1

R01 MH116269

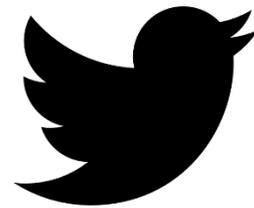
R01 MH118233

# Contact Information

---



[Colin.Walsh@vumc.org](mailto:Colin.Walsh@vumc.org)



@CWalshMD



[www.walshscience.com](http://www.walshscience.com)

VANDERBILT  UNIVERSITY  
MEDICAL CENTER